Dr. MAHALINGAM
MCET
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds Estd. 1998
An Autonomous Institution
(Since 2011)

Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Affiliated to Anna University, Chennai; Approved by AICTE ; Accredited by NAAC with Grade 'A++'
Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)
Udumalai Road, Pollachi - 642 003 Tel: 04259-236030/40/50 Fax: 04259-236070 www.mcet.in

Curriculum and Syllabi

M.E. Embedded System Technologies

Semesters I to IV

Regulations 2019

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Electrical & Electronics Engineering

Vision

We develop globally competent Electrical and Electronics Engineer to solve real time problems of the industry and society and conduct research for the application of knowledge to the society

Mission:

In order to foster growth and empowerment, we commit ourselves to

- Develop electrical and electronics engineers of high caliber to meet the expectations of industries through effective teaching-learning process
- Improve career opportunities in core areas of electrical and electronics engineering.
- Inculcate leadership qualities with ethical and social responsibilities

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Programme: M.E. Embedded System Technologies

Programme Educational Objectives (PEOs) - Regulation 2019

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Develop solutions to real world problems in the frontier areas of Embedded System.

PEO2. Adapt to the latest trends in technology through self-learning and to pursue research to meet out the demands in industries and Academia.

PEO3. Exhibit leadership skills and enhance their abilities through lifelong learning.

Programme Outcomes (POs) - Regulations 2019

On successful completion of the programme the graduates will be able to:

PO1 Carry out research /investigation and development work independently in solving practical problems.

PO2 Write and present a substantial technical report/document.

PO3 Demonstrate a degree of mastery over the area of embedded system technologies.

PO4 Practice professional ethics in multidisciplinary environment with a desire for life-long learning

Programme Specific Outcomes (PSOs) - Regulations 2019

On successful completion of the programme the graduates will be able to:

PSO 1. Evaluate the design and provide optimal solutions to problem areas in embedded systems technologies.

PSO2. Develop electronic systems using modern engineering hardware and software tools.

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Programme Coordinator

Head of the Department

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Programme: M.E EMBEDDED SYSTEM TECHNOLOGIES

2019 REGULATIONS

Curriculum for Semester I to IV

Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19ESCN1101	Microcontroller and RISC Processor Architecture	3	0	0	3	100	-
19ESCN1102	Design of Embedded Systems	3	0	0	3	100	-
XXXXXXXXX	Professional Elective-I	3	0	0	3	100	-
XXXXXXXXX	Professional Elective-II	3	0	0	3	100	-
19COFG1101	Research Methodology and IPR	3	0	0	3	100	All
19ESCN3101	Embedded system lab - I	0	0	4	2	100	-
19ESCN3102	Embedded system lab - II	0	0	4	2	100	-
19SHAG1101	English for Research Paper Writing	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

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Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19ESCN1201	Real Time Operating System	3	0	0	3	100	
19ESCN1202	Embedded Networking and Automation of Electrical System	3	0	0	3	100	
19ESCN1203	Embedded Linux	3	0	0	3	100	
XXXXXXXX	Professional Elective-III	3	0	0	3	100	
XXXXXXXX	Professional Elective-IV	3	0	0	3	100	
19ESCN3201	Embedded system lab - III	0	0	4	2	100	
19ESPN3202	Mini Project with Seminar	0	0	4	2	100	
19SHAG1201	Teaching and Learning in Engineering	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
XXXXXXXXXX	Professional Elective – V	3	0	0	3	100	-
XXXXXXXXXX	Open Elective	3	0	0	3	100	-
19ESPN5301	Project – I	0	0	20	10	200	-
Total		**6**	**0**	**20**	**16**	**400**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19ESPN5401	Project – II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 70

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Professional Elective-I

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19ESEN1101	Advanced Digital System Design	3	0	0	3	100
19ESEN1102	Software for Embedded Systems	3	0	0	3	100
19ESEN1103	Advanced Digital SignalProcessing Methods	3	0	0	3	100
19SHEN1101	Applied Mathematics for Electrical Engineers	2	1	0	3	100

Professional Elective-II

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19ESEN1104	Automotive Embedded System	3	0	0	3	100
19ESEN1105	Embedded Computing	3	0	0	3	100
19ESEN1106	Intelligent Controllers	3	0	0	3	100

Professional Elective-III

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19ESEN1201	VLSI Design and Architecture	3	0	0	3	100
19ESEN1202	MEMS Technology	3	0	0	3	100
19ESEN1203	Smart System Design	3	0	0	3	100

Professional Elective-IV

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19ESEN1204	Machine Learning	3	0	0	3	100
19ESEN1205	Robotics and Automation	3	0	0	3	100
19ESEN1206	SCADA System and ApplicationsManagement	3	0	0	3	100

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Professional Elective-V

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19ESEN1301	IoT for smart systems	3	0	0	3	100
19ESEN1302	Embedded Product Development	3	0	0	3	100
19ESEN1303	Open Source Software	3	0	0	3	100

Open Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19ESOC1301	Digital Image Processing	3	0	0	3	100
19ESOC1302	Energy Management and Economics	3	0	0	3	100

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Detailed Syllabi for Semesters I to IV

Semester I

Course Code: 19ESCN1101	Course Title: Microcontroller and RISC Processor Architecture		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Impart the architecture of PIC Microcontroller and RISC processor.
2. Compare the architecture and programming of 8, 16, 32 bits RISC processor.
3. Impart the implementation of DSP in ARM processor.
4. Discuss on memory management, application development in RISC Processor.
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processor

Unit I PIC Microcontroller **9 Hours**

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 Hours**

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 Hours**

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 Hours**

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 Hours**

PIC implementation - Generation of Gate signals for converters and Inverters - Motor Control –

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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.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basics and requirement of processor functional blocks.	Understand
CO2: Describe the specialty of RISC processor Architecture.	Understand
CO3: Explain the I/O hardware interface of a processor based automation for consumer application with peripherals.	Understand
CO4: Incorporate I/O software interface of a processor with peripherals.	Apply
CO5:Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processor	Apply

Reference Book(s):

1. Steve Furber, 'ARM system on chip architecture', Addision Wesley,2010.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield 'ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2007.
3. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ' PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education 2008
4. John Iovine, 'PIC Microcontroller Project Book ', McGraw Hill 2000
5. William Hohl, ' ARM Assebly Language' Fundamentals and Techniques,2009
6. Rajkamal, "Microcontrollers Architecture, Programming, Interfacing,& System Design,Pearson,2012

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Course Code: 19ESCN1102	Course Title: Design of Embedded Systems		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Provide knowledge on the basics, building blocks of Embedded System
2. Discuss Input/output Interfacing & Bus Communication with processors
3. Describe aboutautomation using scheduling algorithms and Real time operating system
4. Discuss on different Phases & Modeling of a new embedded product
5. Design embedded consumer product based on phases of product development

Unit I Introduction to Embedded Systems **9 Hours**

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

Unit II Embedded Networking by Processors **9 Hours**

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 Hours**

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,

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Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: VxWorks, uC/OS-II, RT Linux.

