VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

Thindal, Erode - 638 012

(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)
(Accredited by NAAC with 'A' grade)

REGULATIONS 2022

CURRICULUM AND SYLLABUS

M.E. – EMBEDDED SYSTEM TECHNOLOGIES

(For the students admitted from 2022-23)

Choice Based Credit System (CBCS)

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Dept. of EEE - VCET

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)
Department	**Electrical and Electronics Engineering**
Programme	**M.E. – Embedded System Technologies**
Regulations	2022

SUMMARY OF CREDIT

S.No	Course Category	Credits per Semester				Total Credits
		I	II	III	IV	
1	FC	4				4
2	PC	14	14			28
3	PE		6	9		15
4	RM	3				3
5	OE			3		3
6	EC			6	12	18
7	VC, OC, AC, SC	✓				-
Total Credits / Sem		21	20	18	12	71

FC - Foundation Courses
PC - Professional Core
PE - Professional Elective
RM - Research Methodology and IPR
OE - Open Elective
EC - Employability Enhancement Course (Project, Seminar, Industrial Training, Internship etc.)
VC - Value Added Courses
OC - Online Course
AC - Audit Course
SC - Self Study course

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	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM
		PG
		R - 2022
Department	Electrical and Electronics Engineering	
Programme	M.E. – Embedded System Technologies	

SEMESTER 1											
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory											
1	22MAT15	Applied Mathematics	FC	4	1	0	4	40	60	100
2	22RMT01	Research Methodology and IPR	RM	3	0	0	3	40	60	100
3	22EST11	RISC Processor Architecture and Programming	PC	3	0	0	3	40	60	100
4	22EST12	Microcontroller Based System Design	PC	3	0	0	3	40	60	100
5	22EST13	Programming Languages for Embedded Software	PC	3	0	0	3	40	60	100
6	22EST14	Design of Embedded Systems	PC	3	0	0	3	40	60	100
7		Audit Course – 1*	AC	2	0	0	0	100	0	100
Practical										
8	22ESL11	Embedded System Laboratory - I	PC	0	0	4	2	60	40	100
							Total Credits	21		

SEMESTER 2										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1	22EST21	Embedded Real Time Operating Systems	PC	3	0	0	3	40	60	100
2	22EST22	Embedded Networking and Automation of Electrical System	PC	3	0	0	3	40	60	100
3	22EST23	Hardware/Software Co-design	PC	3	0	0	3	40	60	100
4	22EST24	IOT Applications for Embedded Systems	PC	3	0	0	3	40	60	100
5		Professional Elective - 1	PE	3	0	0	3	40	60	100
6		Professional Elective - 2	PE	3	0	0	3	40	60	100
7		Audit Course - 2*	AC	2	0	0	0	100	0	100
Practical										
8	22ESL21	Embedded System Laboratory - II	PC	0	0	4	2	60	40	100
							Total Credits	20		

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SEMESTER 3											
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory											
1		Professional Elective - 3	PE	3	0	0	3	40	60	100
2		Professional Elective - 4	PE	3	0	0	3	40	60	100
3		Professional Elective - 5	PE	3	0	0	3	40	60	100
4		Open Elective	OE	3	0	0	3	40	60	100
Practical										
	22ESL31	Project Work – Phase I	EC	0	0	12	6	40	60	100
						Total Credits	18			

* - Audit course is optional

SEMESTER 4										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Practical										
1	22ESL41	Project Work – Phase II	EC	0	0	24	12	40	60	100
						Total Credits	12			

PROFESSIONAL ELECTIVES										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Semester - 2		**Professional Elective - 1**								
1	22ESE01	Design of Embedded Control Systems	PE	3	0	0	3	40	60	100
2	22ESE02	Intelligent Control and Automation	PE	3	0	0	3	40	60	100
3	22ESE03	Electromagnetic Interference and Compatibility in ESD	PE	3	0	0	3	40	60	100
4	22ESE04	Smart Grid Technologies	PE	3	0	0	3	40	60	100
5	22ESE05	Embedded Systems Security	PE	3	0	0	3	40	60	100
Semester - 2		**Professional Elective - 2**								
1	22ESE06	Automotive Embedded System	PE	3	0	0	3	40	60	100
2	22ESE07	Virtual Instrumentation Systems	PE	3	0	0	3	40	60	100
3	22ESE08	Automotive Embedded Product Development	PE	3	0	0	3	40	60	100
4	22ESE09	Embedded Sensor Networks	PE	3	0	0	3	40	60	100
5	22ESE10	Soft Computing Techniques for Renewable Energy Systems	PE	3	0	0	3	40	60	100

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Semester - 3		Professional Elective - 3								
1	22ESE11	Renewable Energy and Grid Integration	PE	3	0	0	3	40	60	100
2	22ESE12	System Design with Embedded Linux	PE	3	0	0	3	40	60	100
3	22ESE13	Automation and Industrial Internet of Things	PE	3	0	0	3	40	60	100
4	22ESE14	Design of Solar Photovoltaic systems	PE	3	0	0	3	40	60	100
5	22ESE15	Optimization Techniques	PE	3	0	0	3	40	60	100
Semester - 3		Professional Elective - 4								
1	22ESE16	Electric Vehicles and Power Management	PE	3	0	0	3	40	60	100
2	22ESE17	Robotics and Automation	PE	3	0	0	3	40	60	100
3	22ESE18	MEMS and NEMS Technology	PE	3	0	0	3	40	60	100
4	22ESE19	Embedded System design using FPGA	PE	3	0	0	3	40	60	100
5	22ESE20	Smart System Design	PE	3	0	0	3	40	60	100
Semester - 3		Professional Elective - 5								
1	22ESE21	Embedded Networking and Automation of Electrical System	PE	3	0	0	3	40	60	100
2	22ESE22	Python Programming for Machine Learning	PE	3	0	0	3	40	60	100
3	22ESE23	Machine Learning and Deep Learning for Embedded System	PE	3	0	0	3	40	60	100
4	22ESE24	Distributed Generation and Micro grids	PE	3	0	0	3	40	60	100
5	22ESE25	Entrepreneurship and Embedded Product Development	PE	3	0	0	3	40	60	100

OPEN ELECTIVES										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
1	22ESO01	Waste to Energy	OE	3	0	0	3	40	60	100
2	22ESO02	Industrial Drives for Automation	OE	3	0	0	3	40	60	100
3	22ESO03	Hybrid Electric Vehicles	OE	3	0	0	3	40	60	100
4	22ESO04	Modern Automotive Electronics Systems	OE	3	0	0	3	40	60	100

AUDIT COURSES (Registration for any of these courses is optional to students; it will be mentioned in the Grade statement. However, it will not be considered for computation of CGPA)										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	22AC01	English for Research Paper Writing	AC	2	0	0	0	100	0	100
2	22AC02	Disaster Management	AC	2	0	0	0	100	0	100
3	22AC03	Constitution of India	AC	2	0	0	0	100	0	100
4	22AC04	Pedagogy Studies	AC	2	0	0	0	100	0	100

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L - Lecture Period
T - Tutorial Period
P - Practical Period

CA - Continuous Assessment
SE - Semester Examination
Tot - Total Marks

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22MAT15	APPLIED MATHEMATICS	L	T	P	C
		4	1	0	4

Pre-requisites: Nil

Preamble

Matrices used to represent the system of equations and we can easily find the characteristics of the system. Fourier series and Fourier transforms are used to convert periodic and non-periodic functions from one domain to another domain respectively. The syllabus is designed to familiarize mathematical formulation and solution of LPP. This course provides the knowledge and training using non- linear programming under limited resources for engineering and business problems.

UNIT 1 MATRIX THEORY **9+3**

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

UNIT 2 FOURIER SERIES **9+3**

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Power signals: Exponential Fourier series – Parseval's theorem and power spectrum– Eigenvalue problems and orthogonal functions – Regular Sturm – Liouville systems –Generalized Fourier series.

UNIT 3 FOURIER TRANSFORM **9+3**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Convolution theorem – Parseval's identity.

UNIT 4 LINEAR PROGRAMMING **9+3**

Formulation – Graphical solution – Simplex method –Transportation model – Initial basic feasible solution -North-west corner rule, Least-cost method, Vogel's approximation method and optimum solution of transportation problem.

UNIT 5 NON-LINEAR PROGRAMMING **9+3**

Constrained Problems – Equality constraints – Lagrangean Method – Inequality constraints – Karush – Kuhn-Tucker (KKT) conditions – Quadratic Programming.

Lecture: 45, Tutorial: 15, Total: 60

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Apply various methods in matrix theory to solve system of linear equations.

CO2 Compute Fourier series for periodic functions, exponential Fourier series, eigenvalue problems and orthogonal functions.

CO3 Compute the Fourier transform of elementary non-periodic wave forms using Fourier Transform properties.

CO4 Formulate and construct mathematical models for linear programming problems and solve the transportation problems.

CO5 Model various real-life situations as optimization problems and effect their solution through Non-linear programming.

TEXT BOOKS:

1 Richard Bronson, "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.

2 Grewal, B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publishers, Delhi (2016)

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3 Kanti Swarup, Gupta PK and Manmohan, "Operations Research", 14th Edition, Sultan Chand & Sons, New Delhi,2014.

REFERENCES:

1 David C. Lay, "Linear Algebra and its applications",4th Edition, Pearson, New Delhi, 2012.

2 Taha, H.A, "Operations Research, An introduction", 10th Edition, Pearson education, New Delhi, 2013.

3 Ramana. B. V., "Higher Engineering Mathematics", First edition, Tata Mc-Graw Hill Publishing Company limited, New Delhi, 2016.

4 Bali. N. P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, University Press India (P) Ltd, Hyderabad (2015).

e-Resources:

1. https://nptel.ac.in/courses/111108157/52, "Matrix Theory" Pro. Chandra R. Murty Department of Electronics and Communication Engineering, Indian Institute of Science Bangalore.
2. http://nptel.ac.in/courses/111106046, "Fourier Series", Prof. R. Radha, and Prof S. Thangavelu, Department of Mathematics, Indian Institute of Technology Madras, Chennai.

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22RMT01	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

Research is a scientific and systematic search for information on a particular topic or issue. It is an attempt to pursue truth through the methods of study, observation, comparison and experiment. In sum, research is the search for knowledge, using objective and systematic methods to find solution to a problem. This course also focuses on Intellectual Property Rights and explain the process of patenting

UNIT 1 RESEARCH PROBLEM FORMULATION **9**

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

UNIT 2 LITERATURE REVIEW **9**

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

UNIT 3 TECHNICALWRITING /PRESENTATION **9**

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

UNIT 4 INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) **9**

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

UNIT 5 INTELLECTUAL PROPERTY RIGHTS (IPR) **9**

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Understand the research problem and research process.

CO2 Understand research ethics.

CO3 Prepare a well-structured research paper and scientific presentations.

CO4 Explore on various IPR components and process of filing.

CO5 Understand the new developments in IPR.

TEXT BOOKS:

1 Ranjit Kumar, 2nd Edition, "Research Methodology: A Step-by-Step Guide for beginners" 2010

2 Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

3 Ranjit Kumar, "Research Methodology: A Step-by-Step guide for beginners", British Library Cataloguing, 4th Edition, 2014.

REFERENCES:

1 Asimov, "Introduction to Design", Prentice Hall, 1962.

2 Mayall, "Industrial Design", McGraw Hill, 1992

3 Niebel, "Product Design", McGraw Hill, 1974.

e-Resources:

1. http://www.it.iitb.ac.in/nmeict/eVideos/IRM_Main/content/content.html, "Introduction to research Methodology", Prof. D. B. Phatak, IIT Bombay.

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22EST11 RISC PROCESSOR ARCHITECTURE AND PROGRAMMING

L	T	P	C
3	0	0	3

UNIT 1 AVR MICROCONTROLLER ARCHITECTURE **9**

Architecture – memory organization – addressing modes – I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART – Interrupt Structure- Serial Communication with PC – ADC/DAC Interfacing

UNIT 2 ARM ARCHITECTURE AND PROGRAMMING **9**

Arcon RISC Machine – Architectural Inheritance – Core & Architectures -- The ARM Programmer's model -Registers – Pipeline - Interrupts – ARM organization - ARM processor family – Co-processors. Instruction set – Thumb instruction set – Instruction cycle timings.

