P.S.R.ENGINEERING COLLEGE

(An Autonomous Institution & Affiliated to Anna University, Chennai)

SIVAKASI - 626140

M.E. –APPLIED ELECTRONICS

PG REGULATION-2023

CURRICULUM AND SYLLABI

[1st To 4th Semester]

PROGRAMME OUTCOMES (PO's)

- **PO1:** An ability to independently carry out and solve practical problems in the key areas of Applied Electronics.
- **PO2:** Design solutions for complex engineering problems with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO3:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO4:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO5:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools to analyze problems.
- **PO6:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PROGRAMME SPECIFIC OUTCOMES (PSO's)

- **PSO1:** Design, simulate and analyze diverse problems in the field of Applied Electronics.
- **PSO2:** Solve problems in the Mixed Logic circuits, Chip Level Design, Embedded System, IOT and Artificial Intelligence with competence in modern tool usage.
- **PSO3:** Apply signal and image processing techniques to analyze a system for machine learning applications.
- **PSO4:** Graduates will have a broad understanding of economical, environmental, societal and health involved in infrastructural development and ability to function within multidisciplinary teams.

P.S.R.ENGINEERING COLLEGE, SIVAKASI-626140
PG REGUALTION-2023
M.E. APPLIED ELECTRONICS
CURRICULUM
[I – IV SEMESTERS - FULL TIME]

Total Credits: 70

SEMESTER - I					
Sl	Code	-Course Title	Category	L-T-P	C
1	232AE11	Analog and Mixed Signal IC Design	PC	3-0-0	3
2	232AE12	Semiconductor Devices and Modeling	PC	3-0-0	3
3	232AE13	Adaptive Signal Processing	PC	3-0-0	3
4	232AE14	Power Conservation Circuits for Electronics	PC	3-0-0	3
5	232AE15	Embedded Systems Design	PC	2-0-2	3
6	232SE13	Research Methodology and IPR	ES	3-0-0	3
7	232ACXX	Audit Course 1	MC	2-0-0	-
8	232AE16	Mixed Circuit Design Laboratory	PC	0-0-4	2
9	232AE17	Adaptive Signal Processing Laboratory	PC	0-0-4	2
					No. of Credits: 22

SEMESTER - II					
Sl	Code	Course Title	Category	L-T-P	C
1	232AE21	Machine Learning Techniques	PC	3-0-0	3
2	232AE22	Flexible Electronics	PC	2-0-2	3
3	232AEEXX	Elective I*	PE	3-0-0	3
4	232AEEXX	Elective II*	PE	3-0-0	3
5	232AEEXX	Elective III*	PE	3-0-0	3
6	232ACXX	Audit Course 2	MC	2-0-0	-
7	232AE23	Machine Learning Techniques Laboratory	PC	0-0-4	2
8	232AE24	Technical Seminar	PC	0-0-4	1
					No. of Credits: 18

SEMESTER - III

Sl	Code	Course Title	Category	L-T-P	C
1	232AEEXX	Elective IV*	PE	3-0-0	3
2	232AEEXX	Elective V*	PE	3-0-0	3
3	232AEEXX	Elective VI*	PE	3-0-0	3
4	232OEXX	Elective VII*	OE	3-0-0	3
5	232AE31	Project Phase – I	EEC	0-0-12	6
					No. of Credits: 18

SEMESTER - IV

Sl	Code	Course Title	Category	L-T-P	C
1	232AE41	Project Phase – II	EEC	0-0-24	12
					No. of Credits: 12

MC- Mandatory Course : PC –Professional Core; PE - Program Elective; EEC – Employability Enhanced Course ; ES –Engineering Scince

PROGRAMME ELECTIVES

Sl. No.	Code	Course Title	Category	L-T-P	C
1.	232AEE01	Graph Theory and Optimization	PE	3-0-0	3
2.	232AEE02	Quantum Computation and Technologies	PE	3-0-0	3
3.	232AEE03	Nanoelectronic Circuit Design	PE	3-0-0	3
4.	232AEE04	Soft Computing Techniques	PE	3-0-0	3
5.	232AEE05	Sensors and Interface Electronics	PE	3-0-0	3
6.	232AEE06	Bio Medical Signal Analysis	PE	3-0-0	3
7.	232AEE07	Augmented Reality	PE	3-0-0	3
8.	232AEE08	Digital Healthcare and Medical Standards	PE	3-0-0	3
9.	232AEE09	Biomedical Image Processing	PE	3-0-0	3
10.	232AEE10	Digital Image and Video Processing	PE	3-0-0	3
11.	232AEE11	ARM Architecture and Programming	PE	3-0-0	3
12.	232AEE12	Architecture of Internet of Things	PE	3-0-0	3
13.	232AEE13	ASIC Design	PE	3-0-0	3
14.	232AEE14	Data Warehousing and Data Mining	PE	3-0-0	3
15.	232AEE15	Big Data Computing	PE	3-0-0	3
16.	232AEE16	CAD for VLSI	PE	3-0-0	3
17.	232AEE17	VLSI Testing and Verification	PE	3-0-0	3
18.	232AEE18	Cloud and Fog Computing	PE	3-0-0	3
19.	232AEE19	Advanced Antenna Engineering	PE	3-0-0	3
20.	232AEE20	Quantum Machine Learning	PE	3-0-0	3
21.	232AEE21	Advanced Wireless Sensor Networks	PE	3-0-0	3
22.	232AEE22	Cognitive Radio Networks	PE	3-0-0	3
23.	232AEE23	Information and Network Security	PE	3-0-0	3
24.	232AEE24	Digital Twin Technology	PE	3-0-0	3

OPEN ELECTIVES

Sl. No .	Code	Course Title	Category	L-T-P	C
1	232OE11	Industrial and Medical IoT	OE	3-0-0	3
2	232OE12	Social Media and Network Analysis	OE	3-0-0	3
3	232OE21	Web Analytics and Development	OE	3-0-0	3
4.	232OE22	Data Analysis for Business Intelligence	OE	3-0-0	3
5	232OE31	Energy Auditing	OE	3-0-0	3
6.	232OE32	Hybrid Energy Systems	OE	3-0-0	3
7.	232OE41	Industrial Safety	OE	3-0-0	3
8.	232OE42	Design of Experiments	OE	3-0-0	3
9.	232OE51	Composite Materials	OE	3-0-0	3
10	232OE52	Building Automation	OE	3-0-0	3

AUDIT COURSES

Sl.No.	Code	Course Title	Category	L-T-P	C
1	232AC01	Report Preparation Tools	MC	2-0-0	-
2	232AC02	Constitution of India	MC	2-0-0	-
3	232AC03	Disaster Management	MC	2-0-0	-
4	232AC04	நற்றமிழ் இலக்கியம்	MC	2-0-0	-

232AE11 **ANALOG AND MIXED SIGNAL IC DESIGN** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: I** **Category:** PC

AIM: To study the concepts of MOS large signal model and small signal model and in-depth understanding of the analog integrated circuit and building blocks

Course Outcomes:

The Students will be able to

CO1: Develop analog and mixed signal IC using MOS Devices.

CO2: Build Small signal models MOSFET based submicron circuits.

CO3 Analyse and model data converters architecture

CO4: Design Analog Layout for mixed signal circuits

CO5: Estimate size of Digital Layout for mixed signal circuits

CO6: Analyze and design mixed signal circuits such as Comparator, ADCs, DACs, PLL.

9

INTRODUCTION AND BASIC MOS DEVICES

Challenges in analog design-Mixed signal layout issues- MOS FET structures and characteristics- large signal model – small signal model- single stage Amplifier-Source follower- Common gate stage – Cascode Stage

9

SUBMICRON CIRCUIT DESIGN

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, The MOSFET Switch, Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise - OP Amp parameters

DATA CONVERTERS **9**

Characteristics of Sample and Hold- Digital to Analog Converters- architecture-Differential Non linearity-Integral Non linearity- Voltage Scaling-Cyclic DAC-Pipeline DAC-Analog to Digital Converters- architecture – Flash ADC-Pipeline ADC-Differential Non linearity-Integral Non linearity. Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC

ANALOG AND DIGITAL LAYOUT DESIGN FOR MIXED SIGNAL **9**

Layout introduction: Introduction, MOS transistor layers, stick diagram, symbolic diagram. Digital layout design: Introduction, guide line of transistor layout, PMOS and NMOS transistor layout, CMOS transistor layout. Introduction to analog layout techniques and Passive component layout - capacitor, resistor and inductor, Floor planning of analog and digital components, power supply and ground pin issues, matching, shielding, interconnection issues

OSCILLATORS AND PLL **9**

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops. Applications of PLL.frequency multiplication and synthesis. Introduction to RF IC Design, building blocks, applications.

Total Periods 45

References

1. P. Allen and D. Holberg, “CMOS Analog Circuit Design”, Oxford University Press, Second Edition, 2012.

2. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2003.

3. R.Jacob Baker,H.W.Li, and D.E. Boyce CMOS Circuit Design ,Layout and Simulation, Prentice-Hall of India,1998.

4. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley Publishers, Fifth Edition, 2009.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		3		3	3		
CO2	2	2	2		3		3	3		
CO3	3	2	3		3		3	3		
CO4	2	2	2		3		3	3		
CO5	3	2	3		3		3	3		
CO6	3	2	2		3		2	3		

232AE12 **SEMICONDUCTOR DEVICES AND MODELING** **L-T-P C**
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: I** **Category:** PC

AIM: To gain adequate understanding of semiconductor device modelling aspects, designing devices for electronic applications

Course Outcomes:

The Students will be able to

CO1: Explore the properties of MOS capacitors.
CO2: Analyze the various characteristics of MOSFET devices.
CO3: Describe the various CMOS design parameters and their impact on performance of the device.
CO4: Discuss the device level characteristics of BJT transistors.
CO5: Analyse Small-Signal Equivalent Circuit of BJT
CO6: Identify the suitable mathematical technique for simulation.

BIPOLAR DEVICES **9**

n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current–Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Falloff at High Currents, Nonideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time-Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor.

MOSFET DEVICES 9

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance , MOSFET Degradation and Breakdown at High Fields

CMOS DEVICE DESIGN **9**

CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

MOS CAPACITORS **9**

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–OxideInterface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown.

MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS. **9**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation.

Total Periods 45

References

1. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
2. A.B. Bhattacharyya “Compact MOSFET Models for VLSI Design”, John Wiley & Sons Ltd, 2009.
3. Ansgar Jungel, “Transport Equations for Semiconductors”, Springer, 2009
4. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, “Device Modeling for Analog and RF CMOS Circuit Design”, John Wiley & Sons Ltd, 2004.
5. Behzad Razavi, “Fundamentals of Microelectronics” Wiley Student Edition, 2nd Edition, 2014

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		3		3	3		
CO2	3	2	3		3		3	3		
CO3	3	3	3		3		2	3		
CO4	3	2	3		2		3	3		
CO5	3	2	3		3		3	3		
CO6	3	2	3		2		3	3		

232AE13 **ADAPTIVE SIGNAL PROCESSING** **L-T-P C**
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: I** **Category:** PC

AIM: The aim of the course is to investigate Adaptive Signal Processing networks approaches from both the software and hardware properties.

Course Outcomes:

The Students will be able to

CO1: Derive the response of LTI system to stochastic processes.
CO2: Comprehend and derive the Wiener filter for signals with known properties.
CO3: Familiar with the Lattice filter implementation of the prediction filter.
CO4: Apply LMS algorithm to the lattice structure to improve convergence times.
CO5: Use Recursive Least Squares algorithms in signal processing.
CO6: Convergent with Unsupervised Adaptive filters applications

ADAPTIVE SYSTEMS AND SIGNAL ANALYSIS **9**

Signal Processing in unknown environments: System identification and Linear prediction Stochastic Processes-Responses of LTI system to stochastic processes - Mean ergodic theorem – Correlation matrix – Stochastic models – Power spectral density – Properties of power spectral Density – Linear transformations – Power spectral estimation.

THE MEAN SQUARE ERROR (MSE) PERFORMANCE CRITERIA 9

Introduction to Mean Square Error (MSE) and MSE Surface-Properties of the MSE Surface: The Normal Equations- Geometrical Properties of the Error Surfaces - Wiener filter. Wiener smoothing and prediction filters. Application of Wiener smoothing to noise cancelling- Application of Wiener prediction filters - Constrained, linear MMSE filtering -Minimum variance beamforming.

LINEAR PREDICTION AND THE LATTICE STRUCTURE **9**

Levinson Durbin's Algorithm - Lattice Derivation-Forward and backward prediction-Adaptive lattice structures. Iterative Solution of the Normal Equations- Weight Vector Solutions –Convergence Properties of Steepest Descent - Mean Square Error Propagation.