Unit IV Modeling with Hardware/Software Design Approaches **9 Hours**

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- Co Synthesis- features comparing Single-processor Architectures & Multi-Processor Architectures--design approach on parallelism in uni processors & Multiprocessors.

UNIT V Embedded System Application Development **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the functionalities of processor internal blocks, with their Requirement.	Understand
CO2: Observe that Bus standards are chosen based on interface overheads without sacrificing processor performance	Understand
CO3: Summarize the role and features of RT operating system, that makes multitask execution possible by processors.	Understand
CO4: Show that using multiple CPU based on either hardcore or soft-core helps data overhead management with processing- speed reduction for microcontroller execution.	Understand
CO5: Design Embedded consumer product based on phases of product development.	Apply

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Reference Book(s):

1. Rajkamal, 'Embedded system-Architecture, Programming, Design', TMH,2011.
2. Peckol, "Embedded system Design",John Wiley&Sons,2010
3. Lyla B Das," Embedded Systems-An Integrated Approach",Pearson2013
4. Elicia White," Making Embedded Systems",O'ReillySeries,SPD,2011
5. BrucePowelDouglass,"Real-Time UML Workshop for Embedded Systems, Elsevier, 2011
6. Advanced Computer architecture , By Rajiv Chopra, S Chand ,2010
7. Jorgen Staunstrup,Wayne Wolf, Hardware/Software Co-Design Principles and Practice, Springer,2009.

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Course Code: 19COFG1101	Course Title: Research Methodology and IPR		
Course Category: Foundation Course		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Describe the overview of research methodology
2. Explain the attitude measurements, scales and sampling methods
3. Apply hypotheses testing in research problem
4. Elucidate the research report writing and presentation effectively
5. Apply patent and copyright for their innovative works

Unit I Overview of Research Methodology **9 Hours**

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process.

Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

Unit II Attitude measurements, Scales and Sampling methods **9 Hours**

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method – convenience sampling, judgment sampling, quota sampling.

Unit III Hypotheses testing **9 Hours**

Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests)

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Unit IV **Report Writing and Presentation** **9 Hours**

Report writing- Types of report, guidelines to review report, typing instructions, oral presentation

Unit V **Patenting** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1. Describe the overview of research methodology	Understand
CO 2. Explain the attitude measurements, scales and sampling methods	Understand
CO 3. Apply hypotheses testing in research problem	Apply
CO 4. Elucidate the research report writing and presentation effectively	Understand
CO 5: Apply patent and copyright for their innovative works	Apply

Reference Book(s):

1. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.
2. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications ,2007.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", Clause 8 Publishing, 2016.
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008.

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Course Code: 19ESCN3101	Course Title: Embedded System Lab - I		
Course Category: Professional Core		Course Level: Practice	
L:T:P 0: 0: 4	Credits: 2	Total Contact Hours: 60	Max. Marks:100

Course Objectives

The course is intended to:

1. Involve the students to practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
2. Explainthe concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
3. Encourage students to practice in open source software / packages /tools
4. Impart hands-on practices in commercial and licensed Hardware-software suites
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in interfacing and use of commercial embedded processors

List of Experiments

1. Interface matrix keyboard with microcontroller and display the key pressed on seven segment display
2. Program to read analog voltage applied at the input and display.
3. Program to generate a PWM waveform.
4. Interfacing LCD
5. Analog sensor interfacing
6. Serial communication
7. Motor control applications
8. Traffic control system
9. Modeling Microwave Oven
10. PWM based motor Control

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop program for embedded processors of CISC and RISC architecture / computational processors with peripheral interface.	Apply
CO2: Experiment with the microcontroller based system for motor control application.	Apply
CO3: Experiment with the system to monitor the temperature using analog sensors	Apply
CO4: Develop the system to control the home appliances using serial communication.	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in interfacing and use of commercial embedded processors	Apply

Reference Book(s):

1. Mohamammad Ali Mazidi & Mazidi ' 8051 Microcontroller and Embedded Systems', Pearson Education
2. Mohammad Ali Mazidi, Rolind Mckinley and Danny Causey, 'PIC Microcontroller and Embedded Systems' Pearson Education,2008.
3. Simon Monk," Make Action-with Arduino and Raspberry Pi,SPD ,2016
4. Wesley J.Chun,"Core Python Applications Programming,3rd Edition,Pearson,2016

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Course Code: 19ESCN3102	Course Title: Embedded system lab - II		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 0: 0: 4	Credits: 2	Total Contact Hours: 60	Max. Marks:100

Course Objectives

The course is intended to:

1. Involve the students to Practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
2. Explain the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
3. Encourage students to practice in open source softwares / packages /tools
4. Impart hands-on practices in commercial and licensed Hardware-software suites
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in interfacing and use of commercial embedded processors

List of Experiments

1. Programming in Higher Level Languages/ Platforms
2. Programming with Arduino Microcontroller Board: Study on In circuit Emulators, cross compilers, debuggers
3. VHDL Programming in FPGA processors
4. Programming & Simulation in Simulators/Tools/others-Simulation-Tools as Proteus/ ORCAD
5. Programming & Simulation in Simulators /Tools/others- Simulation Tools as MATLAB /others

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Construct the optimized code for embedded processor	Apply
CO2: Develop the VHDL programming for FPGA processor	Apply
CO3: Design the circuit to develop solution for embedded based applications using system level simulators.	Apply
CO4: Design the I/O software interface of a processor with peripherals.	Apply
CO5: Improve Employability and entrepreneurship capacity due to knowledge up gradation on Embedded computing and algorithm development with programming concepts.	Apply

Reference Book(s):

1. Simon Monk," Make Action-with Arduino and Raspberry Pi,SPD ,2016.
2. Wesley J.Chun,"Core Python Applications Programming,3rd ed,Pearson,2016
3. VinayK.Ingle,John G.Proakis,"DSP-A Matlab Based Approach",Cengage Learning,2010
4. Taan S.Elali,"Discrete Systems and Digital Signal Processing with Matlab",CRC Press 2009
5. Jovitha Jerome, "Virtual Instrumentation using Labview"PHI,2010.