UNIT 3 ARM APPLICATION DEVELOPMENT **9**

Introduction to RT implementation with ARM – –Exception Handling – Interrupts – Interrupt handling schemes- Firmware and bootloader – Free RTOS Embedded Operating Systems concepts – example on ARM core like ARM9 processor.

UNIT 4 MEMORY PROTECTION AND MANAGEMENT **9**

Protected Regions-Initializing MPU, Cache and Write Buffer-MPU to MMU Virtual Memory-Page Tables-TLB-Domain and Memory Access Permission Fast Context Switch Extension.

UNIT 5 DESIGN WITH ARM MICROCONTROLLERS **9**

Assembler Rules and Directives- Simple ASM/C programs- Hamming Code Division-Negation-Simple Loops –Look up table- Block copy- subroutines application.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the programmer's model of ARM processor and create and test assembly level programming

CO2 Analyze various types of coprocessors and design suitable co-processor interface to ARM processor.

CO3 Identify the architectural support of ARM for operating system and analyze the function of memory Management unit of ARM.

CO4 Students will develop more understanding on the concepts ARM Architecture, programming and application development.

CO5 The learning process delivers insight into various embedded processors of RISC architecture / computational processors with improved design strategies.

TEXT BOOKS:

1 Steve Furber, 'ARM system on chip architecture', Addision Wesley

2 Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield 'ARM System

3 Developer's Guide Designing and Optimizing System Software', Elsevier 2007.

4 Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi 'AVR Microcontroller and Embedded Systems using Assembly and C", Pearson Education 2014.

5 Trevor Martin, 'The Insider's Guide to The Philips ARM7-Based Microcontrollers

e-Resources:

1. www.Nuvoton .com/websites on Advanced ARM Cortex Processors
2. https://nptel.ac.in/courses/106103206

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22EST12	MICROCONTROLLER BASED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

UNIT 1 8051 MICROCONTROLLER 9

Architecture and memory organization – addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication.

UNIT 2 PROGRAMMING WITH 8051 MICROCONTROLLER AND RTOS 9

Assembly language programming – Arithmetic Instructions – Logical Instructions – Single bit Instructions – Timer Counter Programming – Serial Communication Programming – Interrupt Programming – RTOS for 8051 – RTOS Lite – Full RTOS – Task creation and run – LCD digital clock/thermometer using Full RTOS

UNIT 3 PIC MICROCONTROLLER 9

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

UNIT 4 PIC MICROCONTROLLER PERIPHERALS AND INTERFACING 9

Timers – Interrupts, I/O ports - I^2C bus - A/D converter - UART- CCP modules - ADC, DAC and Sensor Interfacing – Flash and EEPROM memories. Interfacing LCD Display – Keypad Interfacing

UNIT 5 CASE STUDY WITH 8051 AND PIC MICROCONTROLLERS 9

Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Stand-alone Data Acquisition System.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 To understand the basics and requirement of processor functional blocks.

CO2 Observe the specialty of RISC processor Architecture.

CO3 Incorporate I/O hardware interface of a processor-based automation for consumer application with peripherals.

CO4 Incorporate I/O software interface of a processor with peripherals.

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation onrecent trends in commercial embedded processors

TEXT BOOKS:

1 Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, 'The 8051 Microcontroller and Embedded Systems' Prentice Hall, 2005.

2 Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey 'PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education 2008

3 Myke Predko, "Programming and Customizing the 8051 Microcontroller", Tata McGraw Hill 2001.

4 John Iovine, 'PIC Microcontroller Project Book', McGraw Hill 2000

5 Rajkamal, "Microcontrollers - Architecture, Programming, Interfacing & System Design", 2nd edition, Pearson,2012.

e-Resources:

1. https://nptel.ac.in/courses/108105102

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22EST13 PROGRAMMING LANGUAGES FOR EMBEDDED SOFTWARE

L	T	P	C
3	0	0	3

UNIT 1 EMBEDDED 'C' PROGRAMMING 9

Bitwise operations, Dynamic memory allocation, OS services, Linked stack and queue, Sparse matrices, Binary tree, Interrupt handling in C, Code optimization issues, Writing LCD drives, LED drivers, Drivers for serial port communication, Embedded Software Development Cycle and Methods (Waterfall, Agile)

UNIT 2 OBJECT ORIENTED PROGRAMMING 9

Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, objects, classes, data members, methods, data encapsulation, data abstraction and information hiding, inheritance, polymorphism

UNIT 3 C++ PROGRAMMING 9

'cin', 'cout', formatting and I/O manipulators, new and delete operators, Defining a class, data members and methods, 'this' pointer, constructors, destructors, friend function, dynamic memory allocation

UNIT 4 OVERLOADING AND INHERITANCE 9

Need of operator overloading, overloading the assignment, overloading using friends, type conversions, single inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, multiple inheritance, virtual base class, polymorphism, virtual functions

UNIT 5 SCRIPTING LANGUAGES 9

Overview of Scripting Languages – Python, PERL, CGI, VB Script, Java Script. PERL: Operators, Statements Pattern Matching etc. Data Structures, Modules, Objects, Tied Variables, Inter process Communication Threads, Compilation & Line Interfacing.

Python: Overview, History and Features-Variables, Operators, Decision Making, Loops, Strings, Lists, Tuples, Functions, Modules, Packages, Exceptions, Classes/Objects, Regular Expressions, CGI Programming, Database Access, Networking, Sending Email, Multithreading, XML Processing, GUI programming.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Write an embedded C application of moderate complexity.

CO2 Develop and analyze algorithms in C++.

CO3 Differentiate interpreted languages from compiled languages.

CO4 Acquire programming skills in core Python.

CO5 Develop applications using scripting languages such as Python.

TEXT BOOKS:

1 Michael J. Pont, "Embedded C", Pearson Education, 2nd Edition, 2008

2 Randal L. Schwartz, "Learning Perl", O'Reilly Publications, 6th Edition, 2011

3 A. Michael Berman, "Data structures via C++", Oxford University Press, 2002

4 Robert Sedgewick, "Algorithms in C++", Addison Wesley Publishing Company, 1999

5 Abraham Silberschatz, Peter B, Greg Gagne, "Operating System Concepts", John Willey & Sons, 2005

6 Martin C. Brown," Python: The Complete Reference", McGraw-Hill Education, 2001

7 E. Balaguruswami, "Object-Oriented Programming with C++", McGraw-Hill Education, 7th Edition, 2017

e-Resources:

1. https://nptel.ac.in/courses/106105151

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22EST14	DESIGN OF EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS **9**

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

UNIT 2 EMBEDDED NETWORKING BY PROCESSORS **9**

Embedded Networking: Introduction, I/O Device Ports & Buses- multiple interrupts and interrupt service mechanism – Serial Bus communication protocols -RS232 standard–RS485–USB–Inter Integrated Circuits (I^2C) - CAN Bus –Wireless protocol based on Wi-fi, Bluetooth, Zigbee – Introduction to Device Drivers.

UNIT 3 RTOS BASED EMBEDDED SYSTEM DESIGN **9**

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

UNIT 4 MODELLING WITH HARDWARE/SOFTWARE DESIGN APPROACHES **9**

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

UNIT 5 EMBEDDED SYSTEM APPLICATION DEVELOPMENT **9**

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 To understand the functionalities of processor internal blocks, with their requirement.

CO2 Observe that Bus standards are chosen based on interface overheads without sacrificing processor performance

CO3 Understand the role and features of RT operating system, that makes multitask execution possible by processors.

CO4 Understand that using multiple CPU based on either hardcore or softcore helps data overhead management with processing- speed reduction for Microcontroller execution.

CO5 Guidelines for Embedded consumer product design based on phases of product development.

TEXT BOOKS:

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", Pearson, 2013

4 Elicia White, "Making Embedded Systems", O'Reilly Series, SPD, 2011

5 Bruce Powel Douglass," Real-Time UML Workshop for Embedded Systems, Elsevier, 2011

e-Resources:

1. https://nptel.ac.in/courses/106105159
2. https://nptel.ac.in/courses/106105193

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22ESL11	EMBEDDED SYSTEM LABORATORY - I	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Programming with 8051 Microcontroller in both assembly and C language.
2. Programming with PIC Microcontrollers in both assembly and C language.
3. Design with PIC Microcontroller: I/O Programming/ Timers/ Interrupts/ Serial port Interfacing
4. Design with PIC Microcontroller: PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing
5. Simulation of sensor interfaces and measurement using programming environments (MATLAB/LabVIEW/)
6. Study on in circuit Emulators, cross compilers and debuggers.
7. Programming of TCP/IP protocol stack using Network Simulator.

Lecture: 0, Tutorial: 0, Practical: 60 Total: 60

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe various embedded processors of CISC and RISC architecture / computational processors with peripheral interface.

CO2 Demonstrate the fundamental concepts of how process can be controlled with µC.

CO3 Working on programming logic of Processor based on software suites (simulators, emulators)

CO4 Incorporate I/O software interface of a processor with peripherals.

CO5 Improve his Employability skills and entrepreneurship capacity due to knowledge up gradation on recent trends in interfacing and use of commercial embedded processors

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22EST21	EMBEDDED REAL TIME OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 REVIEW OF OPERATING SYSTEMS 9

Basic Principles - Operating System structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Introduction to Distributed operating system – issues in distributed system: states, events, clocks - Distributed Scheduling - Fault and recovery.

UNIT 2 OVERVIEW OF RTOS 9

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

UNIT 3 REAL TIME MODELS AND LANGUAGES 9

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

UNIT 4 REAL TIME KERNEL 9

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

UNIT 5 RTOS APPLICATION DOMAINS 9

Case studies-RTOS for Image Processing – Embedded RTOS for Network communication – RTOS for fault-Tolerant Applications – RTOS for Control Systems.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the fundamentals of interaction of OS with a computer and User computation.

CO2 Explain the fundamental concepts of how processes are created and controlled with OS.

CO3 Illustrate programming logic of modeling Process based on range of OS features

CO4 Compare the types and Functionalities in commercial OS.

CO5 Discuss the application development using RTOS.

TEXT BOOKS:

1 Silberschatz, Galvin, Gagne" Operating System Concepts,6th ed, John Wiley, 2003

2 D.M. Dhamdhere," Operating Systems, A Concept-Based Approach, TMH, 2008

3 Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill, 2006.

4 Herma K., "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, 1997.

5 Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill 1997.

e-Resources:

1. nptel.ac.in/courses/106105036/
2. nptel.ac.in/courses/106108101/

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22EST22	EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM	L	T	P	C
		3	0	0	3

UNIT 1 BUILDING SYSTEM AUTOMATION 9

Sensor Types and Characteristics: Sensing Voltage, Current, flux, Torque, Position, Proximity, Accelerometer - Data acquisition system - Signal conditioning circuit design- µC Based and PC based data acquisition – µC 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 2 EMBEDDED NETWORKING OF INSTRUMENT CLUSTER 9

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

UNIT 3 AUTOMATION OF SUBSTATION 9

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

UNIT 4 METERING OF SMART GRID 9

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

UNIT 5 SMART METERS FOR PQ MONITORING 9

Power Quality issues of Grid connected Renewable Energy Sources -Smart meters for Power Quality monitoring and Control - Power Quality issues -Surges – Flicker – Inter-harmonics – Transients – Power Quality Benchmarking – Power Quality Meters- Meter data management in Smart Grid-communication enabled Power Quality metering

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 The criteria of choice of sensors, components to build meters.

CO2 The demand for BUS communication protocols are introduced

CO3 Analyze the need and standards in Substation automation

CO4 Deployment of PAN for metering networked commercial applications

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications

TEXT BOOKS:

1 Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006

2 Krzysztof Iniewski, "Smart Grid, Infrastructure & Networking", Tata McGraw Hill, 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 Shih-Lin Wu, Yu-Chee Tseng, "Wireless Ad Hoc Networking, PAN, LAN, SAN, Aurebach Pub, 2012

6 Sanjay Gupta, "Virtual Instrumentation, LABVIEW", TMH, New Delhi, 2003

7 Ernest O. Doeblin and Dhanesh N Manik, "Measurement Systems – Application and Design", 5th Edition, TMH, 2007.

8 Bhaskar Krishnamachari, "Networking wireless sensors", Cambridge press, 2005

e-Resources:

1. https://nptel.ac.in/courses/108105088

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22EST23	HARDWARE/SOFTWARE CO-DESIGN	L	T	P	C
		3	0	0	3

UNIT 1 NATURE OF HARDWARE AND SOFTWARE 9

Introducing Hardware/Software Co-design, The Quest for Energy Efficiency, The Driving Factors in Hardware/Software Co-design, The Dualism of Hardware Design and Software Design.