LMS & RLS ALGORITHM **9**

Effects of Unknown Signal Statistics- Derivation of the LMS Algorithm- Convergence of the LMS Algorithm - LMS Mean Square Error Propagation-Normalized LMS Algorithm - Recursive Least squares (RLS) Adaptive Algorithms-Performance of RLS Adaptive Algorithms-Convergence of RLS versus LMS-QR RLS Algorithm- Kalman filter

UNSUPERVISED ADAPTIVE FILTERING **9**

Blind Equalizers –Sato Algorithm –Godard algorithms - Equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis

Total Periods 45

References

1. Bernard Widrow, Samuel D. Stearns, Adaptive signal processing, 2012, 1st Edition, Pearson Education, New Delhi.
2. Simon Haykin, Adaptive Filter Theory, 2012, 4th Edition, Pearson Education, New Delhi.
3. John R. Treichler, C. Richard Johnson, Michael G. Larimore, Theory and Design of Adaptive filters, 2012, 1st Edition, John Wiley & Sons, New Jersey, USA.
4. Behrouz Farhang, Boroujeny, Adaptive filters: Theory and Applications, 2013, 2nd Edition, John Wiley & Sons, New Jersey, USA.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		3		2		3	
CO2	3	2	2		3		2		3	
CO3	3	3	3		3		2		3	
CO4	3	2	2		2		3		3	
CO5	3	3	3		3		3		3	
CO6	3	2	3		2		2		3	

232AE14 **POWER CONSERVATION CIRCUITS FOR ELECTRONICS** **L-T-P C**

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: II Category: PC**

AIM: To study advanced converters and switching techniques implemented in recent technology..

Course Outcomes:

CO1: Describe the characteristics, operation of power switching devices and identify their ratings and applications.
CO2: Understand the requirements SCR Protection, Describe the Functioning of SCR their Construction and Performance.
CO3: Analyze and Design the Converter Based on SCR for various Industrial Applications.
CO4: Demonstrate ability to understand High Frequency, Heating Systems, Timers, Relevant Sensors & Actuator and their Application in Industrial Setting.
CO5: Demonstrate the ability to understand and apply Data Communication, Telemetry & SCADA System in Industrial Applications.
CO6: Design advanced converters and switching techniques implemented in recent technology

POWER ELECTRONIC DEVICES AND SEMICONDUCTOR SWITCHES 9

Introduction, Applications of power electronics, Power electronics devices: Characteristics of power devices – characteristics of SCR, diac, triac, GTO, PUJT, power transistors – power FETs – LASCR – two transistor model of SCR Protection of thyristors against over voltage – over current, dv/dt and di/dt. Power Semiconductor Switches: Rectifier diodes, fast recovery diodes.

SCR PERFORMANCE AND APPLICATIONS 9

Turn on circuits for SCR – triggering with single pulse and train of pulses synchronizing with supply – Thyristor turn off methods, natural and forced commutation, self-commutation series and parallel operations of SCRs. Rectifiers: Single phase and three phase controlled Rectifiers with inductive loads, RL load. Construction & Working of Opto- Isolators, Opto-TRIAC, Opto-SCR.

INVERTERS AND VOLTAGE CONTROLLERS 9

Voltage and current source inverters, resonant, Series inverter, PWM inverter. AC and DC choppers – DC to DC converters – Buck, boost and buck – boost. Single phase and three phase Cyclo-conveters, Power factor control and Matrix Converters. Industrial applications DC and AC Drives DC Motor Speed control Induction Motor Speed Control.

TIMERS & DELAY ELEMENTS, HIGH FREQUENCY POWER HEATING, SENSOR AND ACTUATORS 9

RC Base Constant Timers, Timer Circuits using SCR, IC-555, Programmable Timer and their Industrial Applications, Induction Heating and Dielectric Heating System and Their Applications, Sensors, Transducers, and Transmitters for Measurement, Control & Monitoring : Thermoresistive Transducer, Photoconductive Transducers, Pressure Transducers, Flow Transducers, Level Sensors, Speed Sensing, Vibration Transducers, Variable-Frequency Drives, Stepper Motors and Servomotor Drives.

AUTOMATION AND CONTROL 9

Data Communications for Industrial Electronics, Telemetry, SCADA & Automation, AC & DC Drives, Voltage & Power Factor Control through Solid State Devices, Soft Switching, Industrial Robots.

Total Periods 45

References

1. Thomas E. Kissell, Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3rd edition, 2003, Prentice Hall.
2. B. Paul, Industrial Electronic and Control, Prentice Hall of India Private Limited 3rd Ed , 2014.
3. M.H. Rashid, “Power Electronics: Circuits, Devices & Applications”, Prentice Hall of India Ltd. 3rd Edition, 2004.
4.Ned Mohan, T.M. Undeland and W.P. Robbins, “Power Electronics: Converters, Applications and Design”, Wiley India Ltd, 2008.
5. M.S. Jamil Asghar, “Power Electronics” Prentice Hall of India Ltd., 2004

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3		2	2		
CO2	2	2	2	2	2		2	2		
CO3	3	2	3	2	2		2	2		
CO4	3	2	2	2	3		3	3		
CO5	3	2	3	3	2		2	2		
CO6	3	2	2	3	2		2	2		

232AE15 **EMBEDDED SYSTEMS DESIGN** **L-T-P C**
2-0-2 3

Programme: M.E.(Applied Electronics) **Sem: I** **Category:** PC

AIM: The aim of the course is to build a small low cost embedded system using IoT and apply the concept of IOT in the real world scenario

Course Outcomes:

The Students will be able to

CO1: Demonstrate the functionalities of processor internal blocks, with their requirement.

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

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

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

CO5: Recommend Embedded consumer product design based on phases of product development..

CO6: Disscuss on different Phases & Modeling of a new embedded product

EMBEDDED SYSTEM OVERVIEW **5**

Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embeded System on-chip (Soc) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design Process in Embedded Systems, Formalization of System Design, Design Process and Design Examples, Classification of Embedded Systems.

EMBEDDED NETWORKING 5

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

RTOS BASED EMBEDDED SYSTEM DESIGN **5**

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

MODELLING WITH HARDWARE/SOFTWARE DESIGN **5**

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- CoSynthesis- features comparing Single-processor Architectures & Multi-Processor Architectures--design approach on parallelism in uniprocessors & Multiprocessors.

EMBEDDED SYSTEM APPLICATION DEVELOPMENT **5**

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

Periods 25

References

1. Rajkamal, "Embedded system-Architecture, Programming, Design", TMH,2011.
2. Steve Heath, "Embedded System Design", Elsevier, Second Edition, 2004.
3. Lyla B Das," Embedded Systems-An Integrated Approach",Pearson, 2013
4. Bruce Powel Douglass,"Real-Time UML Workshop for Embedded Systems,Elsevier,2011

Laborotary Experiments : **Periods 20**

Total Periods 45

1. LED and LCD Interface using embedded microcontroller.
2. Simple application design using ARM Processor – Motor and Buzzer
3. Sensor interfacing using Raspberry pi /Arduino Boards
4. Design of wireless network using embedded systems
5. Design a simple Robot using Robokits
6. Data Communication through social media

7. Sending out alerts by objects without human intervention
8. Developing an elementary home automation model and Creating a virtual device & configuring Gateway

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	2	3	3		2
CO2	3	3	3	2	2	1	3	3		2
CO3	3	2	2	1	2	2	3	3		2
CO4	2	3	3	2	3	2	2	2		3
CO5	2	3	3	1	3	1	2	2		2
CO6	3	2	2	3	2	2	3	3		1

232SE13 **RESEARCH METHODOLOGY AND IPR** **L-T-P C**
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: I** **Category:** ES

AIM: **To Initiate the learning for fundamental research and development activities.**

Course Outcomes:

The Students will be able to

CO1: Understand research problem formulation.
CO2: Analyze research related information
CO3: Follow research ethics
CO4: Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO5: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D sector.
CO6: Create new and better products, and in turn brings about, economic growth and social benefits.

INTRODUCTION **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

PROPOSAL PREPARATION **9**

Effective literature studies approaches, analysis Plagiarism , Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

INTELLECTUAL PROPERTY RIGHTS **9**

Nature of Intellectual Property: Patents, Designs, Trademarks 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.

PATENT RIGHTS **9**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

NEW DEVELOPMENTS IN IPR **9**

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total Periods 45

References

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners" , 2nd Edition, Abe Books, 2005.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
4. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1			2	3		2				2
CO2			3	2		1				2
CO3			2	1		2				2
CO4			3	2		2				3
CO5			3	1		1				2
CO6			2	3		2				1

232AE16	MIXED CIRCUIT DESIGN LABORATORY		L-T-P	C
			0-0-4	2
Programme:	M.E.(Applied Electronics)	**Sem: I**	**Category:**	**PC**

AIM: The aim of the course is to design of practical hands-on experience in Mixed Circuit Design

Course Outcomes:

The Students will be able to

CO1: Obtain the response of a CMOS amplifier

CO2: Generate Analog Layout by EDA Tool.

CO3: Verify Signal/Power Integrity (SI/PI) aspects of analog/mixed-signal IC design

CO4: Design of Phase Frequency Detector for High Frequency PLL

CO5: Fabricate single side PCB for Analog & Digital Filter circuits using Tina 11.0

CO6: Interface DC motor with PID Controller & Compensator using NI ELVIS

List of Experiments

1. Obtain the Frequency response of a CMOS amplifier
2. CMOS Data Converters -- Analog-to-Digital Converter (ADC)/Digital-to-Analog Converter (DAC)
3. Analog Front-End Circuit (AFE)
4. Analog Layout Generation by EDA Tool
5. High-Speed I/O Circuit
6. Methodology and Signal/Power Integrity (SI/PI) aspects of analog/mixed-signal IC design for SOC
7. Sketch the mixed signal schematic for SAR based Analog to Digital Converter and verify the functionality by completing ASIC Design flow.
8. Design of Phase Frequency Detector for High Frequency PLL
9. Fabricate single side PCB for Analog & Digital Filter circuits using Tina 11.0 Design suite and also obtain the characteristics of different filters.
10. Interface DC motor with PID Controller & Compensator using NI ELVIS

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3			3	3	2	2	3		
CO2	3			2	2	1	2	3		
CO3	2			1	1	2	2	3		
CO4	3			2	2	2	3	3		
CO5	3			1	1	1	2	2		
CO6	2			3	3	2	2	3		

232AE17	ADAPTIVE SIGNAL PROCESSING LABORATORY	L-T-P	C
		0-0-4	2

Programme: M.E.(Applied Electronics) **Sem:** I **Category:** PC

AIM: The aim of the course is to design of practical hands-on experience in adaptive signal processing

Course Outcomes:

The Students will be able to

CO1: Model the Active noise control using adaptive filters

CO2: Apply Kalman filtering for Target tracking.

CO3: Obtain the response DPCM

CO4: Analyze Effect of Blind channel equalization

CO5: Estimate Integration of wavelet with adaptive filtering

CO6: Design an adaptive system for physical modeling of musical signals.

List of Experiments

1. Active noise control using adaptive filters
2. Adaptive cancellation of power line interference
3. Adaptive histogram equalization
4. Adaptive channel equalization
5. Target tracking using Kalman filtering
6. Adaptive DPCM
7. Blind acoustic source separation using Nonlinear Adaptive Techniques
8. Blind channel equalization
9. Integration of wavelet with adaptive filtering.
10. Adaptive system for physical modeling of musical signals.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		2		2		3	
CO2	2	2	2		2		2		3	
CO3	3	2	3		2		2		3	
CO4	3	2	2		2		3		2	
CO5	3	2	3		2		2		3	
CO6	3	2	2		2		2		3	

232AE21 **MACHINE LEARNING TECHNIQUES** **L-T-P C**

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: II Category: PC**

AIM: To introduce students to the basic concepts and techniques of Machine Learning. And study the various probability based learning techniques..

Course Outcomes:

The Students will be able to

CO1: Distinguish between, supervised, unsupervised and semi-supervised learning

CO2: Apply the appropriate machine learning strategy for any given problem

CO3: Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem

CO4: Design systems that uses the appropriate graph models of machine learning

CO5: Modify existing machine learning algorithms to improve classification efficiency

CO6: Classify the various models

INTRODUCTION **9**

Learning –Types of Machine Learning –Supervised Learning –The Brain and the Neuron –Design a Learning System –Perspectives and Issues in Machine Learning –Concept Learning Task –Concept Learning as Search –Finding a Maximally Specific Hypothesis –Version Spaces and the Candidate Elimination Algorithm –Linear Discriminants –Perceptron –Linear Separability –Linear Regression

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.