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Course Code:19SHAG1101	Course Title: English for Research Paper Writing (common to all PG Programmes)	
Course Category: Audit Course	Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Credits:-	Total Contact Hours:30	Max Marks:100

Course Objectives

The course is intended to:

1.Describe how to improve the writing skills and level of readability

2.Apply research writing skills in each section

3.Explain the skills needed when writing titles

Unit I **Research Plan and Preparatory Tools** **10 Hours**

Plan - Word Order - Break up long sentences - Paragraph and Sentence Structures - Concise and Remove Redundancy - Avoid Ambiguity and Vagueness - Preparation

Unit II **Grammar for Research** **10 Hours**

Expand the vocabulary & phrases – Grammar & punctuation - Ensure the content - Review of the Literature - Conclusions

Unit III **Key Skills for Preparation** **10 Hours**

Clarify Who Did What – Highlight the Findings - Hedge and Criticise - Paraphrase - Check Plagiarism - Sections of a Paper - Abstracts –Introduction - Key skills needed when writing - a Title, an Abstract, an Introduction, a Review of the Literature, Methods, Results, Discussion, Conclusions

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe how to improve the writing skills and level of readability	Understand
CO 2: Apply research writing skills in each section	Apply
CO 3: Use the skills needed when writing titles	Apply

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Reference Book(s):

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

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SEMESTER II

Course Code: :19ESCN1201	Course Title: Real Time Operating System		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Expose the students to the fundamentals of interaction of OS with a computer and User computation.
2. Explainthe fundamental concepts of how process are created and controlled with OS.
3. Explain the programming logic of modeling Process based on range of OS features
4. Compare types and Functionalities in commercial OS, application development using RTOS
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design.

Unit I **Review of Operating Systems** **9 Hours**

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 Hours**

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 Hours**

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

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Unit IV **Real-time Kernel** **9 Hours**

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 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain theoperating system structures and types.	Understand
CO2: Insight into scheduling, disciplining of various processes execution.	Understand
CO3: Describe the various RTOS support modelling	Understand
CO4: Explain the commercial RTOS Suite features to work on real time Processes design	Understand
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design	Apply

Reference Book(s):

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

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Course Code: 19ESCN1202	Course Title: Embedded Networking and Automation of Electrical System		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. 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. Discuss networking configuration to develop PAN.
5. Discuss the functions of digital instrument Power quality monitoring.

Unit I Building System Automation **9 Hours**

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

Unit II Embedded Networking of Instrument Cluster **9 Hours**

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

Unit III Automation of Substation **9 Hours**

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

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electric utility asset .

Unit IV Metering of Smart Grid **9 Hours**

Characteristics of Smart Grid- Generation by Renewable Energy Sources based on solar grid- Challenges in Smart Grid and Micro grids- 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 Hours**

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.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the different type of sensors and components to build meters.	Understand
CO2: Describe different type of BUS communication protocols	Understand
CO3: Analyze the need and standards in Substation automation	Analyze
CO4: Deploy PAN for metering networked commercial applications	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications	Apply

Reference Book(s):

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

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3. Robert Faludi,"Building Wireless Sensor Networks,O'Reilly,2011
4. Mohammad Ilyas And Imad Mahgoub, 'Handbook of sensor Networks: Compact wireless and wired sensing systems', CRC Press,2005
5. Sanjay Gupta, "Virtual Instrumentation, LABVIEW", TMH, New Delhi, 2003
6. Ernest O. Doeblin and Dhanesh N Manik, " Measrement Systems – Application and Design", 5thEdition, TMH, 2007
7. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005

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Course Code: 19ESCN1203	Course Title: Embedded Linux		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Impart knowledge about Linux Operating System
2. Expose the students to the fundamentals of Linux Operating system and its basic commands.
3. Explain about the various Linux distributions and running them on a typical Embedded Board.
4. Elucidate the details of various Embedded Boards and programming them.
5. Give an introduction to Linux Device Drivers

Unit I Linux Fundamentals **9 Hours**

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

Unit II Cross-Development Tool chain **9 Hours**

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

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Unit III **Running Linux on Embedded Boards** **9 Hours**

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

Unit IV **Cross-Compilation and Interfacing to the Raspberry Pi Busses** **9 Hours**

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

Unit V **Introduction to Linux Device Drivers** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the Linux fundamentals and its commands	Understand
CO2: Differentiate Embedded Linux from its Desktop counterpart and its internals	Understand
CO3: Develop the Linux program on an Embedded Board, Use Eclipse IDE for Cross- compilation	Apply
CO4: Construct a simple device driver in Linux	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded Linux skills	Apply

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Reference Book(s):

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

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Course Code: 19ESCN3201	Course Title: Embedded System Lab - III		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 0: 0: 4	Credits: 2	Total Contact Hours: 60	Max. Marks:100

Course Objectives

The course is intended to:

1. Practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
2. Clarify the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
3. Practice in open source softwares / packages /tools
4. Impart hands-on practices in commercial and licensed Hardware-software suites
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors and its programmable interfacing

List of Experiments

1. ARM7 / ARM9/ARM Cortex: Study on Incircuit Emulators, cross compilers, debuggers
2. I/O Programming with ARM processor : ARM7 / ARM9/ARM Cortex Microcontrollers
3. I/O Interfacing : Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing
4. Programming with Rasberry Pi Microcontroller Board: Study on in circuit Emulators, cross compilers, debuggers
5. I/O Programming with Arduino ,Rasberry Pi Microcontroller Boards I/O Interfacing : Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing / IoT Applications
6. Programming with DSP processors
7. Study of one type of Real Time Operating Systems (RTOS)
8. Smart System Design using Embedded HW/SW modules

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design with simulators/ experiments, in programming processor boards, processor interfacing/ designing digital controllers.	Apply
CO2: Design & simulation of Arithmetic ,Logic programs, Filters, Signal analysis with simulators/experiments ,in programming processor boards, processor interfacing/ Tools	Apply
CO3: Develop real time solution for embedded applications	Apply
CO4: Construct the program and compile in various tools & software domains	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors and its programmable interfacing	Apply

Reference Book(s):

1. Simon Monk," Make Action-with Arduino and Raspberry Pi,SPD ,2016.
2. Wesley J.Chun,"Core Python Applications Programming,3rd ed,Pearson,2016
3. KraigMitzner, 'Complete PCB Design using ORCAD Capture and Layout', Elsevier
4. VinayK.Ingle,John G.Proakis,"DSP-A Matlab Based Approach",Cengage Learning,2010
5. Taan S.Elali,"Discrete Systems and Digital Signal Processing with Matlab",CRC Press2009.