UNIT 2 DATA FLOW MODELING, TRANSFORMATION AND IMPLEMENTATION 9

Data Flow Modeling and Transformation: Introducing Data Flow Graphs, Analyzing Synchronous Data Flow Graphs, Control Flow Modeling and the Limitations of Data Flow, Transformations.

Data Flow Implementation in Software and Hardware: Software Implementation of Data Flow, Hardware Implementation of Data Flow, Hardware/Software Implementation of Data Flow.

UNIT 3 ANALYSIS OF CONTROL FLOW AND DATA FLOW 9

Data and Control Edges of a C Program, Implementing Data and Control Edges, Construction of the Control Flow Graph, Modern Bipolar Transistor Structures, Construction of the Data Flow Graph.

UNIT 4 FINITE STATE MACHINE WITH DATA PATH 9

Cycle-Based Bit-Parallel Hardware, Hardware Modules, Finite State Machines with Data path, FSMD Design Example: A Median Processor.

UNIT 5 SYSTEM ON CHIP 9

The System-on-Chip Concept, Four Design Principles in SoC Architecture, SoC Modeling in GEZEL. Applications: Trivium Crypto-Coprocessor, CORDIC Coprocessor.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the Hardware/Software Co-design Procedure

CO2 Model the data flow and implement the same through software and hardware.

CO3 Design the Control Flow on Transistor Structures.

CO4 Illustrate the design principles in SoC Architecture

CO5 Design CORDIC and Crypto coprocessor.

TEXT BOOKS:

1 Patrick Schaumont, A Practical Introduction to Hardware/Software Co-design, Springer, 2010.

2 Ralf Niemann, Hardware/Software Co-Design for Data flow Dominated Embedded Systems, Springer, 1998.

3 Balarin, Felice, et al. Hardware-software co-design of embedded systems: the POLIS approach. Springer Science & Business Media, 1997.

4 De Micheli, Giovanni, et al. Readings in hardware/software co-design. Morgan Kaufmann, 2002.

e-Resources:

1. https://nptel.ac.in/courses/106103182

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22EST24	IOT APPLICATIONS FOR EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 8-BIT EMBEDDED PROCESSOR 9

8-Bit Microcontroller – Architecture – Instruction Set and Programming – Programming Parallel Ports – Timers and Serial Port – Interrupt Handling.

UNIT 2 EMBEDDED C PROGRAMMING 9

Memory And I/O Devices Interfacing – Programming Embedded Systems in C – Need for RTOS – Multiple Tasks and Processes – Context Switching – Priority Based Scheduling Policies.

UNIT 3 IOT AND ARDUINO PROGRAMMING 9

ARM Processor – Introduction to the Concept of IoT Devices – IoT Devices Versus Computers – IoT Configurations – Basic Components – Introduction to Arduino – Types of Arduino – Arduino Toolchain – Arduino Programming Structure – Sketches – Pins – Input/Output from Pins Using Sketches – Introduction to Arduino Shields – Integration of Sensors and Actuators with Arduino - Case study: sensors in IoT applications

UNIT 4 IOT COMMUNICATION AND OPEN PLATFORMS 9

IoT Communication Models and APIs – IoT Communication Protocols – Bluetooth – Wi-Fi – ZigBee – GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud - Case study: IoT related standards

UNIT 5 APPLICATIONS DEVELOPMENT 9

Complete Design of Embedded Systems – Development of IoT Applications – Home Automation – Smart Agriculture – Smart Cities – Smart Healthcare - Case study: IoT based home automation solutions, embedded and IoT processor based real-time applications.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Analyze and compare various embedded processors.

CO2 Design and deploy timers and interrupts.

CO3 Write embedded C programs and Design simple embedded applications.

CO4 Design portable IoT using Arduino / Raspberry Pi / open-source platform.

CO5 Analyze applications of IoT in real time scenario.

TEXT BOOKS:

1 Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014.

2 Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", John Wiley & Sons, 2014.

3 Michael J. Pont, "Embedded C", Pearson Education, 2007.

4 Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.

5 Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.

6 IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.

7 Andrew N Sloss, D. Symes, C. Wright, "Arm System Developers Guide", Morgan Kauffman/ Elsevier, 2006. 6. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", VPT, 2014.

e-Resources:

1. https://nptel.ac.in/courses/106105195
2. https://ict.iitk.ac.in/embedded-and-iot-system/

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22ESL21	EMBEDDED SYSTEM LABORATORY - II	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Programming with ARM Processors,
   i) I/O Programming/ Timers /Interrupts
   ii) ADC/DAC/ LCD /RTC Interfacing/ Sensor Interfacing/i/o device Control
   Both Assembly and C programming
2. Programming with Fixed Point and Floating-Point DSP Processors Both Assembly /C programming/CCS Compilers - Programming with DSP processors for Correlation, Convolution, Arithmetic adder, Multiplier, Design of FIR and IIR Filters
3. Design using Xilinx/Altera CPLD - Design and Implementation of simple Combinational/ Sequential Circuits
4. Design using Xilinx/Altera FPGA - Design and Implementation of simple Combinational/ Sequential Circuits
5. Programming with DSP/FPGA Processors - Motor Control/ADC/DAC/LCD / RTC Interfacing/ Sensor Interfacing
6. Study of one type of Real Time Operating Systems (RTOS) with ARM Processor/ Microcontroller
7. Network Simulators Communication Topology of network using NS2/simulators
8. Study on Embedded wireless network Topology
9. Simulation of digital controllers using programming environments
10. Simulation and Programming on DSP /Image Processing using programming environments

Lecture: 0, Tutorial: 0, Practical: 60 Total: 60

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Design with simulators/ experiments, in programming processor boards, processor interfacing/ designing digital controllers

CO2 Design & simulation of Arithmetic, Logic programs, Filters, Signal analysis with simulators/experiments, in programming processor boards, processor interfacing/Tools

CO3 Develop real time solution for embedded applications

CO4 Develop a program programming, compiling in various tools & software domains

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors and its programmable interfacing

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PROFESSIONAL ELECTIVE – 1

22ESE01	DESIGN OF EMBEDDED CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 EMBEDDED SYSTEM ORGANIZATION **9**

Embedded computing – characteristics of embedded computing applications – embedded system design challenges; Build process of Realtime Embedded system – Selection of processor; Memory; I/O devices - RS-485, MODEM, Bus Communication system using I^2C, CAN, USB buses, 8-bit ISA, EISA bus.

UNIT 2 REAL TIME OPERATING SYSTEM **9**

Introduction to RTOS; RTOS - Inter Process communication, Interrupt driven Input and Output - non-maskable interrupt, Software interrupt; Thread – Single, Multithread concept; Multitasking Semaphores.

UNIT 3 INTERFACE WITH COMMUNICATION PROTOCOL **9**

Design methodologies and tools – design flows – designing hardware and software Interface – system integration; SPI, High speed data acquisition and interface - SPI read/write protocol, RTC interfacing and programming

UNIT 4 DESIGN OF SOFTWARE FOR EMBEDDED CONTROL **9**

Software abstraction using Mealy-Moore FSM controller, Layered software development, Basic concepts of developing device driver – SCI – Software - interfacing and porting using standard C and C++; Functional and performance Debugging with benchmarking Real-time system software – Survey on basics of contemporary RTOS – VxWorks, UC/OS-II

UNIT 5 CASE STUDIES WITH EMBEDDED CONTROLLER **9**

Programmable interface with A/D & D/A interface: Digital voltmeter, control- Robot system; - PWM motor speed controller, serial communication interface.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Explain the fundamentals of Embedded System Blocks.

CO2 Describe the fundamental RTOS.

CO3 Illustrate interfacing for processor communication.

CO4 Compare the types and Functionalities in commercial software tools.

CO5 Discuss the Applications development using interfacing.

TEXT BOOKS:

1 Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill, 2006.

2 Steven F. Barrett, Daniel J. Pack, "Embedded Systems – Design and Applications with the 68HC 12 and HCS12", Pearson Education, 2008.

3 Micheal Khevi, "The M68HC11 Microcontroller application in control, Instrumentation & Communication", PH New Jersy, 1997.

4 Chattopadhyay, "Embedded System Design", PHI Learning, 2011.

5 Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, "PIC Microcontroller and Embedded Systems- Using Assembly and C for PIC18", Pearson Education, 2008.

e-Resources:

1. http://nptel.ac.in/courses/106105036/9
2. http://nptel.ac.in/courses/108102045/17

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22ESE02	INTELLIGENT CONTROL AND AUTOMATION	L	T	P	C
		3	0	0	3

UNIT 1 OVERVIEW OF ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC 9

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

UNIT 2 NEURAL NETWORKS FOR MODELLING AND CONTROL 9

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

UNIT 3 FUZZY LOGIC FOR MODELLING AND CONTROL 9

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

UNIT 4 GENETIC ALGORITHM 9

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

UNIT 5 HYBRID CONTROL SCHEMES 9

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Explain the basic architectures of NN and Fuzzy sets

CO2 Design and implement ANN architectures, algorithms and know their limitations.

CO3 Identify and work with different operations on the fuzzy sets.

CO4 Develop ANN and fuzzy logic-based models and control schemes for non-linear systems.

CO5 Describe and explore hybrid control schemes and PSO.

TEXT BOOKS:

1 Laurene V. Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Pearson Education, 2008.

2 Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, Third Edition, 2010.

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.

5 George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall, First Edition, 1995.

e-Resources:

1. https://nptel.ac.in/courses/108104049
2. https://nptel.ac.in/courses/108105088

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22ESE03	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN ESD	L	T	P	C
		3	0	0	3

UNIT 1 EMI/EMC CONCEPTS **9**

Concepts of EMI and EMC- Definitions and Units of parameters- Electromagnetic environment- Mechanisms of EMI generation - Practical experiences and concerns- Natural and Nuclear sources of EMI: Celestial Electromagnetic Noise, Lightning Discharge, Electrostatic Discharge, Electromagnetic Pulse-EMI from apparatus and circuits: Noise from Relays and Switches, Nonlinearities in circuits.

UNIT 2 EMI COUPLING PRINCIPLES **9**

Conducted, radiated and transient coupling- Common ground impedance coupling – Common mode and ground loop coupling - Differential mode coupling – Near field cable to cable coupling - Field to cable coupling – Power mains and Power supply coupling-Cross talk in transmission lines- Transients in transmission lines.

UNIT 3 EMI CONTROL TECHNIQUES **9**

Shielding- Filtering- Grounding- Electrical Bonding- EMI Suppression Cables- EMC connectors- Isolation transformer- Transient suppressors and Surge Suppression Devices.

UNIT 4 EMC DESIGN OF PCBS **9**

Component selection and mounting; Choice of capacitors, inductors, transformers and resistors, PCB trace impedance- Routing-Crosstalk control- Zoning- Grounding-VIAs connection- Terminations.

UNIT 5 EMI MEASUREMENTS AND STANDARDS **9**

Open area test site Measurements-Measurement Precautions-Anechoic Chamber- TEM cell-Reverberating Chamber, GTEM cell- Comparison of test facilities- Civilian standards: CISPR, FCC, EN- Military standards: MIL 461/462.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the EMI/EMC problems in embedded systems and analyze the effects of EMI on system performance

CO2 Select appropriate technique to reduce the EMI effects on embedded systems

CO3 Acquire knowledge in the Real-world EMC design constraints and make appropriate tradeoffs to achieve the most cost-effective design that meets all requirements.

CO4 Design electronic systems and high speed Printed Circuit boards without Errors or problems related to electromagnetic compatibility.

CO5 Illustrate the Measurement techniques for emission and describe the EMC standards.

TEXT BOOKS:

1 V. P. Kodali, "Engineering EMC principles, Measurements and Technology", IEEE Press, Network, Wiley-Blackwell, Second Edition,2016.