TREE AND PROBABILISTIC MODELS **9**

Learning with Trees –Decision Trees–Constructing Decision Trees –Classification and Regression Trees –Ensemble Learning –Boosting –Bagging –Different ways to Combine Classifiers –Probability and Learning –Data into Probabilities –Basic Statistics –Gaussian Mixture Models –Nearest Neighbor Methods –Unsupervised Learning –K means Algorithms –Vector Quantization –Self Organizing Feature Map

DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS **9**

Dimensionality Reduction –Linear Discriminant Analysis –Principal Component Analysis –Factor Analysis –Independent Component Analysis –Locally Linear Embedding –Isomap –Least Squares Optimization –Evolutionary Learning –Genetic algorithms –Genetic Offspring: -Genetic Operators – Using Genetic Algorithms –Reinforcement Learning –Overview –Getting Lost Example –Markov Decision Process

GRAPHICAL MODELS **9**

Markov Chain Monte Carlo Methods –Sampling –Proposal Distribution–Markov Chain Monte Carlo –Graphical Models –Bayesian Networks –Markov Random Fields –Hidden Markov Models –Tracking Methods

Total Periods 45

References

1. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014
2. Jason Bell, ―Machine learning –Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014
3. Stephen Marsland, ―Machine Learning –An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2			2		3	
CO2	2	2	2				2		3	
CO3	3	2	3	2			2		3	
CO4	3	2	2	2			3		2	
CO5	3	2	3				2		3	
CO6	3	2	2				2		3	

232AE22 **FLEXIBLE ELECTRONICS** **L-T-P C**

2-0-2 3

Programme: M.E (Applied Electronics) **Sem: -** **Category: PC**

AIM: To provide an overview of wearable and nearable electronics

Course Outcomes:

The Students will be able to

CO1: Classify the wearable electronics technology.
CO2: Analyze the wearable electronics fabrication process.
CO3: Categorize the wearable electronics materials
CO4: Apply the methods of wearable sheet type and manufacturing
CO5: Acquire the knowledge about the display circuits
CO6:Apply the various wearable electronics applications

OVERVIEW WEARABLE ELECTRONICS TECHNOLOGY **5**

History of Flexible Electronics - Materials for Flexible Electronics - Degrees of Flexibility – Substrates Backplane Electronic – Front plane Technologies – Encapsulation - Fabrication Technology for Flexible Electronics - Fabrication on Sheets by Batch Processing - Fabrication on Web by Roll-to-Roll Processing - Additive Printing.

WEARABLE ELECTRONICS MATERIALS **5**

Introduction of Materials Considerations for Flexible Electronics - Overview - Inorganic Semiconductors and Dielectrics - Organic Semiconductors and Dielectrics – Conductors- materials issue Issues of organic photovoltaicbasic operation -photocurrent - dark current.

WEARABLE SHEET TYPE **5**

Introduction - Sheet-type Image Scanners - Methods - Device Structure and Manufacturing Process Electronic Performance of Organic Photodiodes Organic Transistors Photo sensor Cells Issues Related to Device Processes: Pixel Stability and Resolution A Hierarchal Approach for Slow Organic Circuits

FLEXIBLE DISPLAY AND CIRCUITS **5**

Introduction - Enabling Technologies for Flexible Backplanes and Flexible Substrate Technologies TFT Technologies for Flexible Backplanes Display Media for Flexible Displays (LCD, reflective-EP, OLED) Barrier Layers - Important Organic TFT Parameters for Electronic Systems Field-Effect Mobility

APPLICATION OF WEARABLE NEARABLE **5**

Photovoltaic cells – Solar cells - Photo sensor Cells - lithography - LED –LCD - OLED- Active Matrix OLED.

Periods 25

References

1. Mario Caironi and Yong-Young Noh, “Large Area and Flexible Electronics“, Wiley, 2015.
2. GuozhenShen, “Flexible Electronics from materials to devices”, World Scientific,2015.
3. Alberto Salleo and William S. Wong, “Flexible Electronics Materials and Applications”, Springer, 2009.

List of Experiments **Periods 20**

1. Study and Characterization of Horn Antennas.
2. Design of Waveguides & Coaxial line using HFSS.
3. Design of Microstrip Antenna using HFSS.
4. Design of Ring Hybrid using HFSS.
5. Simulation of directional coupler using HFSS.
6. Simulation of E-plane and H-plane Tee using HFSS.
7. Create, simulate, and analyze a bandpass/bandstop filter using HFSS Design Environment
8. Create, simulate, and analyze a heat sink using the HFSS Design Environment.

Total Periods 45

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2		1	2		
CO2	3	2	2	3	3		2	2		
CO3	3	2	3	2	2		1	2		
CO4	3	2	2	2	3		2	2		
CO5	2	2	3	2	1		1	3		
CO6	2	3	3	3	2		1	2		

232AE23	MACHINE LEARNING LAB	L-T-P	C
		0-0-4	2

Programme: M.E.(Applied Electronics) **Sem**: II **Category:** PC

AIM: The aim of the course is to introduce students to learn state-of-the-art methods and modern programming tools for machine learning.

Course Outcomes:

The Students will be able to

CO1: Understand the fundamental concepts and methods of machine learning, statistical pattern recognition and its applications

CO2 : Analyze and evaluate simple algorithms for pattern classification

CO3: Design simple algorithms for pattern classification, code them with Python programming language and test them with benchmark data sets.

CO4: Perform image and video enhancement and segmentation

CO5 : Detect an object in an image/video using machine learning

CO6 : Classify supervised and unsupervised learning

List of Experiments

1. Implement maximum likelihood algorithm
2. Implement Bayes classifier
3. Implement linear regression
4. Design a classifier using perceptron rule
5. Design a classifier using feedforward back-propagation and delta rule algorithms
6. Implement deep learning algorithm
7. Implement linear discriminant algorithm
8. Design a two class classifier using SVM
9. Design a multiclass classifier using SVM
10. Perform unsupervised learning

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	2	1	2	2		3	
CO2	2	2	2	2	2	2	2		3	
CO3	1	1	3	2	2	3	2		3	
CO4	1	2	2	2	2	2	3		2	
CO5	2	2	3	1	1	2	2		3	
CO6	3	1	2	1	1	3	2		3	

232AE24 **Technical Seminar** **L-T-P C**
0-0-4 2

Programme: M.E.(Applied Electronics) **Sem:** - **Category:** PC

AIM: To acquire the skills of oral presentation andto acquire technical writing abilities for seminars and conferences

Course Outcomes:

The Students will be able to

CO1 : Identify latest developments in the field of Appled Electronics
CO2 : Acquire technical writing abilities for seminars, conferences and journal publications
CO3 : Use modern tools to present the technical details.
CO4: Develop skills to present and defend their work in front of technically qualified audience.
CO5: Publish the work into reputed Journals and Conferences
CO6: Demonstrate the design methodology for the project

Syllabus Contents:

The student will make atleast two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the college. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation. A quiz covering the above will be held at the end of the semester.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2		2		3
CO2	2	2	3	2	2	2		2		3
CO3	2	2	2	2	2	3		3		3
CO4	3	2	2	2	3	2		2		3
CO5	2	2	3	1	2	2		2		3
CO6	2	2	2	3	2	3		2		3

232AE31 **PROJECT PHASE -I** **L-T-P** **C**

0-0-12 **10**

Programme: M.E.(Applied Electronics) **Sem:** **III** **Category:** **PC**

AIM: The aim of the course is to solve the identified problem based on electronics and provide solution to Engineering community

Course Outcomes:

The Students will be able to

CO1: synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.

CO2: Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.

CO3: Ability to present the findings of their technical solution in a written report.

CO4: Presenting the work in International/ National conference or reputed journals.

CO4: Improve their communication skills, presentation skills and other soft skills

CO5: Gain the knowledge about various magazine, newsletters and journals related to their field.

CO6: Demonstrate the design methodology for the project

Syllabus Contents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following

- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industry need
- Problems of national importance
- Research and development in various domain

The student should complete the following:

- Literature survey Problem Definition
- Motivation for study and Objectives
- Preliminary design / feasibility / modular approaches
- Implementation and Verification
- Report and presentation

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	3			3
CO2	2	2	3	2	2	2	3			3
CO3	2	2	2	2	2	3	3			3
CO4	3	2	2	2	3	2	2			3
CO5	2	2	3	1	2	2	2			3
CO6	2	2	2	3	2	3	2			3

232AE41 **PROJECT PHASE-II** **L-T-P** **C**

0-0-24 **16**

Programme: M.E.(Applied Electronics) **Sem:** **IV** **Category:** **PC**

AIM: The aim of the course is to identify the technical knowledge of student's through quality of research project undertaken by the students.

Course Outcomes:

The Students will be able to

CO1 : Demonstrate a sound technical knowledge of their selected project topic.

CO2: Undertake problem identification, formulation and solution.

CO3: perform a literature search to review current knowledge and developments in the chosen project

CO4: Undertake detailed technical work in the chosen area using one or more of theoretical studies and modeling.

CO5: Prepare an interim report describing the work undertaken and results.

CO6: Present the work in a forum involving seminar, conference, project Expo and poster presentations

.

Syllabus Contents:

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them. It may be based on:

- Experimental verification / Proof of concept.
- Design, fabrication and testing of proposed research work.
- The viva-voce examination will be based on the above report and work

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	3			3
CO2	2	2	3	2	2	2	3			3
CO3	2	2	2	2	2	3	3			3
CO4	3	2	2	2	3	2	2			3
CO5	2	2	3	1	2	2	2			3
CO6	2	2	2	3	2	3	2			3

PROGRAMME ELECTIVES

232AEE01 GRAPH THEORY AND OPTIMIZATION TECHNIQUES L-T-P C

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem:** **Category:** **PE**

AIM: To develop the mathematical skill in the area of Game Theory and Optimization.

Course Outcomes:

The Students will be able to

CO1: Understand and apply the fundamental concepts in graph theory.

CO2: Learn the model problems using graphs and to solve these problems algorithmically.

CO3: Expose the concepts of modeling and optimization for solving real world Problems.

CO4: Study a systematic procedure for determining the optimal combination of decisions of dynamic programming.

CO5: Solve complex Engineering problems with linear programming

CO6: Learn the mathematical foundations of the genetic algorithm and ant colony optimization in the field of engineering.

BASIC CONCEPTS IN GRAPH THEORY 9

Undirected graph — Degree of a vertex - Degree sequence - Sub graphs - Vertex induced sub graphs - Complement of a graph - Self complementary graphs – Walk – Path – Connectivity – Eccentricity – Radius –Diameter - Vertex and edge cuts - Vertex partition - Independent set - Clique. Digraph — Orientation – Strongly connected digraphs – Weekly connected digraphs - Unilaterally connected digraphs - Directed acyclic graph. Adjacency matrix - Incidence matrix of graphs. Trees - Spanning trees - Matrix tree theorem.

GRAPH ALGORITHMS 9

Search algorithms — Depth first search and breadth first search - Spanning tree algorithm — Kruskal's and Prim's shortest path algorithm — Dijkstra's and Floyd-Marshall. Matching — Perfect matching, Bipartite matching. Flow networks — Augmenting path algorithm - Min-cut and max-cut algorithms.

NONTRADITIONAL OPTIMIZATION ALGORITHMS 9

Summation convention – Contra variant and covariant vectors – contraction of tensors – inner product – quotient law – metric tensor – Christoffel symbols – covariant differentiation – gradient, divergence and curl.

LINEAR PROGRAMMING 9

Formulation – Graphical solution – Simplex method – Two phase method –Transportation and Assignment Problems.

NON – LINEAR PROGRAMMING 9

Integer programming problem - Pure and mixed integer – Gomory's cutting plane algorithm. Dynamic programming problem - Principle of optimality - Backward and forward induction methods - Calculus method of solution - Tabular method of solution - Shortest path network problems - Applications in production.

Total Periods: 45

References:

1. Jonathan L Gross and Jay Yellen, 'Graph Theory and its Applications', Chapman & Hall, New York,2005.
2. Hamdy A Taha, 'Operations Research. An Introduction', Pearson Education, New Delhi, 2014.
3. West D B, 'Introduction To Graph Theory', Pearson Education, New Delhi, 2007.
4. Kanti Swarup, P.K.Gupta, Man Mohan ' Operations Research',Twelfth Edition, Sultan Chand & Sons ,New Delhi, 2004.
5. Kalyan moy Deb, 'Optimization for Engineering Design, Algorithms and Examples', Prentice Hall, NewDelhi, 2010.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1			2	1		
CO2	3	3	2				2	2		
CO3	2	2	3				1	1		
CO4	2	2	2				2	1		
CO5	2	2	1				1	2		
CO6	2	2	1				2	2		

232AEE02	QUANTUM COMPUTATION AND TECHNOLOGIES	L-T-P	C
		3-0-0	3

Programme: M.E.(Applied Electronics) **Sem:** - **Category:** PC

AIM: The aim of the course is to investigate Quantum Computation and Communication with technologies approaches from both the software and hardware perspectives..

Course Outcomes:

The Students will be able to

CO1. Know the fundamental concepts of quantum mechanics and the quantum information theory.

CO2. Work with quantum circuits and master the mathematical apparatus of quantum mechanics used in quantum computations.

CO3. Apply the most important quantum logic algorithms.

CO4. Know the various types of quantum computing hardware realization techniques.

CO5. Solve the problems associated with noise and decoherence.

CO6. Work with quantum error correcting codes and fault-tolerant computation.

STATISTICAL ASPECTS OF QUANTUM MECHANICS AND QUANTUM ENTANGLEMENT **9**

Introduction and overview on Quantum computation and Quantum information. Qubit, Qubit as a quantum unit of information, Bloch sphere representation of a Qubit, Pure and mixed states of quantum systems, Density matrix and its properties, Multi-Qubit systems, Inseparability of quantum systems, Reduced density matrix. Photon Polarization - Applications of polarization in Quantum Networks. Quantum entanglement-Schmidt decomposition, Bell states, Measurements and Einstein-Podolsky-Rosen (EPR) paradox and Bell inequalities.