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Course Code:19SHAG1201	Course Title: Teaching and Learning in Engineering (common to all PG Programmes)	
Course Category: Humanities	Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Total Contact Hours: 30	Max Marks:100

Course Objectives

The course is intended to:

1. Use Outcome based approach in teaching courses
2. Conduct lecture/practical/tutorial sessions using active learning methods
3. Conduct higher order assessments by using rubrics

Unit 1 Outcome Based Approach **10 Hours**

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy.

Unit 2 Active Learning Methods **10 Hours**

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods.

Unit 3 Assessments **10 Hours**

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use outcome based approach in teaching courses in engineering Programmes	Apply
CO 2: Conduct lecture/practical/tutorial sessions using active learning methods	Apply
CO 3: Conduct higher order assessments by using rubrics	Apply

Reference Book(s):

1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.
2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.
3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc

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Professional Elective-I

Course Code: 19ESEN1101	Course Title: Advanced Digital Systems Design		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Expose the fundamentals of sequential system design, Asynchronous circuits and switching errors.
2. Study on Fault identification in digital switching circuits
3. Introduce logics for design of programmable devices
4. Clarify the fundamentals of modeling through comparative study on the classification of commercial family of programmable device
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on digital circuits design, testing and programming of reconfigurable digital logic processors.

Unit I **Sequential Circuit Design** **9 Hours**

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

Unit II **Asynchronous Sequential Circuit Design** **9 Hours**

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

Unit III **Fault Diagnosis and Testability Algorithms** **9 Hours**

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

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Unit IV Synchronous Design using Programmable Devices **9 Hours**

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

Unit V Architectures and Programming Programmable Logic Devices **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the synchronous switching logics, with clocked circuits design	Understand
CO2: Explain the asynchronous switching logics, with clocked circuits design	Understand
CO3: Write the testing algorithms and fault diagnostic techniques for digital systems	Apply
CO4: Design of computation logics of processors using IEEE standard Software Emulator on reconfigurable device like FPGAs	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on digital circuits design, testing and programming of reconfigurable digital logic processors.	Apply

Reference Book(s):

1. Donald G. Givone, "Digital principles and Design", Tata McGraw Hill2002.
2. R.C.Cofer,Benjamin F.Harding, "Rapid System Prototyping with FPGAs: Accelerating the Design Process" , Elsevier,2006.
3. CharlesH.RothJr.,"DigitalSystemsdesignusingVHDL",CengageLearning, 2010.

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4. Mark Zwolinski, "Digital System Design with VHDL", Pearson
5. Parag K Lala, "Digital System design using PLD", BS Publications,2003
6. John M Yarbrough, "Digital Logic applications and Design", Thomson Learning,2001
7. Nripendra N Biswas, "Logic Design Theory", Prentice Hall of India,2001
8. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning,2004.
9. John V. Oldfeild, Richard C.Dorf, "Field Programmable Gate Arrays", Wiley India Edition,2008

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Course Code: 19ESEN1102	Course Title: Software for Embedded Systems		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Expose the fundamentals of embedded Programming
2. Introduce the GNU C Programming Tool Chain in Linux.
3. Study the basic concepts of embedded C.
4. Clarify the basics of Python Programming
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.

Unit I Basic C Programming **9 Hours**

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 Hours**

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 Hours**

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 Hours**

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

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Unit V **Modules, Packages and Libraries In Python** **9 Hours**

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.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Construct the C programming for embedded systems	Apply
CO2: Explain the various programming languages/software compatible to embedded process development with improved design & programming skills.	Understand
CO3: Develop the knowledge on C programming in Linux environment.	Apply
CO4: Develop python programming for Embedded applications.	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.	Apply

Reference Book(s):

1. Paul Deitel and Harvey Deitel, "C How to Program", 8th Edition, Pearson Education Limited, 2016.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006
4. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.
5. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.
6. Fabrizio Romano, "Learn Python Programming", Second Edition, Packt Publishing, 2018.
7. John Paul Mueller, "Beginning Programming with Python for Dummies", 2nd Edition, John Wiley & Sons Inc., 2018.

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Course Code: 19ESEN1103	Course Title: Advanced Digital Signal Processing Methods		
Course Category:Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Expose the fundamentals of digital signal processing in frequency domain& its application
2. Explain the fundamentals of digital signal processing in time-frequency domain& its application
3. Describe the fundamentals of audio signal processing & its application
4. Discuss on Application development with commercial family of DS Processors
5. Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in signal processing for embedded systems design.

Unit I Introduction to Digital Signal Processing **6 Hours**

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

Unit II Wavelet Transform **9 Hours**

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

Unit III Audio Signal Processing **12 Hours**

Introduction to Speech and Audio Processing - Speech Signal Processing- Pitch-period

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

Unit IV Architectures of Commercial Digital Signal Processors 12 Hours

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

Unit V Implementation of DSP Based Systems 6 Hours

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of Time and frequency analysis of Signal Transforms based on signal types.	Understand
CO2: Describe the fundamentals of Time-Frequency Transforms.	Understand
CO3: Analyze the quality and properties of speech based on DSP	Apply
CO4: Explain the features through comparison on commercial available DSP Processors	Understand
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in signal processing for embedded systems design.	Apply

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Reference Book(s):

1. John G. Proaks, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education 2002.
2. VinayK.Ingle,John G.Proakis,"DSP-A MATLAB Based Approach",Cengage Learning,2010
3. Taan S.Elali,"Discrete Systems and Digital Signal Processing with MATLAB" ,CRC Press2009.
4. Sen M.Kuo and Woon-Seng S. Gan, Digital Signal Processors-Architectures, implementation and applications", Pearson Education 2008.
4. Avatar Sing, S. Srinivasan, "Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx", Thomson India,2004.
5. Ashok Ambardar," Digital Signal Processing: A Modern Introduction", Thomson India edition, 2007.