2 Clayton R. Paul, "Introduction to Electromagnetic compatibility "John Wiley & Sons, 2014.

3 David A. Weston, "Electromagnetic compatibility: Methods, Analysis, Circuits and Measurements'' Third Edition, CRC Press, Septrmber29, 2016.

4 Henry W. Ott, "Noise Reduction Techniques in Electronics System", John Wiley and Sons, New York, 1998.

5 Bernhard Keiser, "Principles of Electromagnetic Compatibility", Artech house, 3rd Ed, 1994.

6 Don R.J. White Consultant Incorporate, "Handbook of EMI/EMC- Vol I-1985", John Wiley and Sons, Newyork,1988

e-Resources:

1. https://nptel.ac.in/courses/108106138

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22ESE04	SMART GRID TECHNOLOGIES	L	T	P	C
		3	0	0	3

UNIT 1 SMART GRID ARCHITECTURE AND COMPONENTS **9**

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid, Present development & International policies in Smart Grid, Smart Grid Architecture Models, Components of Smart Grid: Smart Generation systems, Smart Transmission Grid: Geographic Information System (GIS). Intelligent Electronic Devices (IED) & their application for Monitoring & Protection. Wide Area Monitoring Protection and Control (WAMPAC), Phasor Measurement Unit (PMU) and its applications in Smart Grid.

UNIT 2 MICROGRIDS AND DISTRIBUTED ENERGY RESOURCES **9**

Micro grid: Concept of Micro grid, Need & Applications of Micro grid. Micro grid Architecture, Issues of interconnection, Protection & Control of Micro-grid. Distributed Energy Resources: Plastic & Organic Solar cells, Thin Film Solar cells. Variable Speed Wind Generators, Fuel cells, Micro turbines, Captive Power plants, Integration of Renewable energy sources. Power Quality issues of Grid connected Renewable Energy Sources. Power Quality Conditioners for Smart Grid. Web based Power Quality monitoring and Power Quality Audit.

UNIT 3 SMART METERING AND DISTRIBUTION MANAGEMENT SYSTEM **9**

Smart Distribution Systems: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart Appliances. Smart Substations: Substation Automation, Feeder Automation, Outage Management System (OMS). Smart Sensors: Home & Building Automation.

UNIT 4 SMART GRID AND PLUG IN HYBRID ELECTRIC VEHICLES **9**

Plug in Hybrid Electric Vehicles (PHEV), Algorithms for Vehicle to Grid and Grid to Vehicle Management, Smart Charging Stations. Energy Storage for Smart Grids: Battery Energy Storage Systems (BESS), Superconducting Magnetic Energy Storage (SMES), Compressed Air Energy Storage (CAES).

UNIT 5 COMMUNICATION NETWORKS AND CYBER SECURITY FOR SMART GRID **9**

Communication Architecture for Smart Grids, Home Area Network (HAN): IEEE 802.11, IEEE 802.15.4, 6LoWPAN, Neighborhood Area Network (NAN) / Field Area Network (FAN): Radio over Power-Lines (BPL/PLC), IEEE P1901, Wide Area Network (WAN): Optical Fiber Communication, Cellular Networks, Wi-Max and Wireless Sensor Networks. Big Data Analytics in Smart Grid, Cyber Security Challenges in Smart Grid - Load Altering Attacks - False Data Injection Attacks - Defense Mechanisms.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the concepts of Smart Grid, Architecture Models and its components and present developments.

CO2 Analyze about different Smart Grid transmission technologies.

CO3 Analyze about different Smart Grid distribution technologies.

CO4 Acquire knowledge about different smart meters and advanced metering infrastructure.

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

TEXT BOOKS:

1 Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley, 2016.

2 Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 2012.

3 Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, 2012.

4 Vehbi C. Gungor, DilanSahin, TaskinKocak, Salih Ergut, Concettina Buccella, Carlo Cecati,and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.

5 Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grid

e-Resources:

1. https://nptel.ac.in/courses/108107113
2. https://ict.iitk.ac.in/product/smart-grid-technology1/

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22ESE05	EMBEDDED SYSTEMS SECURITY	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS SECURITY 9

Embedded system Trends, Policies, Threats - Software Security: Buffer overflow exploits, Mitigation of buffer overflow attacks, Return-to-libc attack, Hardware Security: Hardware trojans, Intellectual property (IP) piracy and integrated circuit (IC) overbuilding, Side-channel analysis, Data Protection Protocols: Data-in-Motion Protocols - IP-based network security, Data-at-Rest Protocols

UNIT 2 SYSTEMS SOFTWARE CONSIDERATIONS 9

Role of the Operating System, Multiple Independent Levels of Security, Microkernel versus Monolith, Core Embedded Operating System Security Requirements, Access Control and Capabilities, Hypervisors and System Virtualization, I/O Virtualization, Remote Management, Assuring Integrity of the TCB

UNIT 3 SECURE EMBEDDED SOFTWARE DEVELOPMENT 9

PHASE-Principles of High-Assurance Software Engineering, Minimal Implementation, Component Architecture, Least Privilege, Secure Development Process, Independent Expert Validation, Case Study: HAWS-High-Assurance Web Server, Model-Driven Design

UNIT 4 EMBEDDED CRYPTOGRAPHY 9

Cryptographic Modes, Block Ciphers, Authenticated Encryption, Secret key cryptography - Public Key Cryptography, Key Agreement, Public Key Authentication, Elliptic Curve Cryptography, Cryptographic Hashes, Message Authentication Codes, Random Number Generation, Key Management for Embedded Systems, Cryptographic Certifications

UNIT 5 EMERGING APPLICATIONS 9

Embedded Network Transactions, Automotive Security, Secure Android, Next-Generation Software-Defined Radio; Smart Home Security and Privacy: Vulnerability analysis – Countermeasures - Implantable medical device security - Security and privacy vulnerabilities of in-car wireless systems - RFID security - GPS spoofing and countermeasures - Wireless electronic warfare: jamming and anti-jamming techniques - Smart phone security

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Outline the concepts, issues, principles, and mechanisms in embedded systems security such as embedded security trends, software vulnerabilities, physical attacks and security policies.

CO2 Recognize vulnerabilities, attacks and need of protection mechanisms for embedded systems

CO3 Analyze and evaluate software vulnerabilities and attacks on operating systems

CO4 Identify the terms and concepts relevant to embedded cryptography.

CO5 Develop and deploy solutions for security of embedded software, data protection and securing practical embedded systems

TEXT BOOKS:

1 David Kleidermacher and Mike Kleidermacher, Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development, 1st Edition, Elsevier / Newnes, 2012.

2 Gebotys, Catherine H., "Security in Embedded Devices", Springer

3 Stapko T., "Practical Embedded Security", Elsevier/Newnes

4 Wenliang Du. Computer Security: A Hands-on Approach. 1st Edition, 2017

e-Resources:

1. https://nptel.ac.in/courses/106106199

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PROFESSIONAL ELECTIVE – 2

22ESE06	AUTOMOTIVE EMBEDDED SYSTEM	L	T	P	C
		3	0	0	3

UNIT 1 BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS **9**

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

UNIT 2 SENSORS AND ACTUATORS FOR AUTOMOTIVES **9**

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEM'S/NEM'S sensors and actuators for automotive applications.

UNIT 3 VEHICLE MANAGEMENT SYSTEMS **9**

Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition- Adaptive cruise control - speed control-anti-locking braking system-electronic suspension - electronic steering, Automatic wiper control- body control system; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- Battery management system, power management system-electrically assisted power steering system- Adaptive lighting system- Safety and Collision Avoidance.

UNIT 4 ON-BOARD DIAGONSTICS AND TELEMATICS **9**

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

UNIT 5 ELECTRIC VEHICLES **9**

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

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 The learning process delivers insight into the significance of the role of embedded system for automotive applications

CO2 Understanding the need, selection of sensors and actuators and interfacing with ECU

CO3 Applying the Embedded concepts for vehicle management and control systems.

CO4 Understanding the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems

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TEXT BOOKS:

1 William B. Ribbens, "Understanding Automotive Electronics", Elsevier, 2012

2 Ali Emedi, Mehrded ehsani, John M Miller, "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004.

3 L. Vlacic, M. Parent, F. Harahima, "Intelligent Vehicle Technologies", SAE International, 2001.

4 Jack Erjavec, Jeff Arias, "Alternate Fuel Technology-Electric, Hybrid & Fuel Cell Vehicles", Cengage, 2012

5 Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford

6 Automotive Electricals / Electronics System and Components, Tom Denton, 3rd Edition, 2004.

7 Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1st edition, March 30, 2000.

8 Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4th Edition, 2004.

9 Automotive Hand Book, Robert Bosch, Bently Publishers, 1997.

10 Jurgen, R., Automotive Electronics Hand Book.

e-Resources:

1. https://nptel.ac.in/courses/107106088

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22ESE07	VIRTUAL INSTRUMENTATION SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

General functional description of a digital instrument - Block diagram of a Virtual Instrument, Advantages of Virtual instruments over conventional instruments - Architecture of a Virtual instrument and its relation to the operating system, LabVIEW – Graphical user interfaces - Controls and Indicators, 'G'-programming – Labels and Text-Shape, Size and Color – Owned and free labels

UNIT 2 GRAPHICAL LANGUAGE 9

Datatype, Format, Precision and representation - Datatypes -Data flow programming, Graphical programming palettes and tools - Front panel objects - Functions and Libraries

UNIT 3 PROGRAMMING STRUCTURE 9

FOR loops, WHILE loops, CASE structure, formula nodes, Sequence structures - Arrays and Clusters - Array operations – Bundle - Bundle/Unbundle by name, graphs and charts

UNIT 4 HANDLING STRINGS 9

String and file I/O - High-level and Low-level file I/O's- Attribute modes Local and Global variables, Case Study: Design a case structured calculator using string as input cases.

UNIT 5 HARDWARE ASPECTS 9

Addressing the hardware in LabVIEW- Digital and Analog I/O function- Data Acquisition- Buffered I/O-Real time Data Acquisition- Case Studies: Interface a temperature sensor to microcontroller, acquire the sensor data and display it in LabVIEW, Interface a motor to microcontroller and control the speed of it through LabVIEW

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the concepts of Graphical programming and differentiate Graphical Programming from conventional programming

CO2 Illustrate the basics of Graphical Programming and its structure

CO3 Explain the process of data acquisition using hardware

CO4 Provide a solution to engineering problem using virtual instrumentation system

CO5 Implement the graphical programming using various functions available in VI.

TEXT BOOKS:

1 Jovitha Jerome Virtual Instrumentation Using LabVIEW, 2010, 1st ed., PHI Learning, India.

2 Ian Fairweather, Anne Brumfield, LabVIEW: A Developer's Guide to Real World Integration, 2011, 1st edition., CRC Press, USA.

3 Sanjay Gupta, Joseph John Virtual Instrumentation Using Lab VIEW Tata MaGraw-Hill (2005)

4 D Patranabis, Sensors and Transducers, PHI 2nd Edition (2003)

5 J.P. Holman Experimental Methods for Engineers McGraw Hill, 6th Edition (2000)

e-Resources:

1. https://nptel.ac.in/courses/112107242
2. www.ni.com

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22ESE08 AUTOMOTIVE EMBEDDED PRODUCT DEVELOPMENT

L	T	P	C
3	0	0	3

UNIT 1 AUTOMOTIVE SYSTEM OVERVIEW AND PRODUCT DEVELOPMENT 9

Major Automotive trends (e-mobility, Autonomous Driving, Comfort and Connected Cars), Vehicle EE architecture, Products. Integration of Mechanical, Software, Hardware domains and their interdependences, Design for x Abilities (manufacturability, testability, serviceability, maintainability), Overview of Design guidelines.

UNIT 2 PROCESS, METHODS AND TOOLS 9

Requirements engineering and version control tools: DOORS, PTC, V model, Product Engineering Process, Automotive Spice, TS 16949, Key Performance Indicators for development.

UNIT 3 PRODUCT RELIABILITY, SAFETY AND QUALITY 9

DFMEA, PFMES, Warranty, Design Validations, Process Validations, Customer Line Return, Non-Quality Expenses, First Pass Yield, Statistical tools, ASIL levels, Safety Goals, Safety Measures, HARA, FMEDA, ISO 26262

UNIT 4 EMC, DESIGN FOR MANUFACTURABILITY AND TESTABILITY 9

Introduction to various regulatory requirements and International electrical and EMC standards, understanding origin of pulses, disturbances, circuit and PCB layout design techniques to meet EMC - PCB Layout considerations, Manufacturing interfaces and process flow, ICT, AOI and EOL testing.