QUANTUM GATES, QUANTUM CIRCUITS AND QUANTUM COMPUTATION **9**

Quantum Gates-Simple Quantum Gates, Walsh-Hadamard Transformation, Swap Gate and Fredkin Gate. Correspondence with classical logic gates-NOT Gate, XOR Gate, AND Gate andOR Gate. Universal Quantum Gates. Quantum circuits, summary of the quantum circuit model of computation. Distinctive features of quantum computations- No-cloning theorem, Superdense coding, Quantum teleportation, Experiments on quantum teleportation of a qubit, Quantum Parallelism.

QUANTUM ALGORITHMS **9**

Simple Quantum Algorithms-Deutsch Algorithm, Deutsch-Jozsa Algorithm and BernsteinVazirani Algorithm, Simon's algorithm. Quantum Fourier Transform (QFT)-Period finding, implementing QFT-3(qubits) and more. Eigenvalue algorithm, Shor's algorithm for integerfactorization.

PHYSICAL IMPLEMENTATIONS OF A QUANTUM COMPUTER **9**

Vincenzo criteria, Physical realizations of a quantum computer using NMR (Nuclear Magnetic Resonance), Trapped-Ions, Neutral atoms, Josephson Junction and Quantum dots based qubit methods. Other implementation schemes- Harmonic Oscillator, Optical Photon and Optical cavity quantum electrodynamics.

QUANTUM NOISE & OPERATIONS- QUANTUM ERROR CORRECTING CODES AND ENTROPY **9**

Decoherence- Open Quantum System, Measurements as Quantum operations, Examples of Quantum noise and Quantum Operations. Features of classical error correction theory, Classical three-bit code; Features of quantum error correction theory, Three-Qubit Bit-Flip code and Phase-Flip code-Bit-Flip QECC, Phase-Flip ine-Qubit Code. Fault-tolerant quantum computation. Entropy-Shannon Entropy, Von Neumann Entropy.

Total Periods: 45

References

1. 1.Nielsen, Michael A., and Isaac L. Chuang. Quantum Computation and Quantum Information. Cambridge, UK: Cambridge University Press,10th anniversary edition 2010.
2. John Watrous, The Theory of Quantum Information, Cambridge University Press, 2018.
3. Mikio Nakahara, Tetsuo Ohmi. Quantum Computing: From Linear Algebra to Physical Realizations, CRC Press; 1 st edition, 2008.
4. Claude Cohen Tannoudji, Bernard Diu, Franck Laloë, Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, second edition,Wiley-VCH verlag, GmbH and Co,2019.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO 2	PSO3	PSO4
CO1	3	3	3	3			3	2		
CO2	2	2	2	3			2	2		
CO3	3	2	2	3			3	2		
CO4	3	3	2	2			2	2		
CO5	2	3	2	3			1	3		
CO6	3	3	2	2			3	3		

232AEE03 **NANOELECTRONIC CIRCUIT DESIGN** **L-T-P** **C**

3-0-0 **3**

Programme: M.E (Applied Electronics) **Sem: -** **Category: PE**

AIM: The aim of the course is to investigate Nanoelectronic Circuit Design approaches from both the Software and hardware properties.

Course Outcomes:

The Students will be able to

CO1: Obtain the knowledge on advanced Nanoscale devices

CO2: Understand the operation and design FinFET based circuits.

CO3: Construct reliable circuits using nanowire arrays and CNT interconnects

CO4: Infer logic circuits using quantum cellular automata.

CO5: Understand the design aspects of application specific Nanoscale ICs.

CO6: Analyse the circuits of Fin-FETs, CNT-FETs, GNR-FETs, RTDs and quantum dot devices using various SPICE versions.

INTRODUCTION TO ADVANCED NANOELECTRONIC DEVICES **9**

New device structures for next generation nanotechnology - carbon nanotube field-effect transistors (CNFETs), FinFETs, nanowire FETs, III/V compound-based devices, graphene nanoribbon devices, resonant tunneling diodes and quantum dot devices.

FINFET CIRCUIT AND SRAM DESIGN **9**

Shorted-Gate and Independent-Gate FinFETs, Logic Design Using SG/IG-Mode FinFETs, Principle of TCMS, Logic Design Using TCMS, Latch Design Using SG/IG-Mode FinFETs, Precharge-Evaluate Logic Circuits, FinFET SRAM Design: Physics, Theory, and Modeling of FinFET Devices for SRAM Applications; Low-Power, High-Performance 90-nm DG-FinFET SRAM Design.

RELIABLE CIRCUITS DESIGN WITH NANOWIRE ARRAYS AND CNT INTERCONNECTS **9**

Nanowire Fabrication Techniques, Crossbar Technologies, Architecture of Nanowire Crossbars, Decoder Logic Design. Emerging interconnect technologies: Study of Performances of Low-k Cu, CNTs, and Optical Interconnects; Local Interconnects: CNT Bundles Versus Cu and Global and Semi-global Interconnects.

CIRCUIT DESIGN WITH QUANTUM CELLULAR AUTOMATA **9**

QCA Fundamentals, Basic Logic Gates and Interconnect, Logic Design with QCA and Fabrication Technology and Challenges.

NANOSCALE APPLICATION-SPECIFIC INTEGRATED CIRCUITS **9**

NASIC Building Blocks: Nanowires and xnwFETs, NASIC Circuit Styles, NASIC Logic Styles, NASIC Architectures and manufacturing methods.

Total Periods 45

References

1. Niraj K. Jha and Deming Chen, Nanoelectronic Circuit Design, Springer publications, 2011.
2. K. Goser, P. Glosekotter, Nanoelectronics and Nanosystems, Springer, 2015.
3. Yuan Taur and TakNing, Fundamentals of Modern VLSI Devices, Cambridge University Press, Newyark, 1998.
4. Karl Goser, Peter Glosekotter, Jan Dienstuhl , Nanoelectronics and Nanosystems- From Transistors to Molecular and Quantum Devices, Springer-Verlag, 2004.
5. John P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons, Inc, 2002.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3			3	2		
CO2	2	2	2	3			2	2		
CO3	3	1	1	2			3	1		
CO4	3	3	2	2			2	2		
CO5	2	3	2	3			1	3		
CO6	3	3	2	2			3	3		

232AEE04 SOFT COMPUTING TECHNIQUES L-T-P C

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: To analyze, model and apply the Intelligent computing to real time applications.

Course Outcomes:

The Students will be able to

CO1: Analyze the Fuzzy expert system

CO2: Analyze the components and building blocks of Fuzzy rules and modeling

CO3: Implement Neural networks in Artificial Intelligence

CO4: Design of genetic algorithms for Engineering applications

CO5: Interpret Multilevel Optimization Techniques

CO6: Apply computational intelligence techniques to classification, pattern recognition, Biomedical Engg.

INTRODUCTION TO SOFT COMPUTING 9

Introduction of soft computing - soft computing vs. hard computing - various types of soft computing techniques - Fuzzy Computing - Fuzzy Sets-Basic Definition and Terminology Set-theoretic Operations - Member Function Formulation and Parameterization. Neural Computing - Genetic Algorithms-Associative Memory – Classification – Clustering - Probabilistic reasoning.

FUZZY LOGIC 9

Fuzzy Rules - Fuzzy Relations - Fuzzy If-Then Rules - Fuzzy Reasoning - Fuzzy Inference Systems - Mamdani Fuzzy Models - Sugeno Fuzzy Models - Tsukamoto Fuzzy Models - Input Space Partitioning and Fuzzy Modeling.

NEURAL NETWORKS 9

Supervised Learning Neural Networks - Perceptrons - Adaline - Backpropagation Mutilayer Perceptrons - Radial Basis Function Networks. Unsupervised Learning Neural Networks - Competitive Learning Networks - Kohonen Self- Organizing Networks - Learning Vector Quantization - Hebbian Learning. Case study: Applications of ANN in research

GENETIC ALGORITHM 9

History of Genetic Algorithms (GA) - Working Principle - Various Encoding methods - Fitness function - GA Operators – Reproduction – Crossover – Mutation - Convergence of GA - Bit wise operation in GA - Multi-level Optimization

HYBRID SYSTEMS 9

Fuzzy-Neural Systems, Neuro-Genetic Systems, Fuzzy-Genetic Systems, GA based Weight Determination, Fuzzy BP Architecture, Learning in Fuzzy BP. Soft Computing Applications-Case study- Image processing – Kinematics Problems – Automobile– Control system-Biomedical Applications.

Total Periods 45

References

1. S. Rajasekaran and G.A.V.Pai, .Neural Networks, Fuzzy Logic and Genetic Algorithms., PHI, 2003.
2. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
3. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 2389.
4. J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2		1			2
CO2	3	3	3	2	1		2			2
CO3	2	2	3	2	2		1			2
CO4	3	2	2	2	3		2			2
CO5	2	2	3	3	2		1			3
CO6	3	3	2	3	2		1			2

232AEE05 **SENSORS AND INTERFACE ELECTRONICS** **L-T-P C**

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: To understand the basic laws and phenomena on which operation of sensors and actuators in industrial environment.

Course Outcomes:

The Students will be able to

CO1: Explain fundamental physical and technical base of sensors and actuators,

CO2: Describe basic laws and phenomena that define behaviour of sensors and actuators,

CO3: Analyze various premises, approaches, procedures and results related to sensors and actuators

CO4: Design a self generating sensors

CO5: Create analytical design and development solutions for sensors and actuators,

CO6: Conduct experiments and measurements in laboratory and on real components, sensors and actuators for the development of application.

INTRODUCTION TO MEASUREMENT SYSTEMS **9**

Introduction to measurement systems: general concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static characteristics of measurement systems, accuracy, precision, sensitivity, other characteristics: linearity, resolution, systematic errors, random errors, dynamic characteristics of measurement systems: zero-order, first-order, and second-order measurement systems and response.

RESISTIVE AND REACTIVE SENSORS **9**

Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to the LVDT.

SELF-GENERATING SENSORS **9**

Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.

ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS **9**

Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA Drive, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn, resolver-to-digital and digital-to-resolver converters.

DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS **9**

Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors.

Total Periods 45

References

1. Andrzej M. Pawlak Sensors and Actuators in Mechatronics Design and Applications, 2006.
3. Kevin James, PC Interfacing and Data acquisition, Elsevier, 2011.
4. Ramon Pallás Areny, John G. Webster, "Sensors and Signal conditioning", 2nd edition, John Wiley and Sons, 2012.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2	3		1	3		
CO2	3	3	1	2	2		2	3		
CO3	2	1	3	2	2		1	2		
CO4	3	1	2	2	3		2	2		
CO5	3	3	2	3	2		2	3		
CO6	2	3	2	3	1		2	2		

232AEE06 **BIO MEDICAL SIGNAL ANALYSIS** **L-T-P C**

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: To know the concept about bio signal waves, Time series analysis and to discuss about removal of artifacts and special topics on bio signal processing.

Course Outcomes:

The Students will be able to

CO1: Categorize knowledge about Bio signal wave shapes and its Complexity

CO2: Estimate Time series analysis and Spectral Estimation

CO3: Apply the removal of artifacts in Bio Signals

CO4: Elaborate the Bio signal Pattern Classification

CO5. Build Chaos theory on bio signals

BIO SIGNAL WAVE SHAPES AND WAVEFORM COMPLEXITY **9**

Introduction to Biomedical signals-overview and characteristics of ECG, ENG, EMG, ERPs, EGG, PCG, Carotid pulse, EOG, VMG, VAG, and Oto acoustic emission signals-Bio signal acquisition-conversion and analysis. Morphological analysis of ECG-Envelope extraction and analysis of PCG-Correlation and Cross spectral analysis of EEG Channels.

TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION **9**

Time series analysis-linear prediction models-Time variant systems-Adaptive segmentation - Spectral Estimation-Blackman Tuckey method-Periodogram and model based estimation

9

REMOVAL OF ARTIFACTS

Noise sources in biomedical signals-Review of optimal filtering-adaptive filters-LMS&RLS Adaptive filters-Removal of Artifacts in ECG-Maternal-Fetal ECG-Muscle contraction interference-use of adaptive filters for segmentation in ECG and PCG Signals.

BIO SIGNAL PATTERN CLASSIFICATION AND DIAGNOSTIC DECISION **9**

Pattern classification as applied to Bio signals-supervised pattern classification- unsupervised pattern classification-Probabilistic models and statistical training and test steps-Neural networks-measures of diagnostic accuracy and cost-Reliability of classifiers and decisions.

SPECIAL TOPICS ON BIO SIGNAL PROCESSING **9**

Application of wavelet transform-TFR representation-ECG Characterization-wavelet networks-data compression of ECG and EEG signals-Application of chaos theory on Bio signals.

Total Periods 45

References

1 Rangaraj. M.Rangayyan, “Biomedical Signal Analysis-A Case Study Approach”, IEEE Press-John Wiley & Sons Inc, New York, 2002.