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Course Code: 19SHEN1101	Course Title: Applied Mathematics for Electrical Engineers		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 2: 1: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Develop the ability to apply the concepts of Matrix theory in Electrical Engineering problems.
2. Familiarize the concept of calculus of variations.
3. Achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems.
4. Formulate and solve linear programming problems.
5. Solve engineering problems using Fourier series

Unit I Matrix Theory **9 Hours**

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

Unit II Calculus of Variations **9 Hours**

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

Unit III One Dimensional Random Variables **9 Hours**

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

Unit IV Linear Programming **9 Hours**

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

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Unit V Fourier Series **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply the concepts of Matrix theory in Electrical Engineering problems.	Apply
CO2: Use calculus of variation techniques to solve various engineering problems.	Apply
CO3: Solve electrical engineering problems involving one-dimensional random variables.	Apply
CO4: Formulate and solve linear programming problems in electrical engineering.	Apply
CO5: Solve engineering problems using Fourier series techniques.	Apply

Reference Book(s):

1. Andrews L.C. and Phillips R.L., Mathematical Techniques for Engineers and Scientists, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
2. Elsgolts, L., Differential Equations and the Calculus of Variations, MIR Publishers, Moscow, 2003.
3. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 44th Edition, New Delhi, 2017.
4. Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India
5. Johnson R. A. and Gupta C. B., "Miller & Freund's Probability and Statistics for Engineers" Pearson Education, 8th Edition, New Delhi, 2015.

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6. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Processes, Academic Press, (An imprint of Elsevier), Boston, 2014.
7. O'Neil, P.V., Advanced Engineering Mathematics, Thomson Asia Pvt. Ltd., 8th Edition, Singapore, 2017.
8. Richard Bronson, "Matrix Operation", Schaum's outline series, McGraw Hill, 2nd Edition, New York, 2011
9. Taha, H.A., "Operations Research, An introduction", Pearson education, 10th Edition, New Delhi, 2017.

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Professional Elective-II

Course Code: 19ESEN1104		Course Title: Automotive Embedded System	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Explain the fundamentals and building of Electronic Engine Control systems.
2. Explain on functional components and circuits for vehicles
3. Discuss on programmable controllers for vehicles management systems
4. Explain logics of automation & commercial techniques for vehicle communication
5. Introduce the embedded systems concepts for E-vehicle system development.

Unit I Basic of Electronic Engine Control Systems **9 Hours**

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

Unit II Sensors and Actuators for Automotives **9 Hours**

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

Unit III Vehicle Management Systems **9 Hours**

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

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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 Hours**

On board diagnosis of vehicles -System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications- Navigation- Connected Cars technology – Tracking- Security for data communication- dashboard display and Virtual Instrumentation, multimedia electronics- role of IoT in automotive systems

Unit V Electric Vehicles **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the significance of embedded system for automotive Applications	Understand
CO2: Explain the need, selection of sensors and actuators and interfacing with ECU	Understand
CO3: Apply the Embedded concepts for vehicle management and control Systems	Apply
CO4: Apply the embedded system technology for various aspects of EVs	Apply
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.	Apply

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Unit V **Developing Distributed Real-Time System Applications** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the process delivers insight and internet based communication to establish decentralized control mechanism of system	Understand
CO2: Describe the software and hardware architecture for distributed computing	Understand
CO3: Develop solution for smart card	Apply
CO4: Develop Apps based on android SDK.	Apply
CO5: Improve Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system computing environment.	Apply

Reference Book(s):

1. Amitava Gupta, Anil Kumar Chandra and Peter Luksch "Real-Time and Distributed Real- Time Systems Theory and Applications " CRC Press 2016 International Standard Book Number-13: 978-1-4665-9849-2 (eBook -PDF)
2. Wolfgang Rankl and Wolfgang Effing "Smart Card Handbook" John Wiley & Sons Ltd, 3rd Edition ,2003
3. Reto Meier "Professional Android application development" Wiley Publishing ,Inc ,2009.
4. Joshua " Android hacker's Handbook" John Wiley & sons ,2014
5. Sape Mullender, "Distributed Systems", Addison-Wesley,1993
6. Dietel & Dietel, "JAVA how to program", Prentice Hall1999.

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Course Code: 19ESEN1106	Course Title: Intelligent Controllers		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

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

Unit I Overview of Artificial Neural Network(Ann)&Fuzzy Logic **9 Hours**

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

Unit II Neural Networks for Modeling and Control **9 Hours**

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

Unit III Fuzzy Logic for Modeling and Control **9 Hours**

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

Unit IV Genetic Algorithm **9 Hours**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters.

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Solution of typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization.

UNIT V Hybrid Control Schemes **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic architectures of NN and Fuzzy sets	Understand
CO2: Design and implement ANN architectures, algorithms and know their limitations.	Apply
CO3: Identify and work with different operations on the fuzzy sets.	Apply
CO4:Develop ANN and fuzzy logic based models and control schemes for non-linear systems	Apply
CO5: Describe the hybrid control schemes and PSO	Understand

Reference Book(s):

1. LaureneV.Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms and Applications", Pearson Education,2008.
2. TimothyJ.Ross, "Fuzzy Logic with Engineering Applications",Wiley,3rd Edition, 2010.
3. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education,2009.
4. W.T.Miller,R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.

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Professional Elective-III

Course Code:19ESEN1201	Course Title: VLSI Design and Architecture		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Understand the basic concepts of VLSI and CMOS design.
2. Introduce the IC fabrication methods
3. Study the architectures of various RPLDs.
4. Introduce the basics of analog VLSI design and its importance.
5. Learn about programming of programmable device using hardware description Language.