UNIT 5 PROJECT MANAGEMENT AND ORGANIZATION 9

Matrix Organization, Line responsibilities, Functional responsibility, Team work, Leadership, Scope management, Scheduling, Cost, Monitoring & Tracking, Engineering Change Management, Milestones

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the Major Automotive trends and automotive product development process.

CO2 Apply processes, methods and tools to demonstrate automotive embedded system design skills

CO3 Realize the significance of Reliability, Safety and Quality of an automotive embedded system

CO4 Realize importance of interference related issues in an automotive embedded system

CO5 Illustrate the concept of automotive product development project management.

TEXT BOOKS:

1 Navet, Nicolas, and Françoise Simonot-Lion, eds. Automotive embedded systems handbook. CRC press, 2017.

2 Blyler, John. Software-Hardware Integration in Automotive Product Development. SAE, 2014.

3 Cronin, Mary J. Smart products, smarter services: Strategies for embedded control. Cambridge University Press, 2010.

e-Resources:

1. https://nptel.ac.in/courses/107106088

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22ESE09	EMBEDDED SENSOR NETWORKS	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

Over view of sensor networks - Constraints and Challenges -Advantages of sensor networks - Sensor Network Applications - Collaborative Processing - Key definitions in sensor networks - Tracking scenario -Problem formulation -Sensing Model-Collaborative Localization-Bayesian Estimation-Distributed representation and interference of states - Tracking multiple objects - State Space Decomposition-Data Association-Sensor models - performance comparison and metrics.

UNIT 2 NETWORKING SENSORS 9

Key assumptions - medium access control - A survey of MAC protocols for WSN - S-MAC Protocol - IEEE 802.15.4 standard and Zig Bee -Energy efficient design of wireless sensor nodes - General Issues Geographic, Energy-Aware Routing - Unicast Geographic Routing-Routing on a curve-Energy Minimizing Broadcast-Energy Aware Routing to a Region-Attribute based routing-Directed Diffusion-Rumor Routing Geographic Hash table.

UNIT 3 INFRASTRUCTURE ESTABLISHMENT 9

Topology control - Clustering-Time synchronization - Clocks and Communication Delays-Interval Methods Reference Broadcasts-Localization and Localization Services-Ranging Techniques-Range Based Localization Algorithms-Location Services-Task driven sensing- Role of sensor nodes and Utilities Information based Sensor Tasking-Sensor Selection-IDSQ-Cluster leader based Protocol-Sensor tasking in tracking relations -Joint Routing and Information aggregation-Moving Centre of Aggregation-Multistep Information Aggregation-Multistep Information Directed Routing-Sensor Group Management.

UNIT 4 SENSOR NETWORK DATABASE 9

Sensor Database Challenges - Querying the physical environment -Query Interfaces-Cougar Sensor Database-Probabilistic Queries- In-network aggregation - Query Propagation and Aggregation-Tiny DB Query Processing-Query processing Scheduling and Optimization-Data centric storage - Data indices and range queries - Distributed Hierarchical aggregation -Multi resolution Summarization-Partitioning the summaries-Fractional Cascading-Locality Preserving Hashing-Temporal data-Data Aging-Indexing Motion Data.

UNIT 5 SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor Node Hardware - Sensor network programming challenges -Node level software platforms Operating system Tiny OS - Node level simulators - State centric programming- Applications - Core challenges - Research directions - Tiered architectures - Distributed signal processing - Monitoring and Debugging - Security and Privacy.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1	information processing techniques with the architecture of different layers in a sensor network
CO2	Describe the communication subsystem, sensor tasking and control, and data management
CO3	Illustrate various platform to implement WSN
CO4	design and apply various existing routing protocols of sensor networks
CO5	Describe the sensor network programming challenges and solutions

TEXT BOOKS:

1. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks: An Information Processing Approach", Mogan Kaufmann Publishers,2004.
2. Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks" John Wiley, 2011.

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3 Yingshu Li, My T. Thai, Weili Wu, "Wireless Sensor Networks and Applications" Springer 2008

4 Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.

5 C.S. Raghavendra, Krishna M. Sivalingam and TaiebZnati, "Wireless Sensor Networks Springer Publishers, 2006.

e-Resources:

1. https://nptel.ac.in/courses/106105160

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22ESE10	SOFT COMPUTING TECHNIQUES FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO SOFT COMPUTING TECHNIQUES **9**

Fundamentals – Biological neural network – Artificial neuron – Activation function – Learning rules - Single Layer Feedback Networks - Unsupervised Learning Networks - Membership Functions – Features of membership function - Standard forms and Boundaries - fuzzification - membership value assignments. - Toolboxes of MATLAB – Programming and file processing in MATLAB - Model definition and model analysis using SIMULINK - S-Functions - Converting S-Functions to blocks.

UNIT 2 OPTIMISATION TECHNIQUES FOR PHOTOVOLTAIC ENERGY CONVERSION **9**

Passive filter design using Genetic Algorithm, harmonic elimination in inverters, tuning of controllers, GA, PSO, DE, optimized fuzzy logic for the Maximum Power Point Tracking, MATLAB/SIMULINK Models of MPPT Techniques

UNIT 3 OPTIMISATION TECHNIQUES FOR WIND ENERGY CONVERSION SYSTEMS **9**

MATLAB/SIMULINK model of Wind turbine and Wind Turbine Generators. Prediction of Wind Turbine Power Factor, Pitch Angle Control, MPPT Algorithms, Economic Dispatch for Wind Power System – Related MATLAB/SIMULINK models-FLC based STATCOM - Prediction of Wind Speed based on FLC - Fuzzy Logic Controlled SPWM Converter for WECS.

UNIT 4 GRID INTEGRATION **9**

Integration of small-scale generation into distribution grids, Different types of grid interfaces, Issues related to grid Integration systems - Phase Locked Loop for Grid Connected Power System, Grid Connected Inverters, Current Controllers for PWM inverters, MATLAB/SIMULINK model of Grid Integration, and PLL grid connected power system.

UNIT 5 HYBRID ENERGY SYSTEMS **9**

Need for hybrid energy system, MATLAB/SIMULINK models of Hybrid Solar PV and Wind Energy System- - CUK-SEPIC converter, Boost Converter, Hybrid model of Solar PV and Diesel Energy System – Hybrid Solar PV and Wind Energy Conversion Systems

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1	Use neural networks to model the process plants
CO2	Develop fuzzy logic-based controllers for different processes
CO3	Combine fuzzy logic with neural networks for hybrid systems
CO4	Design controllers using fuzzy logic and apply genetic algorithms for optimization
CO5	Develop a model and simulate Hybrid Solar PV and Wind Energy Conversion Systems

TEXT BOOKS:

1. S. Sumathi, Ashok Kumar. L, P. Sureka, "Solar PV and Wind Energy Conversion Systems - An Introduction to Theory, Modeling with MATLAB/SIMULINK, and the Role of Soft Computing Techniques" – Green Energy and Technology, Springer, 2015 edition (20 April 2015).
2. Randall Shaffer, "Fundamentals of Power Electronics with MATLAB" Charles River Media Boston Massachusetts, 2007.
3. Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education India, New Delhi, 2004.
4. Rao S S, "Optimization Theory and Applications", Wiley Eastern Limited, New Delhi, 2003.
5. H.P. Garg and J. Prakash, "Solar Energy, Fundamentals and Applications", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
6. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 2004

e-Resources:

1. https://nptel.ac.in/courses/106105173
2. https://nptel.ac.in/courses/115105127

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PROFESSIONAL ELECTIVE – 3

22ESE11	RENEWABLE ENERGY AND GRID INTEGRATION	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

Various techniques of utilizing power from renewable energy sources, concept of nano/micro/mini grid. Need of integrating large renewable energy sources, issues related to integration of large renewable energy sources, rooftop plants. Concept of VPP.

UNIT 2 POWER SYSTEM EQUIPMENT'S FOR GRID INTEGRATION 9

Synchronous generator: synchronization/integration to existing grid, load sharing during parallel operation, stability (swing equation and solution) Induction Generator: working principle, classification, stability due to variable speed and counter measures Power Electronics: need of power electronic equipment's in grid integration, converter, inverter, chopper, ac regulator and cyclo converters for AC/DC conversion

UNIT 3 POWER QUALITY AND MANAGEMENT 9

THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, system protection, grid codes

UNIT 4 GRID STABILIZATION 9

Scheduling and dispatch, Forecasting, reactive power and voltage control, frequency control, operating reserve, storage systems, electric vehicles Ancillary services in Indian Electricity Market (regulatory aspect), CERC and CEA orders (technical and safety standards)

UNIT 5 INTEGRATION OF ALTERNATE SOURCES OF ENERGY 9

Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Apply advanced knowledge of electrical power system operations and control to analyze the challenges and opportunities for distributed renewable energy generation in both large interconnected grid and microgrid settings.

CO2 Assess renewable energy applications and projects in the context of integration into both the physical and economic electricity markets.

CO3 Describe the principles and requirements of the next generation future power network, incorporating distributed generation and storage and demand management.

CO4 Understand the principles, power and limitations of complex power networks incorporating distributed generation and storage.

TEXT BOOKS:

1 Integration of Alternative sources of Energy, Felix A. Farret and M. Godoy Simoes, IEEE Press – Wiley Inter-science publication, 2006.

2 Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P. Kothari, CRC Press (Taylor & Francis group), 2017

3 Renewable Energy Grid Integration, Marco H. Balderas, Nova Science Publishers, New York, 2009.

4 Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, IET Power and Energy Series 50 (JET digital library), 2007

5 Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, John Wiley & Sons, New York, 2013 (3rd edition)

e-Resources:

1. https://nptel.ac.in/courses/108107113
2. https://nptel.ac.in/courses/103103206

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22ESE12	SYSTEM DESIGN WITH EMBEDDED LINUX	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, Architecture

UNIT 2 EMBEDDED LINUX 9

Kernel Architecture – HAL, Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC, User space, Start-up sequence

UNIT 3 BOARD SUPPORT PACKAGE 9

Embedded Storage: MTD, Architecture, Drivers, Embedded File System, Embedded Drivers: Serial, Ethernet, I2C, USB, Timer, Kernel Modules

UNIT 4 PORTING APPLICATIONS 9

Real-Time Linux: Linux and Real time, Programming, Hard Real-time Linux

UNIT 5 BUILDING AND DEBUGGING 9

Kernel, Root file system, Embedded Graphics, Case study of μC-linux

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Familiarity of the embedded Linux development model.

CO2 Write, debug, and profile applications and drivers in embedded Linux.

CO3 Understand and create Linux BSP for a hardware platform

TEXT BOOKS:

1 Karim Yaghmour, "Building Embedded Linux Systems", O'Reilly & Associates

2 P Raghvan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications

3 Christopher Hallinan, "Embedded Linux Primer: A Practical Real-World Approach", Prentice Hall, 2nd Edition, 2010

4 Derek Molloy, "Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux", Wiley, 1st Edition, 2014

e-Resources:

1. https://elinux.org/Main_Page
2. https://www.arm.com/resources/education/online-courses/embedded-linux
3. https://nptel.ac.in/courses/106105193

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22ESE13 AUTOMATION AND INDUSTRIAL INTERNET OF THINGS

L	T	P	C
3	0	0	3

UNIT 1 INDUSTRIAL AUTOMATION: SENSORS, ACTUATORS AND SCADA 9

History and evolution of automation: Plants to Parts-Plant Layout-Types of automation Transducer: Sensor and Actuator-Sensors – Types of sensors, sampling, analog to digital conversion, selection criteria of sensor and ADC-Data acquisition, storage and analytics Real time analytics- Actuators-Types-Characteristics-Control of Actuators- Analog & Digital I/O Modules, SCADA System and RTU-IEDs- Analysis of Automated Flow Lines- material handling function- Automated Storage Systems- Product identification system: Barcode, RFID etc., - Concept of Data, Information, Knowledge and Wisdom -Understanding fundamental nuances between IoT and Big data-Usage of IoT data in various business domains.