2 Arnon-Cohen, “Bio-Medical Signal Processing”, Vol I&II, CRC Press. 2395.

3 W.J.Tompkins, “Biomedical Digital signal processing”. Prentice hall, New Jersey, 2393.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	1		2		2	
CO2	3	3	1	2	2		2		3	
CO3	2	3	3	2	2		2		2	
CO4	3	2	3	2	2		2		1	
CO5	3	1	2	1	2		2		3	
CO6	3	1	2	1	1		2		2	

232AEE07	AUGMENTED REALITY	L-T-P	C
		3-0-0	3

Programme: M.E.(Applied Electronics) **Sem:** - **Category:** PE

AIM: To explore the concepts of Augmented reality and develop 3D virtual environment.

Course Outcomes:

The Students will be able to

CO1: Introduce Augmented Reality, the tools and technical components

CO2: Describe the history and recent developments of AR

CO3: Provide the technological components needed for AR

CO4: Impart the importance of augmented reality in Industry 4.0 with real-time examples

CO5: Discuss the revolution and impact of AR

CO6: Develop the applications of AR and VR

INTRODUCTION TO AUGMENTED REALITY **9**

History of AR - Augmented reality characteristics – Difference between Augmented Reality and Virtual Reality – AR technological components – Technologies used in AR – Feature Extraction – Hardware components – AR devices – Importance of AR - Real world uses of AR – AR types – Software tools available for AR

TECHNOLOGIES NEEDED FOR AUGMENTED REALITY **9**

Hardware technology – virtual scenes – 3D objects – AR components – Display – HMD – Eyeglasses – Contact Lenses – significance of AR – AR powered devices – AR application development drawbacks – Compatibility – Performance – AR libraries – Motion tracking – Environmental understanding – Anchors

9

TECHNOLOGY INTEGRATION AND IMPLEMENTATION OF AR

Technology use and integration in industrial settings – Assistive training to faculty members – Planning and administration for implementation – AR implications – Practical data – AR labs – Platforms to form AR content – Coordinated utilization of AR application s – Hands-on preparation

AUGMENTED REALITY AND VIRTUAL REALITY FOR MICRO LEARNING **9**

Micro learning techniques – Utilizing VR for learning – VR for Practical online assessment – VR info graphics – Virtual case considerations - Utilizing AR for learning – Accessible learning – sensible data – elevated learner engagement - VR technology – Components of VR – VR Hardware – VR applications – Civil Engineering – Real Estate – Biology and Medicine – Virtual Mall – VR in Education – Virtual Laboratory – Factory Planning – Automobile Industry

TOOLS AND APPLICATIONS OF AUGMENTED REALITY **9**

Tools available for Augmented Reality and Recognition – Software Tools – Google Poly – Unity – software approaches – recognition types – native software solutions – ARKit – ARCore – software development kit - Cloud services - AR business applications – weather prediction – market prediction – smart cities - AR application for Education - AR application for Healthcare sector – Agriculture – Civil Engineering – Architecture – Archaeology – Crime and Security – Games – IoT - – Use cases – Social Media – Gaming – Education – Healthcare – Shopping and Business

Total Periods **45**

References

1 Kaliraj, P., Devi, T. (2021). Innovating with Augmented Reality: Applications in Education and Industry (P. Kaliraj, Ed.) (1st ed.). CRC Press, Taylor & Francis Group, Boca Raton, ebook ISBN 9781003175896 Auerbach Publications. https://doi.org/10.1201/9781003175896

2. . Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575

3. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; First edition, 2016.

4. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble & Shel Israel, Patrick Brewster Press; First edition, 2016

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	1		2		2	
CO2	3	3	1	2	2		2		3	
CO3	2	3	3	2	2		2		2	
CO4	3	2	3	2	2		2		1	
CO5	3	1	2	1	2		2		3	
CO6	3	1	2	1	1		2		2	

232AEE08 **DIGITAL HEALTH CARE AND MEDICAL STANDARDS** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: To gain knowledge in various aspects of health informatics and medical standards.

Course Outcomes:

The Students will be able to

CO1: Understand the basic concepts in Biomedical Informatics

CO2: Apply the various aspects of health informatics and medical standards

CO3: Develop clinical decision support systems.

CO4: Comprehend the basics of bioinformatics and the resources in the field.

CO5: Analyze various bioinformatics tools and explore the databases available in NCBI

CO6: Design and implement the construction standards in a hospital

BIOMEDICAL INFORMATICS **9**

Historical highlights and Evolution, Hospital Information System, its characteristics and functional online and offline modules, Health Informatics, Medical Informatics, Clinical Informatics, Nursing Informatics, Public Health Informatics, Imaging informatics.

ELECTRONIC PATIENT RECORD AND STANDARDS **9**

Electronic Patient Record, Medical data formats, Medical Standards, HL7, DICOM, LOINC, PACS, Medical Standards for Vocabulary, ICD 10, DRG, MeSH, UMLS, SNOMED. Healthcare Standards - JCAHO, HIPAA

ELECTRONIC DECISION SUPPORT SYSTEMS **9**

Biomedical decision making. Probabilistic clinical reasoning. Medical Knowledge and Decision Support, Methods for decision support, Clinical decision-support systems, Strategies for medical knowledge acquisition, Predictive tools for clinical decision support.

BIOINFORMATICS AND TOOLS **9**

Introduction to Bioinformatics. Biological information resources. Genome sequence acquisition and analysis, Retrieval of biological data. Data acquisition, databases, structure and annotation. Data mining and data characteristics. NCBI, Human Genome Project, GenBank, Sequence alignment, BLAST, FASTA, CLUSTALW, Phylogenetic analyses.

NORMS FOR HOSPITALS AND STANDARDS **9**

Design and construction standards for the hospitals, BIS –India, JCIA, AIA and NHS, general guidelines and standard for out-patient area, in-patient area and diagnostic area in the hospitals. Voluntary & Mandatory standards, General standards, Mechanical standards, Electrical Standards, Standard for centralized medical gas system, Standards for biomedical waste.

Total Periods 45

References

1. Edward H. Shortliffe, James J. Cimino, "Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics)", 2014, 4th edition, Springer.
2. Kenneth R. Ong, "Medical Informatics: An Executive primer", 2015, 1st edition, HIMSS Publishing, Chicago.
3. Lazakidou, Athina A., "Web-Based Applications in Healthcare and Biomedicine, Annals of Information Systems", 2010, 7th edition, Springer.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2			2		3	
CO2	2	2	3	1			3		3	
CO3	2	2	3	2			2		2	
CO4	3	2	2	1			2		3	
CO5	2	2	3	3	3		2		3	
CO6	2	2	3	3	3		2		2	

232AEE09 BIOMEDICAL IMAGE PROCESSING **L-T-P C**

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: To learn the concept of MRI, ultrasound imaging, segmentation techniques and 3D visualization.

Course Outcomes:

The Students will be able to

CO1: Bring out the procedure for medical image acquisitions.

CO2: Examine the basic principles of the major medical imaging techniques

CO3: Demonstrate different types of Radio diagnostic techniques.

CO4: Design image analysis techniques in the form of image segmentation and to evaluate the Methodologies for segmentation.

CO5: Analyze the constraints in image processing when dealing with 3D data sets

CO6: Apply image processing algorithms in practical applications.

INTRODUCTION **9**

Introduction to imaging modalities-Image quality X-rays in Diagnostic imaging-X-ray production, X-ray interactions-X-ray spectra-X-ray dosimetry-X-ray detection-radiography-mammography-fluoroscopy. Computed tomography systems- Scanner design-reconstruction techniques-image quality artifacts-multi slice imaging scanner performance..

MAGNETIC RESONANCE IMAGING **9**

Basic principles of nuclear magnetic resonance-Image creation- Slice selection, Frequency encoding, Phase Encoding, pulse sequence, Image characteristics and artifacts, Hardware and software components

ULTRASOUND IMAGING **9**

The wave equation-Impedance, Power and reflection-Acoustic properties of Biological tissues-Transducers, beam patterns and resolution-Diagnostic imaging modes –Doppler principles.

SEGMENTATION **9**

Image preprocessing-Thresholding-Edge based techniques-Region based segmentation-Classification deformable models-Image Registration-Geometrical Transformations-Point based methods-Surface based Methods-Intensity based methods.

3D VISUALIZATION **9**

Pre processing-Scene-based visualization-object based visualization-Manipulation. Medical Applications and Systems– Diagnostics-Therapeutics- Interventions.

Total Periods 45

References

1. Isaac Bankman, I. N. Bankman , “Handbook of Medical Imaging: Processing and Analysis”, Academic Press,2000.
2. Avinash C.Kak, Malcolm Slaney, “Principles of Computerized Tomographic Imaging”, Society of industrial and applied mathemetics,2001.
3. Albert Macowski, “Medical Imaging Systems”, Prentice Hall, New Jersy-2383.
4. AtamP.Dhawan, ‘Medical Image Analysis’, Wiley Interscience Publication, NJ, USA 2003.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2			2		2	
CO2	3	1	3	2			3		2	
CO3	2	2	3	1			2		3	
CO4	2	2	2	3			1		3	
CO5	2	2	1	2			3		2	
CO6	2	2	1	2			2		3	

232AE10 **DIGITAL IMAGE AND VIDEO PROCESSING** **L-T-P C**
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: II** **Category:** PC

AIM: To learn the concept of MRI, ultrasound imaging, segmentation techniques and 3D visualization.

Course Outcomes:

The Students will be able to

CO1: Learn different techniques for image enhancement, video and image recovery
CO2: Apply various transforms to images and videos
CO3: Analyze the image and video restoration
CO4: Understand techniques for image and video segmentation
CO5: Study techniques for image and video compression and object recognition
CO6: Recognize the object using object tacking techniques

DIGITAL IMAGE AND VIDEO FUNDAMENTALS **9**

Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/3-D filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations, Image Transforms , Need for image transforms, DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform

IMAGE AND VIDEO ENHANCEMENT AND RESTORATION **9**

Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, video resolution enhancement, Image and Video restoration (recovery).

IMAGE AND VIDEO SEGMENTATION **9**

Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation, Morphological image processing.

IMAGE AND VIDEO COMPRESSION **9**

Lossless image compression including entropy coding, lossy image compression, video compression techniques, and international standards for image and video compression (JPEG, JPEG 2000, MPEG-2/4, H.264, SVC), Video Quality Assessment

OBJECT RECOGNITION **9**

Image Feature representation and description-boundary representation, boundary descriptors, regional descriptors, feature selection techniques, introduction to classification, supervised and unsupervised learning, Template matching, Bayes classifier

Total Periods 45

References

1. Ed. Al Bovik ,"Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2000.
2. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding",2nd Edition, Academic Press, 2011.
3. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall, 2008.
4. A. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015.

ourse Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	2			2		3	
CO2	2	2	2	2			2		3	
CO3	1	1	3	2			2		3	
CO4	1	2	2	2			3		2	
CO5	2	2	3	1			2		3	
CO6	3	1	2	1			2		3	

232AE11 **ARM ARCHITECTURE AND PROGRAMMING** **L-T-P C**
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: This course will provide an opportunity to the students to become familiar with ARM microprocessor architecture, instruction set and programming.

Course Outcomes:

The Students will be able to
CO1: Analyze the advance microprocessor family set.
CO2: Illustrate the architecture of ARM processor.
CO3: Apply the instruction set of ARM processor to various applications.
CO4: Apply the hybrid (assembly & C) program for ARM microprocessor.
CO5: Outline input/output devices like Keyboard, LED, LCD, sensors with ARM7TDMI.
CO6: Design memory for Embedded products using ARM

INTRODUCTION **9**

Need of advance microprocessors, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, History of ARM microprocessor, ARM processor family, Development of ARM architecture.

THE ARM ARCHITECTURE AND PROGRAMMERS MODEL **9**

The Acorn RISC Machine, ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmer's model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store architecture, Core extensions, Architecture revisions, ARM development tools.

ARM INSTRUCTION SET **9**

Data processing instructions, Arithmetic and logical instructions, Rotate and barrel shifter, Branch instructions, Load and store instructions, Software interrupt instructions, Program status register instructions, Conditional execution, Multiple register load and store instructions, Stack instructions, Thumb instruction set, advantage of thumb instructions, Assembler rules and directives, Assembly language programs for shifting of data, swapping register contents, moving values between integer and floating point registers.

C PROGRAMMING FOR ARM **9**

Overview of C compiler and optimization, Basic C data types, C Looping structures, Register allocations, function calls, pointer aliasing, structure arrangement, bit fields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, Portability issues. C programs for General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC.

MEMORY MANAGEMENT UNITS **9**

Moving from memory protection unit (MPU) to memory management unit (MMU), Working of virtual memory, Multitasking, Memory organization in virtual memory system, Page tables, Translation look aside buffer, Caches and write buffer, Fast context switch extension, Advanced Microprocessor Bus Architecture (AMBA) Bus System, User peripherals, Exception handling in ARM, ARM optimization techniques.