Unit I CMOS Design **9 Hours**

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

Unit II IC Fabrication **9 Hours**

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

Unit III Programmable Logic Devices and ASIC Design **9 Hours**

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

Unit IV Analog VLSI Design **9 Hours**

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

Unit V HDL Programming **9 Hours**

Overview of digital design with HDL, structural, data flow and behavioral modeling- logic

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synthesis-simulation-Combinational and Sequential logic design examples, Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Test Bench

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the learning process of developing CMOS design techniques and development of low power VLSI logic circuits.	Understand
CO2: Insight into IC fabrication methods.	Understand
CO3: Improved skill set in RPLD/SOC usage for real time applications.	Understand
CO4: Design of reprogrammable analog devices and its usage for embedded applications.	Apply
CO5: Explain the usage of HDL computational processes with improved design strategies.	Understand

Reference Book(s):

1. M.J.SSmith,"ApplicationSpecificintegratedcircuits",Addition Wesley LongmanInc.1997
2. Kamran E shraghian,Douglas A.Pucknell and Sholeh Eshraghian, "Essentials of VLSI circuits and system", Prentice Hall India,2005.
3. Wayne Wolf, "Modern VLSI design " Prentice HallIndia,2006.
4. MohamedIsmail,TerriFiez,"Analog VLSI Signal and information Processing", McGrawHill International Editions,1994
5. Samir Palnitkar, "VeriLog HDL,-A Design guide to Digital and Synthesis" 2nd Edition,Pearson,2005.
7. Debprasad Das, VLSI Design, Oxford University Press,2010.
8. Zainalatsedin Navabi, 'VHDL Analysis and Modeling of Digital Systems', 2nd Edition,Tata McGraw Hill,1998.

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Course Code:19ESEN1202	Course Title: MEMS Technology		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Introduce the diverse technological and functional approaches of MEMS and applications.
2. Explain the microstructures and fabrication methods.
3. Provide an insight of micro sensors, actuators.
4. Emphasis the need and role of MEMS process techniques.
5. Update the ongoing trends and real time applications of MEMS technology.

Unit I **Introduction to MEMS** **9 Hours**

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

Unit II **Micro-Machining and Micro Fabrication Techniques** **9 Hours**

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

Unit III **Micro Sensors and Micro actuators** **9 Hours**

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

Unit IV **MEMS Process Techniques** **9 Hours**

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

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development.

UNIT V MEMS Application and Recent trends **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the material properties and the significance of MEMS for industrial automation.	Understand
CO2: Describe the knowledge on micromachining and micro fabrication.	Understand
CO3: Apply the fabrication mechanism for MEMS sensor and actuators.	Apply
CO4: Apply the concepts of MEMS to models, simulate and process the sensors and actuators.	Apply
CO5: Improve Employability and entrepreneurship capacity due to knowledge up gradation on MEMS technology.	Apply

Reference Book(s):

1. Chang Liu, "Foundations of MEMS", Pearson International Edition,2006
2. MarcFmadou"Fundamentalsofmicrofabrication, "CRCPress2002 2nd EditionMarc Madou
3. M.H.Bao, "Micro mechanical transducers: Pressure sensors, accelerometers and gyroscopes",Elsevier, Newyork,2000.
4. MalufNadim"An introduction to Micro Electro-mechanical Systems Engineering "ARTech house, Boston2000.
5. Mohamed Gad–el– Hak, "MEMS Handbook" Edited CRC Press 2002
6. MEMS and Microsystems: design, manufacture and Nanoscale...2nd Edition,byTai-. Ran Hsu, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008

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Course Code:19ESEN1203	Course Title: Smart System Design		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Understand about the smart system technologies and its role in real time applications
2. Expose different open source platforms and attributes.
3. Teach the architecture and requirements of Home Automation
4. Provide an insight into smart appliances and energy management concepts.
5. Familiarize the design and development of embedded system based system design

Unit I Introduction **9 Hours**

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

Unit II Mobile Embedded System **9 Hours**

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

Unit III Home Automation **9 Hours**

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

Unit IV Smart Appliances and Energy Management **9 Hours**

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

Unit V Embedded Systems and Robotics **9 Hours**

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Robots and Controllers-components - Aerial Robotics -Mobile Robot Design- Three-ServoAnt Robot- Autonomous Hexacopter System

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of smart system design and its present developments.	Understand
CO2: Explain the different embedded open source and cost effective techniques for developing solution for real time applications.	Understand
CO3: Describe the different platforms and Infrastructure for Smart system design.	Understand
CO4: Explain the smart appliances and energy management concepts	Understand
CO5: Build Employability and entrepreneurship capacity due to knowledge up gradation on embedded system technologies.	Apply

Reference Book(s):

1. Thomas Bräunl, Embedded Robotics,Springer,2003.
2. Grimm,Christoph,Neumann,Peter,MahlknechandStefan,EmbeddedSystemsforSmart Appliances and Energy Management , Springer2013
3. RajKamal,EmbeddedSystemsArchitecture,.ProgrammingandDesign", McGraw-Hill. 2008
4. NilanjanDey,AmartyaMukherjee,EmbeddedSystemsandRoboticswithOpenSource Tools,CRC press,2016
5. KarimYaghmour, Embedded Android , O'Reilly,2013.
6. StevenGoodwin,SmartHomeAutomationwithLinuxandRaspberryPi,Apress,2013
7. C.K.Toh, " AdHoc mobile wireless networks", Prentice Hall, Inc,2002.
8. KazemSohraby,DanielMinoliandTaiebZnati,"WirelessSensorNetworks Technology,Protocols,andApplications",JohnWiley&Sons,2007.
9. AnnaHa´c,"WirelessSensorNetworkDesigns",JohnWiley&SonsLtd,2003.

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Professional Elective-IV

Course Code:19ESEN1204	Course Title: Machine Learning		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 60	Max. Marks:100

Course Objectives

The course is intended to:

1. Study the fundamental concepts and methods for machine learning.
2. Get acquaint with basic learning algorithms and techniques and their applications.
3. Acquire knowledge in processing, analyzing and handling data sets.
4. Demonstrate typical applications of various clustering based learning algorithms
5. Apply Bayesian learning algorithms to solve problems

Unit I Introduction to Machine Learning **12 Hours**

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

Unit II Data Preprocessing **12 Hours**

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

Unit III Supervised Learning **12 Hours**

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

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Unit IV **Clustering and Unsupervised Learning** **12 Hours**

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

Unit V **Bayesian Learning** **12 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Demonstrate the basic theory underlying machine learning.	Understand
CO2: Reveal a range of machine learning algorithms along with their strengths and weaknesses	Apply
CO3: Formulate machine learning problems corresponding to different applications.	Apply
CO4: Apply machine learning algorithms to solve problems of moderate Complexity	Apply
CO5: Apply Bayesian learning algorithms to solve problems	Apply

Reference Book(s):

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2011.
2. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2011
3. Jiawei Han, MichelineKamber, Jian Pei, Data Mining: Concepts and Techniques: Concepts and Techniques, Elsevier, 2011.
4. Ferdinand van der Heijden, Robert Duin, Dick de Ridder, David M. J. Tax, Classification,Parameter Estimation and State Estimation: An Engineering Approach Using MATLAB, John Wiley & Sons, 2005.