UNIT 2 INDUSTRIAL INTERNET OF THINGS 9

Concept and definitions-Embedded Systems-Computer Networks- M2M (Machine to Machine Communication)- Internet of Everything (IoE)- Machine Learning- Distributed Computing, - Artificial Intelligence-Industrial automation-Interoperability-Identificationlocalization-Communication, Software Defined Assets-Understanding IT and OT convergence: Evolution of IIoT-OT Components: Industrial control system, PLC, SCADA, DCS-IT Components: Hardware-Software- People ,Processes IIoT Adoption-Market statistics, early adopters, Roadmap-Business opportunities: Product + Service model Development, deployment and monetization of applications as service-Use cases

UNIT 3 PROGRAMMABLE LOGIC CONTROLLERS AND INDUSTRIAL COMMUNICATION SYSTEMS 9

Introduction - Relay logic- Block diagram of PLCs-hardware design - Logic Functions Input & Output Modules- Programming of PLC Systems- Timer & Counter Instructions Typical PLC Programming Exercises for Industrial Applications-smart PLCs Principles of interface, serial interface and its standards- parallel interfaces and buses Characteristic features of industrial networks- Low level networks and their features-Field bus architecture- Use of field buses in industrial plants, functions, international standards, performance- HART network- PROFIBUS-PA: Basics, architecture, model, network design and system configuration-MODBUS-CAN BUS-Wireless Sensor Area Networks -Sensor nodes-WSN communication technologies -Bluetooth, zig bee and Wi-Fi-Cellular communication and LPWAN technologies- Applications.

UNIT 4 DESIGN AND DEVELOPMENT OF IIOT SYSTEMS 9

IIoT reference architectures-Standardization Initiatives-Interoperability Issues-Industrial Internet Reference Architecture from Industrial Internet Consortium (IIC)-IIoT design considerations-Architectures Device, Network and Cloud-Centralized vs. distributed architectures-Networks, communication technologies and protocols-Industry 4.0: Smart factory initiative-Product, process and people integration-Smart factories and cyber physical systems-Design Principles-Challenges.

UNIT 5 DISTRIBUTED CONTROL SYSTEMS AND APPLICATIONS 9

Functional Requirements, Configurations - Distributed Control Systems-IIoT in DCS Industrial cloud platforms- Industrial Gateways-Commercial Gateways solutions from Intel, Cisco-Cloud based Gateway solutions- Industrial IoT Security-Industrial IoT and Security Standards and Best Practices-Common Vulnerabilities-Remote health monitoring of the plant-Attack surfaces- Cyber security for Industrial Control Systems. Automation, Control and IIoT Applications in Petroleum Refineries-Cement Plant – Thermal Power Plant – Pharmaceutical Industries – Steel plant- Water Treatment Plant Automobile Industries-Smart Energy Management.

Lecture: 45, Tutorial: 0, Total: 45

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Course Outcomes: Upon completion of this course, students will be able to:

CO1 Get an understanding of what all is required for IoT and industrial automation Components.

CO2 Understand the architecture, emerging industrial infrastructure and challenges involved in deployment of IIoT based industrial automation

CO3 Understand the concepts, programming and hardware design of Programmable Logic Controllers for smart automation and also discuss the network standards, interfacing and communication techniques.

CO4 Design and develop a suitable IIoT controller for automated system involving for smart manufacturing.

CO5 Discuss the fundamental requirements of process control systems and describe the architecture of various distributed control systems of IIoT and analysis the security issues and applications of IIoT in DCS

TEXT BOOKS:

1 M.P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing" Pearson Education Limited, New Delhi, 2015.

2 Clarence W. De Silva, "Sensors and actuators: Control System Instrumentation" CRC Press, 2007

3 Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things" Academic Press, 1st edition, June 2016.

4 Cuno Pfster, "Getting Started with the Internet of Things" Published by O'Reilly Media, Inc.2011.

5 Jose' Cecilio, and Pedro Furtado, "Wireless Sensors in Industrial Time-Critical Environments" Springer International Publishing, Switzerland 2014.

e-Resources:

1. https://nptel.ac.in/courses/106105195
2. https://www.tti.com/content/ttiinc/en/resources/market---technology-resource-centers/industrial-iot-overview/industrial-iot-resources.html

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22ESE14	DESIGN OF SOLAR PHOTOVOLTAIC SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 FUNDAMENTALS OF SOLAR PHOTOVOLTAIC TECHNOLOGY 9

Historical review- Basic approaches and objectives - Phenomena of light and energy- Energy from the sun – Photovoltaic (PV) cell characteristics - Model of PV cell - Datasheet study.

UNIT 2 SOLAR PHOTOVOLTAIC MODULES 9

Design structure of PV modules – Series and parallel connection of cells - Identical cells in series- Nonidentical cells in series - Protecting cells in series - Interconnecting modules in series - Identical cells in parallel, non-identical cells in parallel - Protecting cells in parallel – I-V and power curve of PV modules - Effect of temperature.

UNIT 3 SOLAR RADIATION 9

Insolation and irradiance- Insolation variation with time of day - Solar radiation outside the earth's atmosphere - Solar radiation at the earth's surface – Solar radiation data - Solar radiation geometry - Effect of solar irradiation - Energy on a horizontal flat surface - Energy on a tilted flat surface – Energy with atmospheric effects- PV System Emulation.

UNIT 4 SIZING OF PV 9

Batteries - Capacity – Factors affecting battery performance - Choice of battery – Battery charging and discharging methods – Battery size. Charge controllers - Types of charge controllers - Maximum Power Point Tracking (MPPT) - Algorithms of MPPT- Impedance control methods, Reference cell, Sampling method, Power slope methods, Hill climbing method – PV module simulation.

UNIT 5 PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS 9

Classifications - Standalone, grid connected and hybrid PV systems - configurations - working principle - Application examples. Economic Analysis: Payback Period-Life cycle costing - Time value of Money-present worth factor -Life cycle cost with example.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the fundamentals of solar photovoltaic technology

CO2 Design the structure of solar photovoltaic modules

CO3 Understand the solar radiation

CO4 Analyse the sizing of PV

CO5 Understand the applications of photovoltaic system design

TEXT BOOKS:

1 Chetan Singh Solanki, "Solar Photovoltaics: Fundamental, Technologies and Applications", PHI Learning Pvt. Ltd, New Delhi, 2015.

2 Parimita Mohanty, Tariq Muneer, Mohan Kolhe, "Solar Photovoltaic System Applications: A Guidebook for Off-Grid Electrification", Springer, 2015.

3 S. Sumathi, L. Ashok Kumar, P. Surekha, "Solar PV and Wind Energy Conversion Systems: An Introduction to Theory, Modeling with MATLAB/SIMULINK, and the Role of Soft Computing Techniques", Springer, 2015.

e-Resources:

1. https://nptel.ac.in/courses/117108141
2. https://nptel.ac.in/courses/115107116

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22ESE15	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

UNIT 1 LINEAR PROGRAMMING 9

Statement of Optimization problems, Graphical method, Simplex method, Revised simplex method, Two phase simplex method, Duality in linear programming, Sensitivity analysis.

UNIT 2 NON-LINEAR PROGRAMMING (UNCONSTRAINED OPTIMIZATION) 9

Direct search methods - Univariate method, Pattern search method, Simplex method, Descent methods - Steepest Descent method, Conjugate gradient method, Quasi Newton method.

UNIT 3 NON-LINEAR PROGRAMMING (CONSTRAINED OPTIMIZATION) 9

Direct methods - The Complex method, Zoutendijk's Method of Feasible Directions, Rosen's Gradient Projection Method, Indirect method - Transformation Techniques, Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Exterior Penalty Function Method.

UNIT 4 DYNAMIC PROGRAMMING 9

Multistage decision process, Sub optimization and Principle of Optimality, Computational procedure, Final value problem to initial value problem.

UNIT 5 CASE STUDY 9

Linear Programming as a Case of Dynamic Programming, Continuous dynamic programming

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Formulate real-life problems with Linear Programming.

CO2 Discuss real-life problems with Non-Linear Programming for unconstrained optimization.

CO3 Analyze real-life problems with Non-Linear Programming for constrained optimization.

CO4 Examine dynamic programming with optimization

TEXT BOOKS:

1 Sharma J K., "Operations Research: Theory and Applications", Macmillan Company, New Delhi, 2013.

2 Hamdy A Taha, "Operations Research: An Introduction", Pearson Education, New Delhi, 2012.

3 Gupta C B., "Optimization Techniques in Operations Research", I K International, New Delhi, 2012.

e-Resources:

1. https://nptel.ac.in/courses/105108127
2. https://nptel.ac.in/courses/112101298

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PROFESSIONAL ELECTIVE – 4

22ESE16	ELECTRIC VEHICLES AND POWER MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT 1 ELECTRIC VEHICLES AND VEHICLE MECHANICS **9**

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

UNIT 2 ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS **9**

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

UNIT 3 CONTROL OF DC AND AC DRIVES **9**

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor-based vector control operation – Switched reluctance motor (SRM) drives

UNIT 4 BATTERY ENERGY STORAGE SYSTEM **9**

Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries

UNIT 5 ALTERNATIVE ENERGY STORAGE SYSTEMS **9**

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Understand the operation of Electric vehicles

CO2 Understand the architecture of Electric vehicles

CO3 Understand the various energy storage technologies for electrical vehicles

TEXT BOOKS:

1 Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).

2 Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel Dekker, Inc 2010

e-Resources:

1. https://nptel.ac.in/courses/108106182
2. https://nptel.ac.in/courses/108102121

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22ESE17	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO ROBOTICS 9

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

UNIT 2 POWER SOURCES AND SENSORS 9

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

UNIT 3 MANIPULATORS, ACTUATORS AND GRIPPERS 9

Construction Of Manipulators – Manipulator Dynamics and Force Control – Electronic and Pneumatic Manipulator Control Circuits – End Effectors – Various Types of Grippers – Design Considerations.

UNIT 4 KINEMATICS AND PATH PLANNING 9

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

UNIT 5 CASE STUDIES 9

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Selection of suitable embedded boards for robots

CO2 Understanding the concepts of robotics & automation and working of robot

CO3 Analyze the function of sensors and actuators in the robot

CO4 Write program to use a robot for a typical application

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

TEXT BOOKS:

1 Industrial Automation and Robotics by A.K. Gupta, Jean Riescher Westcott, and Satish Kumar Arora, 2007.

2 Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", Mc Graw-Hill Singapore, 1996.

3 Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

4 Deb. S.R., "Robotics Technology and Flexible Automation", John Wiley, USA 1992.

5 Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An Integrated Approach", Prentice Hall of India, New Delhi, 1994.

e-Resources:

1. https://nptel.ac.in/courses/107106090
2. https://nptel.ac.in/courses/112107289

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22ESE18	MEMS AND NEMS TECHNOLOGY	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO MEMS AND NEMS 9

Introduction to Design of MEMS and NEMS, Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.

UNIT 2 MEMS FABRICATION TECHNOLOGIES 9

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.

UNIT 3 MICRO SENSORS 9

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester

UNIT 4 MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study: RF Switch.

UNIT 5 NANO DEVICES 9

Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Interpret the basics of micro/nano electromechanical systems including their applications and advantages

CO2 Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.

CO3 Analyze the key performance aspects of electromechanical transducers including sensors and actuators

CO4 Comprehend the theoretical foundations of quantum mechanics and Nano systems

TEXT BOOKS:

1 Marc Madou, Fundamentals of Microfabrication, CRC press 1997.

2 Stephen D. Senturia, Micro system Design, Kluwer Academic Publishers,2001

3 Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata McGraw Hill, 2002.

4 Chang Liu, Foundations of MEMS, Pearson education India limited, 2006

5 Sergey Edward Lyshevski, MEMS and NEMS: Systems, Devices, and Structures CRC Press, 2002

e-Resources:

1. https://nptel.ac.in/courses/117105082
2. https://nptel.ac.in/courses/108108113

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22ESE19	EMBEDDED SYSTEM DESIGN USING FPGA	L	T	P	C
		3	0	0	3

UNIT 1 EMBEDDED SYSTEM OVERVIEW **9**

H/W-FPGA-Embedded SoC and use of VLSI circuit technology-platform FPGA's-Altera Cyclone

UNIT 2 HARDWARE DESCRIPTION LANGUAGES **9**

Hardware Description Languages - VHDL, Verilog, Other High-Level HDLs, From HDL to Configuration Bit-stream

UNIT 3 SYSTEM DESIGN USING FPGA **9**

Principles of system design-Design quality, Modules and interfaces, Abstraction and state, Cohesion and coupling, Designing and Reuse, Control flow graph, Design-Origins of platform

UNIT 4 FPGA PLATFORM **9**

Components, Adding to platform FPGA systems, assembling custom compute cores. Software Design-System Software Options, Root File system, Cross-Development Tools, Monitors and Boot-loader.