Total Periods: 45

References:

1. William Hohl, ChristppherHinds , "Arm Assembly Language, Fundamentals and Techniques", 2nd edition, 2014.
2. Andrew N. Sloss , "Arm System Developer's Guide, Designing and Optimizing Software", 1st Edition 2004.
3. Steve Furber , "Arm System-on-chip Architecture", 2nd Edition, 2000.
4. Muhammad Ali Mazidi, "ARM Assembly Language programming & Architecture", 1st edition, 2016

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3		2	2		
CO2	3	3	1	2	2		2	3		
CO3	3	2	3	2	2		3	1		
CO4	3	1	2	2	3		2	2		
CO5	3	3	3	2	2		3	3		
CO6	2	2	2	2	3		2	2		

232AEE12 ARCHITECTURE OF INTERNET OF THINGS L-T-P C
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem:** - **Category:** PE

AIM: The aim of the course is to make the students design and implement IOT in real time applications.

Course Outcomes:

The Students will be able to
CO1: Identify the components of IOT
CO2: Construct a portable IOT using appropriate boards
CO3: Program the sensors and controller as part of IOT
CO4: Apply the schemes for the applications of IOT in real time scenarios.
CO5: Determine the real time performance of real time packet based Networks.
CO6: Analyze trade-offs in interconnected wireless embedded sensor networks.

INTRODUCTION 9

Definition – phases – Foundations – Policy– Challenges and Issues - identification - security –privacy. Components in internet of things: Control Units – Sensors – Communication modules – Power Sources – Communication modules – RFID – Bluetooth – Zigbee – Wifi – RFlinks – Mobile Internet – Wired Communication

PROGRAMMING THE MICROCONTROLLER FOR IOT 9

Basics of Sensors and actuators – examples and working principles of sensors and actuators – Cloud computing and IOT – Arduino/ Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors Communication: Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using wifi / ethernet

RESOURCE MANAGEMENT IN THE INTERNET OF THINGS 9

Clustering – software Agents – Data Synchronization – Clustering Principles in an Internet of Things Architecture – The Role of Context – Design Guidelines –Software Agents for object – Data Synchronization – Types of Network Architectures – fundamental concepts of Agility and Autonomy –Enabling Autonomy and agility by the Internet of Things

BUSINESS MODELS FOR THE INTERNET OF THINGS 9

The Meaning of DiY in the Network Society – Sensor actuator Technologies and Middleware as as Basis for DiY Service Creation Framework –Device Integration –Middleware Technologies Needed for DiY Internet of Things Semantic Interoperability as a Requirement for DiY creation –Ontology – value Creation in the Internet of Things – Application of Ontology Engineering in the Internet of Things –Semantic Web Ontology – the Interne of Things in Context of Eurudice – Buisness Impact

FROM THE INTERNET OF THINGS TO THE WEB OF THINGS 9

Resource-oriented Architecture and Best Practices-Designing REST ful Smart Things –Web –enabling Constrained Devices – The Future Web of Things –Set up Cloud environment - Send data from microcontroller to cloud – Case Studies – Open Source e- Health sensor platform –Be Close Elderly monitoring – other recent projects

Total Periods 45

References

1. Charalampos Doukas, Building Internet of Things with the Arduino, Create Space, April 2002.
2. Dieter Uckelmann et.al, "Architecting the Internet of Things", Springer, 2011.
3. CunoPfister, "Getting Started with the Internet of Things", O'Reilly, 2011.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	1	2		1
CO2	2	3	2	2	1	2	2	2		2
CO3	3	3	3	2	2	2	1	2		1
CO4	3	3	2	2	1	2	2	2		2
CO5	2	3	3	3	2	2	1	3		1
CO6	2	3	2	2	1	2	1	2		2

232AEE13 **ASIC DESIGN** **L-T-P C**

3-0- 0 3

Programme: M.E.(Applied Electronics) **Sem:** I **Category:** PC

AIM To design and analyze the ASIC and FPGA using CMOS VLSI technology

Course Outcomes

The Students can be able to

CO1: Illustrate Semi custom IC Design and the principles of design logic cells, I/O cells and interconnect architecture,

CO2: Develop FPGA and ASIC design for the circuit and layout design point of view.

CO3: Design the next transistor and block level abstractions of FPGA and ASIC.

CO4: Analyze CAD design for VLSI and have gained sufficient theoretical knowledge for carrying out FPGA and ASIC designs.

CO5: Identify faults in the VLSI circuits

CO6: Solve the Routing problems in VLSI Circuits

INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN 9

Types of ASICs - Design flow - CMOS transistors CMOS Design rules - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort – Library cell design - Library architecture.

PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS 9

Anti fuse - static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.

PROGRAMMABLE ASIC INTERCONNECT, PROGRAMMABLE ASIC DESIGN SOFTWARE 9

Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Logic Synthesis - Half gate ASIC.

LOGIC SYNTHESIS, SIMULATION AND TESTING 9

Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation - automatic test pattern generation.

ASIC CONSTRUCTION, FLOOR & POWER PLANNING, PLACEMENT AND ROUTING 9

System partition - FPGA partitioning - partitioning methods - floor planning - placement – physical design flow global routing - detailed routing - special routing - circuit extraction – DRC, Power Planning, Clock Rate Synthesis, Static Timing Analysis.

Total Periods 45

References:

1. 1. M.J.S .Smith, "Application Specific Integrated Circuits, Addison -Wesley Longman Inc., 1997.
2. FarzadNekoogar, “From ASICs to SOCs: A Practical Approach”, Prentice Hall PTR, 2003.
3. Wayne Wolf, “FPGA-Based System Design”, Prentice Hall PTR, 2004.
4. R. Rajsuman, “System-on-a-Chip: Design and Test”, Artech House Publishers, 2000.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2		2	2		
CO2	2	2	2	1	2		2	2		
CO3	3	2	3	2	1		2	1		
CO4	3	2	2	2	2		3	2		
CO5	2	2	3	1	2		2	3		
CO6	2	1	2	1	2		2	2		

232AEE14 DATA WAREHOUSING AND DATA MINING L-T-P C
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: To familiar the fundamental concepts different types of data and its processing algorithms

The Students will be able to

CO1: Demonstrate the basic working principles of data warehousing.
CO2: Examine the concepts of data mining techniques.
CO3: Design the architecture to process the data.
CO4: Categorize the data processing based on their prediction techniques.
CO5: Analyze the data using recent technology.
CO6: Classify various data set for both supervised and unsupervised data's.

INTRODUCTION AND DATA WAREHOUSING 9

Introduction, Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Implementation, Further Development, Data Warehousing to Data Mining

DATA PREPROCESSING, LANGUAGE, ARCHITECTURES, CONCEPT DESCRIPTION 9

Why Preprocessing, Cleaning, Integration, Transformation, Reduction, Discretization, Concept Hierarchy Generation, Data Mining Primitives, Query Language, Graphical User Interfaces, Architectures, Concept Description, Data Generalization, Characterizations, Class Comparisons, Descriptive Statistical Measures.

ASSOCIATION RULES& DATABASES 9

Association Rule Mining, Single-Dimensional Boolean Association Rules from Transactional Databases, Multi- Level Association Rules from Transaction Databases

CLASSIFICATION AND CLUSTERING 9

Classification and Prediction, Issues, Decision Tree Induction, Bayesian Classification, Association Rule Based, Other Classification Methods, Prediction, Classifier Accuracy, Cluster Analysis, Types of data, Categorization of methods, Partitioning methods, Outlier Analysis.

RECENT TRENDS IN DATA MINING 9

Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Databases, Multimedia Databases, Time Series and Sequence Data, Text Databases, World Wide Web, Applications and Trends in Data Mining.

Total Periods 45

References

1. J. Han, M. Kamber, "Data Mining: Concepts and Techniques", Harcourt India / Morgan Kauffman, 2001.
2.Margaret H.Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education 2004.
3. Sam Anahory, Dennis Murry, "Data Warehousing in the real world", Pearson Education 2003.
4. David Hand, Heikki Manila, PadhraicSymth, "Principles of Data Mining", PHI 2004.

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Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3			3	1		
CO2	2	2	3	3			2	2		
CO3	3	2	1	1			3	1		
CO4	3	3	2	2			2	2		
CO5	2	2	1	1			1	2		
CO6	2	1	2	2			2	1		

232AEE15 **BIG DATA COMPUTING** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: To highlight and explore the need for big data.

Course Outcomes:

CO1: Identify the various sources of Big Data
C02: Design new algorithms for collecting Big Data from various sources
CO3: Design algorithms for pre-processing Big Data other than the traditional approaches
CO4: Examine methodologies to extract data from structured and un-structured data for analytics
CO5: Develop big data application in HADOOP environment
CO6: Apply data privacy concepts in real time bigdata applications

INTRODUCTION TO BIG DATA ACQUISITION **9**

Big data framework -Fundamental concepts of Big Data management and analytics -Current challenges and trendsin Big Data Acquisition.

DATA COLLECTION AND TRANSMISSION **9**

Big data collection-Strategies-Types of Data Sources-Structured Vs Unstructured data-ELT vs ETL - storage infrastructure requirements -Collection methods-Log files-Sensors-Methods for acquiring network data (Libcap-based and zero-copy packet capture technology) -Specialized network monitoring softwares (Wireshark, martsniff and Winnetcap)-Mobile equipment's-Transmission methods- Issues

DATA PREPROCESSING **9**

Data pre-processing overview-Sampling-Missing Values -Outlier Detection and Treatment - Standardizing Data-Categorization -Weights of Evidence Coding -Variable Selection and Segmentation.

DATA ANALYTICS **9**

Predictive Analytics (Regression, Decision Tree, Neural Networks) -Descriptive Analytics (Association Rules, Sequence Rules), Survival Analysis (Survival Analysis Measurements, Kaplan Meir Analysis, Parametric Survival Analysis) -Social Network Analytics (Social Network Learning-Relational Neighbor Classification)

BIG DATA PRIVACY AND APPLICATIONS **9**

Data Masking –Privately Identified Information (PII) -Privacy preservation in Big Data-Popular Big Data Techniques and tools-Map Reduce paradigm and the Hadoop system-Applications-Social Media Analytics- Recommender Systems-Fraud Detection.

Total Periods **45**

Reference Books

1. Bart Baesens," Analytics in a Big Data World:The Essential Guide to Data Science and its Applications",John Wiley & Sons, 2014.
2.Min Chen, Shiwen Mao, Yin Zhang, Victor CM Leung ,Big Data: Related Technologies, Challenges and Future Prospects, Springer, 2014.
3.MichaelMinelli,MicheleChambers,AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends",John Wiley& Sons, 2013.
4.Raj, Pethuru, "Handbook of Research on Cloud Infrastructures for Big Data Analytics", IGI Global.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3			3	1		
CO2	2	2	2	3			2	2		
CO3	3	1	1	4			3	1		
CO4	3	3	2	2			2	2		
CO5	2	3	2	3			1	3		
CO6	3	3	2	2			3	3		

232AEE16 **CAD FOR VLSI CIRCUITS** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: To gain the knowledge on Simulation and Synthesis in VLSI Design Automation

Course Outcomes:

The Students will be able to

CO1.Identify various VLSI design methodlogies

CO2. Apply various VLSI design rules for fabrication.

CO3. Design Floor Planning of VLSI Circuits

CO4 : Develop Routing Algorithm using HDL

CO5. Simulate the modeling and sysnthesis of VLSI circuits

CO6: Model the hardware architecture and synthesis using CAD tools

VLSI DESIGN METHODOLOGIES **9**

Introduction to VLSI Design methodologies -Review of Data structures and algorithms -Review of VLSI Design automation tools -Algorithmic Graph Theory and Computational Complexity -Tractable and Intractable problems -general purpose methods for combinatorial optimization.

DESIGN RULES **9**

Layout Compaction -Design rules -problem formulation -algorithms for constraint graph compaction - placement and partitioning –Circuit representation –Placement algorithms -partitioning.

FLOOR PLANNING **9**

Floor planning concepts -shape functions and floorplan sizing -Types of local routing problems -Area routing -channel routing -global routing -algorithms for global routing.

SIMULATION **9**

Simulation -Gate-level modeling and simulation -Switch-level modeling and simulation -Combinational Logic Synthesis -Binary Decision Diagrams -Two Level Logic Synthesis.

MODELLING AND SYNTHESIS **9**

High level Synthesis -Hardware models -Internal representation -Allocation -assignment and scheduling -Simple scheduling algorithm –Assignment problem–High level transformations.

Total Periods 45

References

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.

2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

3.Erik Brunvand " Digital VLSI Chip Design with Cadence and Synopsys CAD Tools" Pearson; 1st edition, 2009

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2			1	2		
CO2	3	1	2	3			3	1		
CO3	2	3	2	3			2	3		
CO4	2	3	2	1			1	3		
CO5	1	2	2	1			3	2		
CO6	2	2	3	1			2	3		

232AEE17 **VLSI TESTING AND VERIFICATION** **L-T-P C**

3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: -** **Category:**

AIM: To discuss different aspects of VLSI testing and formal verification of designs.