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Course Code:19ESEN1205	Course Title: Robotics and Automation		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Teach the need of embedded system technology for robot building
2. Study the various parts of robots and fields of robotics.
3. Study the various kinematics and inverse kinematics of robots.
4. Study the trajectory planning for robot.
5. Study the control of robots for some specific applications.

Unit I **Introduction to Robotics** **9 Hours**

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

Unit II **Power Sources and Sensors** **9 Hours**

Hydraulic, Pneumatic And Electric Drives – Determination Of HP Of Motor And Gearing Ratio – Variable Speed Arrangements – Path Determination – Micro Machines In Robotics – Machine Vision – Ranging – Laser – Acoustic – Magnetic, Fiber Optic And Tactile Sensors-smart sensors

Unit III **Manipulators, Actuators and Grippers** **9 Hours**

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 Hours**

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

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Unit V Case Studies **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Select suitable embedded boards for robots	Understand
CO2: Explain the concepts of robotics & automation and Working of Robot	Understand
CO3: Analyze the Function of Sensors and actuators In the Robot	Analyze
CO4: Construct program to Use a Robot For a Typical Application	Apply
CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge up-gradation on Embedded system based robot development	Apply

Reference Book(s):

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", McGraw-Hill Singapore, 1996.
2. Ghosh,ControlInRoboticsAndAutomation:SensorBasedIntegration,AlliedPublishers, 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. McKerrow P.J. "Introduction To Robotics", Addison Wesley, USA, 1991.

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Course Code:19ESEN1206	Course Title: SCADA System and Applications Management		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Understand the basic concepts and components of SCADA
2. Introduce the SCADA communication protocols
3. Apply the SCADA technology to power systems for automation
4. Provide the knowledge about SCADA based energy management center.
5. Emphasize the role of SCADA monitoring and control concepts

Unit I **Introduction to SCADA** **9 Hours**

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

Unit II **SCADA Communication** **9 Hours**

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

Unit III **SCADA in Power System Automation** **9 Hours**

Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning,

Case Studies:SCADA Design for 66/11KV and 132/66/11KV or 132/66 KV any utility Substation

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and IEC 61850 based SCADA Implementation issues in utility Substations

Unit IV Energy Management Centre **9 Hours**

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

Unit V SCADA Monitoring and Control **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the SCADA system components and its significance	Understand
CO2: Explain the need and advantages of communication protocols for SCADA	Understand
CO3: Implement the application of SCADA to Power System.	Apply
CO4: Apply the best operating mechanism for Energy centre based on SCADA concepts	Apply
CO5: Realize the need and importance of monitoring and control logic for SCADA based power systems	Understand

Reference Book(s):

1. Stuart A. Boyer, 'SCADA-Supervisory Control and Data Acquisition', Instrument Society of America Publications,USA,2004.
2. Gordon Clarke, Deon Reynders, 'Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems', Newnes Publications, Oxford, UK,2004.
3. William T. Shaw, 'Cybersecurity for SCADA systems', PennWell Books, 2006.
4. David Bailey, Edwin Wright, 'Practical SCADA for industry', Newnes, 2003.
5. Michael Wiebe, 'A guide to utility automation: AMR, SCADA, and IT systems for electric Power', PennWell, 1999.
6. Dieter K. Hammer, Lonnie R. Welch, Dieter K. Hammer, 'Engineering of Distributed Control Systems', Nova Science Publishers, USA, 1st Edition, 2001.

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Professional Elective-V

Course Code: 19ESEN1301	Course Title: IoT for Smart Systems		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Introduce the Internet of Things technologies and its role in real time applications.
2. Select the Infrastructure required for IoT
3. Provide insight about the embedded processor and sensors required for IoT
4. Familiarize the accessories and communication techniques for IoT.
5. Familiarize the different platforms and Attributes for IoT

Unit I Introduction to Internet of Things **9 Hours**

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 Hours**

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 **9 Hours**

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 Services/Attributes **9 Hours**

Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT: Introduction to Python programming -Building IOT with

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RASPERRY PI and Arduino.

Unit V Case Studies **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of IoT and its present developments.	Understand
CO2: Analyze different IoT technologies	Analyze
CO3: Describe different platforms and infrastructures available for IoT	Apply
CO4: Comprehend the big data analytic and its importance	Understand
CO5: Implement IoT solutions for smart applications	Apply

Reference Book(s):

1. OliverHersent,DavidBoswarthickandOmarElloumi"TheInternetofThings",Wiley,2016.
2. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach "Internet of Things",Universities Press 2015
3. Samuel Greengard, " The Internet of Things", The MIT press,2015
4. AdrianMcEwenandHakim Cassimally"DesigningtheInternetofThings"Wiley,2014.
5. 5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 010
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014
7. Lingyang Song/DusitNiyato/ Zhu Han/ EkramHossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013
9. Vijay Madisetti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014

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Course Code: 19ESEN1303	Course Title: Open Source Software		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Introduce and define open source software
2. Identify and discuss various software licensing models
3. Understand the motivation, theory, strengths and weaknesses of open source software.
4. Become familiar with Linux, MySQL, PHP, Python, Apache and other Tools and technologies
5. Obtain an insight into the recent trends in embedded system design

Unit I Introduction **9 Hours**

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

Unit II Open Source Database **9 Hours**

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

Unit III Open Source Programming Languages **9 Hours**

PHP: Introduction - Programming in web environment - variables - constants - data types - operators - Statements - Functions - Arrays - OOP - String Manipulation and regular expression - File handling and data storage - PHP and SQL database - PHP and LDAP - PHP

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Connectivity - Sending and receiving E-mails - Debugging and error handling - Security

Unit IV **Software Development using Open Source Systems** **9 Hours**

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

Unit V **Open Source Web Server, Tools and Technologies** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain about the terms, tools used for Open source software	Understand
CO2: Develop programming Languages in the open source category for application development.	Understand
CO3 Gain improved employability and entrepreneurship capacity	Apply
CO4: Develop solutions to problems using open source tools available	Apply
CO5: Obtain an insight into the recent trends in embedded system design	Apply

Reference Book(s):

1. Remy Card, Eric Dumas and Frank Mevel, "The Linux Kernel Book", Wiley Publications, 2003
2. Steve Suchring, "MySQL Bible", John Wiley,2002
3. RasmusLerdorf and Levin Tatroe, "Programming PHP", O'Reilly, 2002
4. Wesley J. Chun, "Core Phython Programming", Prentice Hall,2001
5. Martin C. Brown, "Perl: The Complete Reference", 2nd Edition, Tata McGraw- Hill Publishing Company Limited, Indian Reprint 2009.
6. Steven Holzner, "PHP: The Complete Reference", 2nd Edition, Tata McGraw- Hill Publishing Company Limited, Indian Reprint 2009.