UNIT 5 PARTITIONING, SCHEDULING & COMMUNICATION **9**

Overview of Partitioning Problem, Analytical Solution to Partitioning-Basic definitions, expected performance gain, Resource considerations, Analytical Approach. Communication-Invocation/Coordination, Transfer of State, Practical Issues- Profiling Issues, Data Structures Manipulate Feature Size

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Comprehend overview of Embedded System

CO2 Learn Hardware Description Languages

CO3 Acquire abilities to Design an embedded system using FPGA and Use Xilinx IP Cores

CO4 Comprehend Partitioning concepts

CO5 Comprehend Scheduling & Communication, Identify and exploitation of Parallelism concepts

TEXT BOOKS:

1 Ron Sass, Andrew G Schmidt Embedded Systems Design with Platform FPGAs Principles and Practices, 2011, First Edition, Tata McGraw Hill, India.

2 Charles H Roth. Jr Digital Systems design using VHDL, 2012, Re-Print, PWS publishing company (Thomson Books), USA.

3 V A. Padroni Circuit Design with VHDL 2011, First Edition, MIT Press Cambridge, England.

4 Wayne Wolf, FPGA Based System Design, 2011, First Edition, Prentices Hall Modern Semiconductor Design Series, USA.

e-Resources:

1. https://nptel.ac.in/courses/117108040
2. https://nptel.ac.in/courses/106105159
3. https://nptel.ac.in/courses/108102169

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22ESE20	SMART SYSTEM DESIGN	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

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

UNIT 2 MOBILE EMBEDDED SYSTEM 9

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

UNIT 3 HOME AUTOMATION 9

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

UNIT 4 SMART APPLIANCES AND ENERGY MANAGEMENT 9

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

UNIT 5 EMBEDDED SYSTEMS AND ROBOTICS 9

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

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

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

CO3 Students will acquire knowledge on different platforms and Infrastructure for Smart system design.

CO4 Students will learn the art of implementing embedded system for smart applications and control.

TEXT BOOKS:

1 Thomas Bräunl, Embedded Robotics, Springer, 2003.

2 Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013.

3 Raj Kamal, Embedded Systems - Architecture, Programming and Design", McGraw- Hill, 2008

4 Nilanjan Dey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016.

5 Karim Yaghmour, Embedded Android, O'Reilly, 2013.

6 Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress, 2013

e-Resources:

1. https://nptel.ac.in/courses/108105057
2. https://nptel.ac.in/courses/108105063

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PROFESSIONAL ELECTIVE – 5

22ESE21	EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM	L	T	P	C
		3	0	0	3

UNIT 1 BUILDING SYSTEM AUTOMATION 9

Sensor Types and Characteristics: Sensing Voltage, Current, flux, Torque, Position, Proximity, Accelerometer - Data acquisition system- Signal conditioning circuit design- µC Based and PC based data acquisition - µC 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 2 EMBEDDED NETWORKING OF INSTRUMENT CLUSTER 9

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

UNIT 3 AUTOMATION OF SUBSTATION 9

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

UNIT 4 METERING OF SMART GRID 9

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 5 SMART METERS FOR PQ MONITORING 9

Power Quality issues of Grid connected Renewable Energy Sources -Smart meters for Power Quality monitoring and Control - Power Quality issues -Surges -Flicker - Inter-harmonics - Transients - Power Quality Benchmarking - Power Quality Meters- Meter data management in Smart Grid, communication enabled Power Quality metering.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Explain the different type of sensors and components to build meters.

CO2 Describe different type of BUS communication protocols

CO3 Analyze the need and standards in Substation automation

CO4 Deploy PAN for metering networked commercial applications

CO5 Build Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications

TEXT BOOKS:

1 Control and automation of electrical power distribution systems, James Northcote Green, Robert Wilson, CRC, Taylor and Francis, 2006

2 Krzysztof Iniewski, "Smart Grid, Infrastructure & Networking", Tata McGraw Hill, 2012

e-Resources:

1. https://nptel.ac.in/courses/108102169
2. https://nptel.ac.in/courses/112102011
3. https://nptel.ac.in/courses/108107113

22ESE22	PYTHON PROGRAMMING FOR MACHINE LEARNING	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO MACHINE LEARNING **9**

Applications of Machine Learning, Supervised vs Unsupervised Learning, Python libraries suitable for Machine Learning

UNIT 2 REGRESSION **9**

Linear Regression, Non-linear Regression, Model evaluation methods

UNIT 3 CLASSIFICATION **9**

K-Nearest Neighbour, Decision Trees, Logistic Regression, Support Vector Machines, Model Evaluation

UNIT 4 UNSUPERVISED LEARNING **9**

K-Means Clustering, Hierarchical Clustering, Density - Single Linkage Clustering - Based Clustering - Algorithms for Hierarchy Clustering

UNIT 5 RECOMMENDER SYSTEMS **9**

Content-based recommender systems, Collaborative Filtering and its Challenges, Python for data science

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Identify machine learning concepts and techniques.

CO2 Use the concept of regression to the practical aspects of machine learning.

CO3 Use the concept of classification to the practical aspects of machine learning.

CO4 Use the concepts of unsupervised learning.

CO5 Use the concepts of recommender systems.

TEXT BOOKS:

1 Machine Learning using Python - Manaranjan Pradhan, Wiley, 2017

2 Introduction to Machine Learning with Python: A Guide for Data Scientists - Andreas Muller, 2016

e-Resources:

1. https://nptel.ac.in/courses/106105152
2. https://nptel.ac.in/courses/106106139

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22ESE23	MACHINE LEARNING AND DEEP LEARNING FOR EMBEDDED SYSTEM	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

Learning Problems – Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.

UNIT 2 LINEAR MODELS 9

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT 3 BASICS OF NEURAL NETWORKS 9

Basic Concept of Neurons – Perceptron Algorithm – Feed Forward and Backpropagation Networks – Deep Feed-Forward Neural Networks.

UNIT 4 CONVOLUTIONAL NEURAL NETWORKS 9

CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning – Recurrent and Recursive Nets – Recurrent Neural Networks – Deep Recurrent Networks – Recursive Neural Networks – Applications.

UNIT 5 APPLICATIONS OF DEEP LEARNING 9

Images segmentation – Object Detection – Automatic Image Captioning – Image generation with Generative adversarial networks – Video to Text with LSTM models – Attention models for Computer Vision – Case Study: Named Entity Recognition

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Differentiate between supervised, unsupervised, semi-supervised machine learning approaches

CO2 Analyse and suggest the appropriate machine learning approach for the various types of problem

CO3 Design and implement convolutional neural networks.

CO4 Design and implement deep learning applications.

TEXT BOOKS:

1 Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

2 Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.

3 Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2009.

4 Ian J. Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.

5 Francois Chollet, "Deep Learning with Python", Manning Publications, 2018

e-Resources:

1. https://nptel.ac.in/courses/106106139
2. https://nptel.ac.in/courses/106106184

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22ESE24	DISTRIBUTED GENERATION AND MICRO GRIDS	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION **9**

Energy Sources and their availability -trends in energy consumption, conventional and non-conventional energy sources – review of solar photovoltaic – wind energy systems – fuel cells, energy storage systems: batteries – ultra capacitors – fly wheels – captive power plants.

UNIT 2 DISTRIBUTED GENERATION **9**

Concept and topologies, renewable energy in distributed generation, IEEE 1547 Standard for interconnecting distributed generation to electric power systems – DG installations – siting and sizing of DGs – optimal placement –regulatory issues

UNIT 3 ISSUES IN GRID INTEGRATION OF DISTRIBUTED ENERGY RESOURCES **9**

Basic requirements of grid interconnections – operational parameters – voltage, frequency and THD limits – grid interfaces – inverter based DGs and rotary machines based DGs – reliability, stability and power quality issues on grid integration – impact of DGs on protective relaying and islanding issues in existing distribution grid.

UNIT 4 MICROGRIDS **9**

Introduction to microgrids – types – structure and configuration of microgrids – AC and DC microgrids – power electronic interfaces for microgrids – energy management and protection control strategies of a microgrid - case studies.

UNIT 5 CONTROL AND OPERATION OF MICROGRID **9**

Modes of operation and control of microgrid: grid connected and islanded mode, active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication-based techniques, microgrid communication infrastructure, power quality issues in microgrids, regulatory standards, microgrid economics, and introduction to smart microgrids.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Understand the grid system.

CO2 Students able to know the issues in grid integration of distributed energy resources.

CO3 Understand the control and operation of micro grids.

CO4 Economic analysis for microgrid operational modes with control system.

TEXT BOOKS:

1 Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley, 2016

2 Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 2012.

3 Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, 2012.

e-Resources:

1. https://nptel.ac.in/courses/108108034
2. https://nptel.ac.in/courses/108107112

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22ESE25	ENTREPRENEURSHIP AND EMBEDDED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

UNIT 1 BASICS FOR ENTREPRENEURSHIP 9

The entrepreneurial culture and structure -theories of entrepreneurship -entrepreneurial traits - types - behavioural patterns of entrepreneurs -entrepreneurial motivation -establishing entrepreneurial systems -idea processing, personnel, financial information and intelligence, rewards and motivation - concept bank -Role of industrial Fairs.

UNIT 2 CHALLENGES FOR ENTREPRENEURSHIP 9

Setting quality standards- recruitment strategies- time schedules- Financial analysis - credit facilities- Marketing channel – advertisement- institutions providing technical, financial and marketing assistance- factory design -design requirements -applicability of the Factories Act.

UNIT 3 RESPONSIBILITIES IN ENTREPRENEURSHIP 9

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

UNIT 4 SCOPE IN EMBEDDED SYSTEM FIELD 9

Entrepreneurship opportunities in Embedded system technologies - embedded systems design, modeling, Feasibility study on embedded system products- Entrepreneurial skills for embedded system hardware and software architecture, software and hardware co-design and challenges; problems of entrepreneurship in Embedded system field.

UNIT 5 SCOPE THROUGH EMBEDDED PRODUCTS 9

Embedded system Product development- feature driven development- release management-market pull product search, Entrepreneurial case studies: Mobile phone development- automation components-Washing machine- Food Processing system and devices- High Performance embedded computers- Industrial Controllers.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Analyze the internal/external factors affecting a business/organization to evaluate business opportunities.

CO2 Demonstrate extemporaneous speaking skills developed through in-class discussion of text materials, case study analyses, and current entrepreneurship-related issues.

CO3 Demonstrate basic computer proficiency, including the use of word processing, presentation, and spreadsheet software packages, as well as a basic facility with the internet and other research tools.

CO4 Key concepts underpinning entrepreneurship and its application in the recognition and exploitation of product/ service/ process opportunities

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

TEXT BOOKS:

1 Kuratko, Entrepreneurship: A Contemporary Approach, Thomson Learning, 2001.

2 Thomas Zimmerer et.al., Essentials of Entrepreneurship and small business Management 3rd Ed. Pearson Education, 2002.

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3 Greene, Entrepreneurship: Ideas in Action, Thomson Learning, Mumbai, 2000
4 Jeffry Timmons, New Ventrure creation, McGraw Hill, 1999.
5 Gupta, C. B., and N. P. Srinivasan. "Entrepreneurial development." Sultan Chand & Sons, New Delhi, 1992
6 LyLa B. Das "Embedded Systems: An Integrated Approach" Pearson, 2013
7 James K. Peckol," Embedded Systems: A contemporary Design Tool", Wiley, 2014

e-Resources:

1 https://nptel.ac.in/courses/110106141

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OPEN ELECTIVE COURSES

22ESO01	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT 2 BIOMASS PYROLYSIS 9

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

UNIT 3 BIOMASS GASIFICATION 9

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

UNIT 4 BIOMASS COMBUSTION 9

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

UNIT 5 BIO ENERGY 9

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

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

TEXT BOOKS:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

e-Resources:

1. https://nptel.ac.in/courses/103107125

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22ESO02	INDUSTRIAL DRIVES FOR AUTOMATION	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

Construction and Principle of operation of PMSM and SynRM – AC drive Hardware Blocks – Control Blocks

UNIT 2 AUTOMATIC MOTOR ADAPTATION 9

Basics of automatic motor adaptation - Challenges in automatic motor adaptation - Parameterization of Drives (Local and Remote).