Course Outcomes:

The Students will be able to

CO1: Analyze the use of Multilevel and Heuristic Minimization

CO2: Design Binary Decision Diagram for VLSI circuits

CO3: Apply various testing tools in VLSI circuits

CO4: Understand the various faults in VLSI Circuits.

CO5: Generate various test pattern vector for VLSI circuits

CO6: Use advanced testing tools

INTRODUCTION **9**

Introduction to Digital VLSI Design Flow- High Level Design Representation- Transformations for High Level Synthesis- Scheduling, Allocation and Binding- Introduction to HLS: Scheduling, Allocation and Binding Problem- -Scheduling Algorithms - Binding and Allocation Algorithms- Logic Optimization and Synthesis- Two level Boolean Logic Synthesis - Heuristic Minimization of Two-Level Circuits- Finite State Machine Synthesis- Multilevel Implementation

VERIFICATION **9**

Binary Decision Diagram- Binary Decision Diagram: Introduction and construction- Ordered Binary Decision Diagram- Operations on Ordered Binary Decision Diagram- Ordered Binary Decision Diagram for Sequential Circuits- Temporal Logic- Introduction and Basic Operations on Temporal Logic- Syntax and Semantics of CLT- Equivalence between CTL Formulas- Model Checking- Verification Techniques
- Model Checking Algorithm- Symbolic Model Checking

TESTING **9**

Introduction to Digital Testing- Introduction to Digital VLSI Testing- Functional and Structural Testing -Fault Equivalence.

FAULT ANALYSIS & PATTERN GENERATION **9**

Fault Simulation and Testability Measures- Fault Simulation- Testability Measures (SCOAP)
- Combinational Circuit Test Pattern Generation- Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras-Algorithm

ADVANCED TESTING **9**

Sequential Circuit Testing and Scan Chains- ATPG for Synchronous Sequential Circuits- Scan Chain based Sequential Circuit Testing- Built in Self test (BIST)- Built in Self Test- Memory Testing

Total Periods 45

References

1. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High-Level Synthesis: Introduction to Chip and System Design, Springer, 1st edition, 2392.
2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003.
3. M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning about systems, Cambridge University Press, 2nd Edition, 2004.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2			1	3		
CO2	3	1	3	2			3	1		
CO3	2	3	2	1			2	3		
CO4	1	2	2	3			3	2		
CO5	3	2	3	1			3	2		
CO6	2	3	1	2			2	1		

232AEE18

CLOUD AND FOG COMPUTING

L-T-P
3-0-0

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: The aim of the course is to investigate Advanced Antenna Engineering approaches from both the software and hardware perspectives.

Course Outcomes:

The Students will be able to
CO1: Deploy their data in the cloud for simple applications
CO2: Apply the analytics in cloud to extract information
CO3: Appreciate and deploy fog data processing layers
CO4: Integrate sensor data to cloud through fog computation layers
CO5: Develop edge analytics using python and tensor flow.
CO6: Perform data pushing and processing in commercial clouds

CLOUD COMPUTING BASICS AND ENABLING TECHNOLOGIES 9

Basics of cloud computing-Need for clouds- concepts and models: Roles and boundaries – Cloud characteristics – Cloud delivery models – Cloud deployment models. Broadband Networks and Internet Architecture – Data Center Technology – Virtualization Technology.

CLOUD VIRTUALISATION 9

Server oriented – Virtual Machines (IaaS), Modern Serverless Configurations- Functions/ (PaaS) Lambda functions – App, Biz function, logics, data ingestion (elasticity, scalability – on demand) DB services, Analytics services (SaaS).

CLOUD APPLICATION DEVELOPMENT IN PYTHON& FEDERATED CLOUD SERVICE MANAGEMENT AND IOT 9

Python for Cloud: Amazon Web Services – Google Cloud – Windows Azure. Python for MapReduce. Cloud Service management (federated) –Cloud Life Cycle-service and management-Cloud architectures -Self organizing cloud architectures

FOG COMPUTING 9

Need for Fog computation, Fog data processing layers – Security and Identity Management – Business process integration – Big data interfaces – Wireless sensors and actuators, Fog in 5G, Architecture Harmonization Between Cloud Radio Access Networks and Fog Networks, Fog applications.

FOG AND EDGE COMPUTING 9

Need for edge computation-Edge computing architectures, Device registration, Remote diagnostics, SW update, Geo distributed computing-concept of cloud orchestration, Edge Networks (Low bandwidth networks/ Security/protcols),WAN vs Low bandwidth networks.

Total Periods 45

References

1. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, “Cloud Computing: Concepts, Technology & Architecture”, Arcitura Education, 2013.
2. Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-on Approach”, 2013.
3. Ovidiu Vermesan, Peter Friess, “Internet of Things – From Research and Innovation to Market Deployment”, River Publishers, 2014
4. Michael Missbach, Thorsten Staerk, Cameron Gardiner, Joshua McCloud, Robert Madl, Mark Tempes, George Anderson, “SAP on Cloud”, Springer, 2016
5. John Mutumba Bilay , Peter Gutsche, Mandy Krimmel, Volker Stiehl , “SAP Cloud Platform Integration: The Comprehensive Guide”, Rheinwerg publishing, 2 nd edition, 2019

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2		2	3		
CO2	3	2	1	2	3		3	2		
CO3	3	3	2	3	3		3	2		
CO4	3	3	1	2	2		3	2		
CO5	3	2	2	2	2		2	3		
CO6	3	3	2	3	2		2	3		

232AEE19 **ADVANCED ANTENNA ENGINEERING** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem:** **Category:** **PE**

AIM: The aim of the course is to investigate Advanced Antenna Engineering approaches from both the software and hardware perspectives.

Course Outcomes:

The Students will be able to

CO1: Explain the radiation mechanism of antenna and problems related to antenna parameters.

CO2: interpret non uniform excitation coefficients using array synthesis techniques

CO3: Design and analyze rectangular and circular microstrip antenna with power divider network.

CO4: Illustate the importance of defected ground structures metamaterial surfaces and high impedance surfaces.

CO5: Exploit the antennas for wireless communication and radar applications.

CO6: Comprehend the working of antenna for Software defined and cognitive radio and computational techniques

ANTENNA FUNDAMENTALS AND ARRAY SYNTHESIS **9**

Radiation Mechanism, antennas used in various applications and selection criteria, Antenna measurements using anechoic chamber - Radiation pattern, Radiation Intensity, Power gain, Directivity, impedance, Radiation efficiency, Polarization

ARRAY SYNTHESIS **9**

Fourier Transform - Woodward-Lawson Sampling - Schelkunoff Method- Dolph-Tchebyscheff - Taylor Line Source Method

MICROSTRIP ANTENNAS **9**

Basic characteristics, feeding methods, Methods of analysis – Transmission line model and cavity model - Design of Rectangular patch, Circular patch –Microstrip antenna array and feed network

ANTENNA DESIGN TECHNIQUES **9**

Antenna Design using Artificial Impedance Surface Metamaterial- Electromagnetic Band GapDefective Ground Structure - High Impedance Surface - Method of moments (MoM), Finite element method (FEM), Finite difference time domain method

ANTENNA APPLICATIONS **9**

Integrated Antenna for wireless personal communication, mobile communication- Antenna design consideration for MIMO diversity systems - medical therapy Antenna for Software Defined Radio – Cognitive Radio- Electronic Warfare- Ground penetrating Radar.

Total Periods: 45

References:

1. C.A. Balanis, Antenna Theory: Analysis and Design, 2016, 4th edition, Wiley, India
2. C.A. Balanis, Modern Antenna Handbook, 2012, 1st Edition, Wiley, India
3. W.L. Stutzman and G.A. Thiele, Antenna Theory and design, 2012, 3rd Edition, Wiley, India
4. J. D. Kraus, Antennas and Wave propagation, 2012, 4th Edition, McGraw Hill, India.
5. Sanjay Kumar, Saurabh Shukla, Wave Propagation and Antenna Engineering, 2016, 1st Edition PHI, India

ourse Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1										
CO2										
CO3										
CO4										
CO5										
CO6										

232AEE20 **QUANTUM MACHINE LEARNING** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: To introduce several quantum machine learning algorithms and implement them in Python.

Course Outcomes:

The Students will be able to

CO1: Distinguish between quantum computing paradigms relevant for machine learning

CO2 : Implement learning algorithms on quantum computers

CO3 : Develop Regression Algorithm using quantum machine learning

CO4 : Choose selected Quantum algorithm for Clustering , Pattern Recognition and Classification

CO5 : Analyze the Quantum Process Tomography and Regression

CO6 : Use of Boosting and Adiabatic Quantum Computing

Introduction **9**

Machine Learning-Quantum Mechanics States and Superposition -Density Matrix Representation and Mixed States - Composite Systems and Entanglement – Evolution – Measurement - Uncertainty Relations Tunneling-Adiabatic Theorem -No-Cloning Theorem - Quantum Computing -Qubits and the Bloch Sphere - Quantum Circuits - Adiabatic Quantum Computing - Quantum Parallelism - Grover's Algorithm - Complexity Classes - Quantum Information Theory

Classical Learning Algorithms **9**

Unsupervised Learning - Principal Component Analysis - Manifold Embedding - K-Means and K-Medians Clustering - Hierarchical Clustering - Density-Based Clustering - Pattern Recognition and Neural Networks - The Perceptron - Hopfield Networks - Feedforward Networks -Deep Learning - Computational Complexity - Supervised Learning and Support Vector Machines - K-Nearest Neighbors 74 - Optimal Margin Classifiers - Soft Margins - Nonlinearity and Kernel Functions - Least-Squares Formulation - Generalization Performance - Multiclass Problems - Loss Functions - Computational Complexity

9

Regression Analysis

Regression Analysis - Linear Least Squares - Nonlinear Regression - Nonparametric Regression - omputational Complexity - Boosting - Weak Classifiers - AdaBoost - A Family of Convex Boosters - Nonconvex Loss Functions

Quantum Clustering , Pattern Recognition and Classification **9**

Clustering Structure and Quantum Computing - Quantum Random Access Memory - Calculating Dot Products - Quantum Principal Component Analysis - Toward Quantum Manifold Embedding -Quantum K-Means - Quantum K-Medians - Quantum Hierarchical Clustering - Computational Complexity - Quantum Pattern Recognition - Quantum Associative Memory - The Quantum Perceptron -Quantum Neural Networks - Physical Realizations - Computational Complexity - Quantum Classification - Nearest Neighbors - Support Vector Machines with Grover's Search - Support Vector Machines with Exponential Speedup - Computational Complexity

Quantum Process Tomography and Regression **9**

Channel-State Duality -Quantum Process Tomography - Groups, Compact Lie Groups, and the Unitary Group - Representation Theory - Parallel Application and Storage of the Unitary -Optimal State for Learning - Applying the Unitary and Finding the Parameter for the Input State - Boosting and Adiabatic Quantum Computing - Quantum Annealing - Quadratic Unconstrained Binary Optimization - Ising Model - QBoost - Nonconvexity - Sparsity, Bit Depth, and Generalization Performance - Mapping to Hardware - Computational Complexity

Total Periods 45

References

1 Peter Wittek " Quantum Machine Learning : What Quantum Computing Means to Data Mining" First Edition , Elsevier Publkication, 2014.

2 Santanu Ganguly "Quantum Machine Learning: An Applied Approach" First Edition , Apress Berkeley, CA, 2021.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3			2	3		
CO2	2	3	3	3			3	3		
CO3	3	3	3	2			2	2		
CO4	2	3	3	3			3	3		
CO5	1	2	3	2			3	2		
CO6	3	3	2	3			2	2		

232AEE21 ADVANCED WIRELESS SENSOR NETWORKS L-T-P C
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: The aim of the course is to investigate Advanced Wireless Sensor Networks approaches from both the software and hardware perspectives

Course Outcomes:

CO1: Understand the Architectures of WSNs.
CO2: Design Physical and MAC Layers
CO3: Design Network layer in WSN.
CO4: Understand Clustering and WSN Standards of WSN.
CO5: Design Localization process in WSN.
CO6: Understand and write code for Operating Systems in WSN.

ARCHITECTURES OF WSN'S 9

Challenges and enabling technologies for Wireless Sensor Networks, Single-Node architecture, Hardware components, Energy consumption of sensor node, Sensor network scenarios.

PHYSICAL AND MAC LAYERS 9

Physical layer and transceiver design considerations in WSNs, MAC Protocols for WSNs: Schedule-based protocols, Random Access-based protocols, Sensor-MAC: Periodic listen and sleep operations, Schedule selection and coordination, Schedule synchronization, Adaptive listening, Access control and data exchange, Message pass.

NETWORK LAYER AND CLUSTERING IN WSN 9

Challenges for routing, Data centric and flat architecture- Hierarchical protocols, Geographical routing, QoS based protocols

WSN STANDARDS & LOCALIZATION IN WSN 9

802.15.4 - PHY and MAC, Zigbee, NFC,LORA, 6LoWPAN- Challenges in localization, Ranging techniques, Range-based localization, Range-free localization.

OPERATING SYSTEMS IN WSN 9

Introduction, WSN - operating system design issues, Examples of OS, TinyOS.