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Course Code:19ESEN1302	Course Title: Embedded Product Development		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Provide the basic concepts of product design, product features & its architecture.
2. Think innovatively in developing automation into consumer products of market value
3. Understand the techniques & procedures that are practiced in Industry for Product manufacture
4. Develop an embedded product with hardware-software components.
5. Need for knowing role of IDE Tools, reverse engineering.

Unit I **Concepts of Product Development** **9 Hours**

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

Unit II **Interfaces for Product Development** **9 Hours**

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

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Unit III **Approaches for New Product Development** **9 Hours**

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

Unit IV **Industrial Design** **9 Hours**

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

Unit V **Developing Embedded Product** **9 Hours**

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

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain recent trends in embedded systems design with integration of customer requirements in product design	Understand
CO2: Apply structural approach to concept generation, creativity, selection and testing.	Apply
CO3: Explain various aspects of design such as industrial design, design of Consumer specific product , its Reverse Engineering manufacture ,economic analysis through product architecture	Understand
CO4: Observe the success strategies practiced by Industries in New Product Development	Understand
CO5: Develop an embedded product	Apply

Reference Book(s):

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development", 4th Edition,2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
2. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition,4th Edition, 2009, ISBN 978-007-127189-9
3. I.Komninos, D. Milossis, N. Komninos, Product Life Cycle Management A Guide to New Product Development, 1991
4. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN 9788177588217
5. Katheryn, A. Ingle ,Reverse Engineering, , McGraw-Hill, 1994

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Open Electives

Course Code:19ESOC1301	Course Title: Digital Image Processing		
Course Category: Open Elective		Course Level: Practice	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain fundamentals of digital images
2. Learn different image transforms
3. Study concept of segmentation
4. Discuss image enhancement techniques and color image processing
5. Compare image compression schemes

Unit I Digital Image Fundamentals **9 Hours**

A simple image model, Sampling and Quantization, Imaging Geometry, Digital Geometry, Image Acquisition Systems, Different types of digital images. Basic concepts of digital distances, distance transform, medial axis transform, component labeling, thinning, morphological processing, extension to gray scale morphology.

Unit II Image Transforms **9 Hours**

1D DFT, 2D transforms - DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Wavelet transform.

Unit III Segmentation of Gray Level Images **9 Hours**

Histogram of gray level images, multilevel thresholding, Optimal thresholding using Bayesian classification, Watershed and Dam Construction algorithms for segmenting gray level image. Detection of edges and lines: First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

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Unit IV **Image Enhancement and Color Image Processing** **9 Hours**

Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration. Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demosaicing.

Unit V **Image Compression** **9 Hours**

Lossy and lossless compression schemes, prediction based compression schemes, vector quantization, sub-band encoding schemes, JPEG compression standard, Fractal compression scheme, Wavelet compression scheme

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Discuss digital image fundamentals	Understand
CO2. Elucidate various image transforms	Understand
CO3.Explain segmentation of grey level images	Understand
CO4. Discuss image enhancement techniques and color image processing	Understand
CO5. Compare image compression schemes	Understand

Reference Book(s):

1. Gonzalez and Woods, Digital Image Processing, Prentice-Hall. Fourth edition,2018
2. A.K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, Addison-Wesley, 1989.
3. Bernd Jähne, Digital Image Processing, Springer-Verlag Berlin Heidelberg 2005.
4. Bovik (ed.), "Handbook of Image and Video Processing", Academic Press, 2000.

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Course Code:19ESOC1302	Course Title: Energy Management and Economics		
Course Category: Open Elective		Course Level: Practice	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the basics of energy conservation.
2. Familiar with energy auditing process
3. Gain knowledge on energy management
4. Explain various parameters effect on chemical processes.
5. Gain knowledge on energy economics

Unit I Energy Conservation **9 hours**

Thermal energy auditing and management - Design of heat exchangers, heat pumps, HVAC systems, waste heat recovery and cogeneration systems, boiler and furnace performances. Methodology of upgrading boiler performance and energy conservation in steam systems.

Unit II Energy Audit **9 hours**

Electrical Energy Auditing and Management - Electrical energy conservation in various industries; Conservation methods.

Unit III Energy Management **9 hours**

Energy Management opportunities in electrical mechanical systems: Case studies. Load forecasting: Application and techniques; HVDC transmission.

Unit IV Energy Economics **9 hours**

Energy Economics - Basic concept of energy economics; Unit cost of power generation from different sources, Payback period, NPV, IRR, and benefit cost analysis. Overview of national energy use, energy supply and renewable energy programme.

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Unit V **Energy Economics for Renewable Energy Systems** **9 hours**

Modeling of Energy Systems and Policies- Basic concept of Econometrics and statistical analysis; Rural economic and social development considerations; Economic approach to environmental protection and management; Financing of Renewable Energy Systems; Case studies.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the basics of energy conservation.	Understand
CO2. Describe the energy auditing process	Understand
CO3. Gain knowledge on energy management	Understand
CO4. Explain various parameters effect on chemical processes.	Understand
CO5. Gain knowledge on energy economics	Understand

Reference Book(s):

1. Reay, D. A., "Industrial energy conservation", Pergamon Press, 1st edition, 2003
2. White, L. C., "Industrial Energy Management and Utilization", Hemisphere Publishers, 2002
3. Beggs,Clive, "Energy – Management, supply and conservation", Taylor and Francis, 2nd Edition, 2009
4. Smith, C.B., "Energy Management Principles", Pergamon Press, 2006.
5. Subhes C.Bhattacharyya., "Energy Economics", Springer, 2011.
6. Aswath narayana U., "Green energy: Technology, Economics and policy", CRC press, 2010
7. Mallon K., "Renewable Energy Policy and Politics", Earth scan, 2006.

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