UNIT 3 CONFIGURATIONS OF DIFFERENT I/O CONTROL 9

Digital Input and output – Analog Input and output Control-word access – Motion control - Sequential Logic Control (SLC) - Parameterization for different communication protocol: RS 485 – MODBUS – PROFIBUS

UNIT 4 CONFIGURATION FOR DIFFERENT APPLICATIONS 9

AQUA – HVAC – Automation – Master/ Slave control

UNIT 5 CASE STUDY 9

Performance characterization of PMSM and SynRM - Conveyor control – Cascaded Pump Control – Synchronization of Drives with Master Slave Control.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Discuss the basic components of the drive system from automation perspective.

CO2 Analyze the automatic motor adaptation concepts.

CO3 Understand the configurations of different I/O control

CO4 Design a component or a product applying all the relevant standards with realistic constraints.

TEXT BOOKS:

1 Ned Mohan, "Advanced Electric Drives: Analysis, Control and Modeling using Simulink", John Wiley and Sons Ltd, 2001.

2 Programming Guide for FC Drives by Danfoss Industries Pvt. Ltd., 2009.

3 Monograph prepared by PSG-Danfoss CoE for Climate and Energy, 2010.

e-Resources:

1. https://nptel.ac.in/courses/108105062
2. https://nptel.ac.in/courses/108105063

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22ESO03	HYBRID ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

UNIT 1 INTRODUCTION 9

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT 2 BASICS OF HYBRID ELECTRIC VEHICLE 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

UNIT 3 DRIVE –TRAIN TOPOLOGIES 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Basic concepts of electric traction, introduction to various electric drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT 4 ELECTRIC COMPONENTS IN HYBRID AND ELECTRIC VEHICLES 9

Electric Drives in HEV/EVs, Classification and Characteristics, configuration and Control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives and Switched Reluctance Motor drives for HEV/EVs applications, Drive System efficiency. Performance matching of Electric Machine and the Internal Combustion Engine (ICE), Sizing the propulsion motor, sizing of power electronic devices and Energy Storage systems.

UNIT 5 ENERGY MANAGEMENT STRATEGIES 9

Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies - implementation issues.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.

CO2 Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.

CO3 Analyze various electric drives suitable for hybrid electric vehicles.

CO4 Discuss different energy storage technologies used for hybrid electric vehicles and their control.

CO5 Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

TEXT BOOKS:

1 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010.

2 Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2009.

3 Sira -Ramirez, R. Silva Ortigoza, 'Control Design Techniques in Power Electronics Devices', Springer, 2006

e-Resources:

1. https://nptel.ac.in/courses/108103009
2. https://nptel.ac.in/courses/108102121

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22ESO04	MODERN AUTOMOTIVE ELECTRONICS SYSTEMS	L	T	P	C
		3	0	0	3

UNIT 1 FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system. Security and warning system.

UNIT 2 STARTING SYSTEM 9

Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, Starter switches.

UNIT 3 CHARGING SYSTEM 9

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout. Voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects. Bridge rectifiers and new developments.

UNIT 4 BATTERIES AND ACCESSORIES 9

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods. Horn, wiper system and trafficator.

UNIT 5 SENSORS AND ACTIVATORS 9

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids. Stepper motors and relay.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Understand the basics of automotive electronics.

CO2 Analyze the various charging systems.

CO3 Understand the needs of sensors and activators.

TEXT BOOKS:

1 Bechhold, Understanding Automotive Electronics, SAE, 1998.

2 W.H. Crouse, Automobile Electrical Equipment, McGraw-Hill, 1996.

3 A W Judge, Modern Electrical Equipment of Automobiles, Chapman & Hall, 1992.

4 P.L. Kholi, Automotive Electrical Equipment, Tata McGraw-Hill, 1995.

5 A.P. Young, L. Griffiths Automotive Electrical Equipment, ELBS & New Press, 1999.

6 William. B. Riddens, Understanding Automotive Electronics, Butter worth Heinemann Woburn, 1998.

7 Robert Bosch Automotive Hand Book, SAE, 2000.

e-Resources:

1. https://nptel.ac.in/courses/107106088
2. https://nptel.ac.in/courses/108108147

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AUDIT COURSES

22AC01	ENGLISH FOR RESEARCH PAPER WRITING Audit Course – 1*	L	T	P	C
		2	0	0	0

Preamble

The course was designed to meet their needs in writing up their research in the form of conference papers and research articles, developing writing skills by analyzing model texts written by 'expert' writers, consolidating more advanced aspects of English grammar relevant to writing research papers and comparing various practices and conventions used in writing research papers across a range of disciplines.

UNIT 1 INTRODUCTION TO RESEARCH PAPER WRITING 9

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

UNIT 2 PRESENTATION SKILLS 9

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

UNIT 3 TITLE WRITING SKILLS 9

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

UNIT 4 RESULT WRITING SKILLS 9

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

UNIT 5 VERIFICATION SKILLS 9

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Understand that how to improve your writing skills and level of readability

CO2 Learn about what to write in each section

CO3 Understand the skills needed when writing a Title

CO4 Understand the skills needed when writing the Conclusion

CO5 Ensure the good quality of paper at very first-time submission

TEXT BOOKS:

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

e-Resources:

1. https://nptel.ac.in/courses/110105091

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22AC02	DISASTER MANAGEMENT Audit Course – 2*	L	T	P	C
		2	0	0	0

Preamble

This course is useful to provide students an exposure to disasters- their significance and types and knowledge on relationship between vulnerability- disasters- disaster prevention and risk reduction.

UNIT 1 INTRODUCTION 9

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

UNIT 2 REPERCUSSIONS OF DISASTERS AND HAZARDS 9

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

UNIT 3 DISASTER PRONE AREAS IN INDIA 9

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

UNIT 4 DISASTER PREPAREDNESS AND MANAGEMENT 9

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

UNIT 5 RISK ASSESSMENT 9

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

Total Periods: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Identify and explain the types of disasters- causes and their impact on environment and society.

CO2 Identify and explain the vulnerability and various types of hazards.

CO3 Draw the hazard and vulnerability profile of India- Scenarios in the Indian context- Disaster damage assessment and management.

CO4 Apply the remote sensing and GIS techniques for predicting the natural disasters.

CO5 Discuss how to work on recovery & risk assessment due to disasters.

TEXT BOOKS:

1. Singhal J.P, - Disaster Managementl, Laxmi Publications - 2010.
2. Tushar Bhattacharya, - Disaster Science and Managementl, McGraw Hill India Education Pvt. Ltd.- 2012.

REFERENCES:

1. Gupta Anil, K. Sreeja, S. Nair, - Environmental Knowledge for Disaster Risk Management- NIDMl, New Delhi - 2011.
2. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
3. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company, 2007.

e-Resources:

1. https://nptel.ac.in/courses/105104183

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22AC03	CONSTITUTION OF INDIA Audit Course – 3*	L	T	P	C
		2	0	0	0

Preamble

Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' Constitutional. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism

UNIT 1 HISTORY ANDPHILOSOPHY OF THE INDIAN CONSTITUTION **6**

History: History, Drafting Committee, (Composition & Working), Philosophy: Preamble, Salient Features.

UNIT 2 CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES **6**

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

UNIT 3 ORGANS OF GOVERNANCE **6**

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

UNIT 4 LOCAL ADMINISTRATION **6**

District's Administration head: Role and importance, Municipalities: Introduction, Mayor and roleof Elected Representative, CEO, Municipal Corporation. Panchayati Raj: Introduction, PRI: ZilaPanchayat. Elected officials and their roles, CEO ZilaPanchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT 5 ELECTION COMMISSION **6**

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

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Describe the emergence and evolution of Indian Constitution, structure and composition of Indian Constitution and federalism in the Indian context.

CO2 Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO3 List the functions of Centre, States and District Administrations, Fundamental rights needed to develop human personality in free society.

CO4 Identify different levels of Panchayat Raj system and its working.

CO5 Elaborate the role of Election Commission and its power to conduct free and fair election throughout India.

REFERENCES:

1 The Constitution of India,1950(Bare Act), Government Publication.

2 Dr. S.N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution,1st Edition, 2015.

3 M.P. Jain, Indian Constitution Law, 7th Edition., Lexis Nexis,2014.

4 D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

e-Resources:

1. https://nptel.ac.in/courses/129106003

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22AC04	PEDAGOGY STUDIES Audit Course – 4*	L T P C 2 0 0 0

Preamble

The general aims of the course are that the student should acquire knowledge of pedagogical theories of relevance to work with people. Learning outcomes on completion of the course, the student should - describe the basic view of different pedagogical orientations - apply concepts related to learning theory - describe and reflect on different theories of motivation and learning - account for different forms of supervision.

UNIT 1 INTRODUCTION 9

Dimensions of Individual development: Physical, Cognitive, Affective, Social and Moral their interrelationships and implications for teachers - Key Cognitive Processes: Perception, Attention, Memory, Language, Thinking, Problem Solving, Emotions and Motivation. - Stages of Development- Developmental tasks with focus on processes of growth and development across various stages from Infancy to Post Adolescence and their significance to Learning.

UNIT 2 LEARNING THEORIES 9

Theories of Learning (Concepts, Principles and applicability is different learning situations): - Thorndike, Pavlov, Skinner, Kohler, Guthrie -Piaget, Rogers, Bandura ,Vygotsky - Distinction between learning as Construction of Knowledge and Learning as Transmission and Reception of Knowledge- Meaning of Cognition and its role in learning. Socio-Cultural factors influencing Cognition and Learning - Understanding processes that facilitate Construction of Knowledge : (i) Experiential Learning and Reflection (ii) Social Mediation (iii) Negotiability (iv) Situated Learning and Cognitive Apprenticeship (v) Meta-cognition - Role of a teacher in a teaching-learning context: (a) Transmitter of knowledge (b) Model (c) Facilitator (d) Negotiator (e) Learner.

UNIT 3 OUTCOME BASED EDUCATION 9

Introduction – Accreditation – Approach to design Outcome based learning – Instructional design for active learning (ADDIE model, etc.,) – Accreditation - Framing Vision, Mission- Graduate attributes, Program outcomes and Program Educational Objectives - Bloom's Taxonomy – Writing Learning outcomes for a course – Assessment and Evaluation – Assessment Methods - Evaluation.
Assignment/ Activity: Course Module development for a course.

UNIT 4 TEACHING AND LEARNING 9

Traditional Teaching methods- Outcome based Modern teaching methods – Good Teaching Attributes - Active Learning methods (Problem based learning, Cooperative Learning, Focused groups) - Flipped classroom.
Assignment / Activity: Innovative Teaching methods.

UNIT 5 RESEARCH IN EDUCATION 9

What is educational research – Overview of educational research process – Ethics in educational research- Qualitative research methods and Quantitative research methods.

Lecture: 45, Tutorial: 0, Total: 45

Course Outcomes: Upon completion of this course, students will be able to:

CO1 Explain different dimensions of learning

CO2 Apply suitable learning theory for the class

CO3 Use outcome-based education approaches to their class

CO4 Exhibit different teaching methods for active learning

CO5 Apply the concepts and tools of qualitative and quantitative research methods in education.

TEXT BOOKS & REFERENCE BOOKS:

1. Dr. V V Rao, "Outcome based education and accreditation", Notion press, 2015

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2. Mukunda Sarma and Kishor Kumar, "Educational Theories and practices: Towards a new social", Mittal publications, January 2021.
3. Dale H. Schunk, "Learning Theories: An Educational Perspective", Springer 2007
4. Raymond P Perry, John C Smart, "Scholarship teaching and learning in Higher education: An evidence-based perspective", Springer 2007
5. Book chapter by Harry G Murray, "Low inference teaching behaviors and college teaching effectiveness: Recent developments and controversies", 2012

e-Resources:

1 https://nptel.ac.in/courses/121105010

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