Total Periods 45

References

1. Holger Karl, Andreas Wiilig, Protocols and Architectures for Wireless Sensor Networks, 1st Edition, John Wiley & Sons, New Jersey.
2. Kazem Sohraby, Daniel Minoli, Taieb Znati, Wireless Sensor Networks-Technology, Protocols, and Applications, 2012, 1st Edition, John Wiley & Sons, New Jersey.
3. Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, 2011, 1st Edition, John Wiley & Sons, New Jersey.
4. Anna Hac, Wireless Sensor Network Designs, 2013, 1st Edition, John Wiley & Sons, New Jersey

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1			2	2		
CO2	3	2	2	1			3	3		
CO3	2	3	2	2			2	2		
CO4	2	1	2	1			3	1		
CO5	2	2	1	1			2	2		
CO6	3	2	2	2			3	3		

232AEE22 **COGNITIVE RADIO NETWORKS** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: To Realize the concepts of cognitive radio , spectrum sensing and dynamic spectrum access.

Course Outcomes:

The Students will be able to

CO1: Classify software defined radio and cognitive radio networks.

CO2: Explain about cognitive network architecture

CO3: Analyze various spectrum sensing techniques

CO4: Identify the unlicensed and licensed spectrum sharing methods

CO5: Design MAC and Network layer for cognitive networks.

CO6: Implement cognitive radio netwoks in various applications

INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO **9**

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

COGNITIVE RADIO ARCHITECTURE **9**

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS **9**

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection , Bayesian Approach, Neyman Pearson fusion rule for spectrum sensing, Optimum spectrum sensing - Kullback Leibler Divergence and other approaches, Fundamental Tradeoffs in spectru m sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO **9**

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques

ADVANCED TOPICS IN COGNITIVE RADIO **9**

Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques – Requirement and challenges of IoT – Energy efficiency– MIMO Cognitive Radio – Power allocation algorithms.

Total Periods **45**

References

1. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, “Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2. Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006.
3. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
4. Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
5. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2			3	3		
CO2	3	1	2	3			2	3		
CO3	3	2	3	1			2	2		
CO4	3	2	3	2			2	3		
CO5	3	3	3	3			2	2		
CO6	2	3	3	3			3	3		

232AEE23 INFORMATION AND NETWORK SECURITY L-T-P C
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem:** - **Category:** PE

Prerequisites:

AIM: The aim of the course is to investigate Information and Network Security approaches from both the software and hardware perspectives.

Course Outcomes:

The Students will be able to

CO1. Comprehend and analyze OSI Security Architecture and Symmetric Key Encryption.

CO2. Comprehend the various mathematic techniques in cryptography including number theory, Finite Field, modulo operator and Discrete Logarithm.

CO3. Analyze block ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES) and public key cryptography.

CO4. Analyze Diffie-Hellman key exchange, ElGamal Cryptosystem in asymmetric key cryptosystem and authentication schemes.

CO5. Understand the different types of network security protocols and its standards.

CO6: Know the various network security mechanisms.

INTRODUCTION **9**

Need of Security – OSI Security architecture – Security attacks – Security mechanisms – Model for network security – Information security management lifecycle –Classical Techniques - Substitution – Transposition

MATHEMATICS OF CRYPTOGRAPHY -SECRET KEY CRYPTOGRAPHY **9**

Number Theory, Finite Fields, Fermat's and Euler's Theorems - Euler's Totient function - The Chinese Remainder Theorem, Discrete Logarithms, Elliptic and Hyper elliptic curve Arithmetic. Block ciphers and Data Encryption Standard (DES): Double DES – Triple DES. Advanced Encryption Standard (AES) – IDEA

PUBLIC KEY CRYPTOGRAPHY **9**

Principles of Public Key Cryptography - RSA – Elliptic Curve Cryptography (ECC) – Digital Signatures - Key Management: Diffie-Hellman key exchange - Elgammal cryptosystem - Kerberos. Hash Functions: SHA and MD5 - Message Authentication Codes: HMAC.

NETWORK SECURITY PROTOCOLS & STANDARDS **9**

Application level security: PGP, S/MIME, HTTPS and SET. Security in transport layer: SSL and TLS. Security in Network Layer: IPsec, Internet Key Exchange (IKE) and VPN. Fire walls – Scanning, filtering and blocking – Virus filtering – Content filtering – Spam - Wireless LAN: WEP and Honeypots.

CYBER CRIMES, HACKERS AND FORENSICS **9**

Cyber Crimes and Laws – Hackers – Dealing with the rise tide of Cyber Crimes – Forensics analysis

Total Periods: 45

References:

1. William Stallings, Cryptography and Network security: Principles and Practice, 2014, 5th Edition, Pearson Education, Noida, India
2. Joseph Migga Kizza, Computer Network Security, 2012, 1st Edition, Springer Science & Business Media, New York, USA.
3. Christof Paar, Jan Pelzl, Understanding Cryptography – A Textbook for Students and Practitioners, 2014, 1st Edition, Springer Science & Business Media, New York, USA
4. Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography & Network Security, 2013, 3rd Edition, The McGraw Hill Education, New Delhi, India.
5. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: Private Communication in a public World, 2016, 2nd Edition, Pearson Education, Noida, India

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3			3	2		
CO2	3	3	3	2			2	3		
CO3	3	2	2	2			1	2		
CO4	3	3	2	2			2	2		
CO5	3	3	3	2			2	3		
CO6	3	3	2	2			2	3		

232AEE24	DIGITAL TWIN TECHNOLOGY		L-T-P	C
			3-0-0	3
Programme:	M.E.(Applied Electronics)	**Sem:** -	**Category:**	PE

Prerequisites:

AIM: The aim of the course is to ntroduce the computing, mathematical, and engineering background to understand and develop the concept of the digital twin. It provides background in modeling/simulation, computing technology, sensor/actuators, and so forth, needed to develop the next generation of digital twins.

Course Outcomes:

The Students will be able to

CO1. Differentiate various computing technologies in Digital Twin
CO2. Analyze various stochastic dynamic systems
CO3. Apply machine learning alogithm to digital twin
CO4. Develop dynamic model of the digital twin
CO5. Measure Digital Twin at Multiple Time Scales
CO6: Design digital twin of nonlinear MDOF systems.

INTRODUCTION **9**

Introduction- Modeling and Simulation- Sensors and Actuators- Signal Processing- Estimation Algorithms- Industry 4.0- Applications -Digital Twin Use cases and the Internet of things (IOT)-Edge Computing- Telecom and 5G- Cloud- Big Data- Google Tensorow- Blockchain and digital twin

DYNAMIC SYSTEMS & STOCHASTIC ANALYSIS **9**

Single-degree-of-freedom undamped systems- Single-degree-of-freedom viscously damped systems-Multiple-degree-of-freedom undamped systems- Proportionally damped systems- Non-proportionally damped systems- Probability theory- Reliability- Simulation methods in UQ and reliability-Robustness

DIGITAL TWIN OF DYNAMIC SYSTEMS & SURROGATE MODELS **9**

Dynamic model of the digital twin- Digital twin via sti ness evolution- Digital twin via mass evolution Digital twin via mass and sti ness evolution- Discussions- Analysis of Variance Decomposition Polynomial Chaos Expansion- Support Vector Machines- Neural Networks-- Gaussian Process- Hybrid polynomial correlated function expansion

SURROGATE BASED DIGITAL TWIN OF DYNAMIC SYSTEM **9**

The dynamic model of the digital twin- Overview of Gaussian process emulators- Gaussian process based digital twin- The problem statement- Digital twin for multi-timescale dynamical systems- Illustration of the proposed framework

DIGITAL TWIN OF NONLINEAR MDOF SYSTEMS **9**

Physics based nominal model- Bayesian ltering algorithm- Supervised machine learning algorithm
High delity predictive model-Examples

Total Periods: 45

References:

1. Ranjan Ganguli, Sondipon Adhikari, Souvik Chakraborty, Mrittika Ganguli “Digital Twin A Dynamic System and Computing Perspective” CRC Press, 2023.
2. Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs , “Building Industrial Digital Twins″ , Packt Publishing, 2021
3. Vijay Raghunathan , Santanu Deb Barma “ Digital Twin: A Complete Guide For The Complete Beginner” Kindle Edition, 2022.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3			2	3		
CO2	2	2	2	3			2	3		
CO3	3	2	2	2			3	3		
CO4	3	3	2	2			2	2		
CO5	2	3	2	3			2	3		
CO6	3	3	2	2			3	3		

OPEN ELECTIVES

232OE11 **INDUSTRIAL AND MEDICAL IoT** **L-T-P** **C**

3-0-0 **3**

Programme: M.E.(Applied Electronics) **Sem: -** **Category: PE**

AIM: To develop and implement Industrial and medical IoT technologies, solutions, and applications.

Course Outcomes:

The Students will be able to

CO1: Understand the basics of Industrial IOT and Medical IOT

CO2 :Identify the technical and industrial requirement procedures for IIOT applications

CO3 : Develop various applications using IIOT architectures (L3)

CO4 :Choose selected IOT devices for understanding the system architecture of medical IOT

CO5 :Analyze privacy and security measures for industry and medical standard solutions

CO6: Provise potential Solutions for Security Vulnerabilities.

Introduction to Industrial IoT: **9**

Technical requirements, IoT background-History and definition, IoT enabling factors, IoT applications, IoT key technologies, I-IoT, IoT and I-IoT – similarities and differences, Industry environments and scenarios covered by I-IoT.

Understanding the Industrial Process and Devices Technical requirements: **9**

The industrial process-Automation in the industrial process, Control and measurement systems, Types of industrial processes.

Industrial Data Flow and Devices **9**

Technical requirements, The I-IoT data flow in the factory , Measurements and the actuator chain .Sensors , The converters - Digital to analogical , Analog to digital, Actuators, Controllers - Microcontrollers, Embedded microcontrollers , Microcontrollers with external memory, DSP's. Industrial protocols -Automation networks, The fieldbus, Developing Industrial IoT and Architecture- Introduction to the I-IoT platform and architectures, OSGi, micro service, containers, and server less computing, The standard I-IoT flow.

Internet of Medical Things Introduction and system architecture **9**

Introduction, IoMT Devices-On-Body Devices, In- Home Devices, Community Devices, In-Clinic Devices, In- Hospital Devices ,IoMT System Architecture-Data Collection Layer, Data Management Layer, Medical Server Layer.

Internet of Medical Things Security Threats, Security Challenges and Potential Solutions: **9**

Challenges in IoMT Security Schemes, Current Security Plans for IoMT, Potential Solutions for Security Vulnerabilities.

Total Periods 45

References

2 Veneri, Giacomo, and Antonio Capasso- Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0, 1stEd., Packt Publishing Ltd, 2018.

3 D. Jude Hemanth and J. Anitha George A. Tsihrintzis- Internet of Medical Things Remote Healthcare Systems and Applications, covered by Scopus

3. Alasdair Gilchrist- Industry 4.0: The Industrial Internet of Things, 1st Ed., Apress, 2017.

4. Reis, Catarina I., and Marisa da Silva Maximiano, eds.- Internet of Things and advanced application in Healthcare, 1st Ed., IGI Global, 2016

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2			2	2		
CO2	3	3	2	2			2	3		
CO3	2	2	3	2			3	2		
CO4	2	2	3	2			2	2		
CO5	3	2	3	2			3	2		
CO6	2	2	2	3			2	2		

232OE12 SOCIAL MEDIA AND NETWORK ANALYSIS L-T-P C
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem: - Category: PE**

AIM: The aim of the course is to understand the concept of semantic web and related modeling and applications.

Course Outcomes:

The Students will be able to

CO1: Explore semantic web related applications.
CO2: Represent knowledge using ontology.
CO3:Predict human behavior in social web and related communities
CO4:Identify Multi-Relational characterization of dynamic social network communities
CO5: Visualize social networks.
CO6: Identify social networks in collaborative and co-citation networks.

INTRODUCTION 9

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web -Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis.

MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION 9

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modeling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations.

EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS 9

Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities - Decentralized online social networks - Multi- Relational characterization of dynamic social network communities.

PREDICTING HUMAN BEHAVIOUR AND PRIVACY ISSUES 9

Understanding and predicting human behaviour for social communities - User data management - Inference and Distribution - Enabling new human experiences - Reality mining - Context - Awareness - Privacy in online social networks - Trust in online environment - Trust models based on subjective logic - Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and counter measures.

VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS 9

Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.

Total Periods 45

References

1. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
2. BorkoFurht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
3.GuandongXu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011
4.. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modeling", IGI Global Snippet, 2009.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2			1	2		
CO2	3	1	1	2			3	2		
CO3	2	3	3	1			2	3		
CO4	1	2	3	1			3	1		
CO5	3	2	1	2			2	2		
CO6	2	2	1	3			2	1		

232OE02 **INDUSTRIAL SAFETY** **L-T-P C**
3-0-0 3

Programme: M.E.(Applied Electronics) **Sem:** **Category:** **OE**

AIM: To understand about fire and explosion, preventive methods, relief and its sizing methods

Course Outcomes:

Co1: Analyse the effect of release of toxic substances
CO2: Understand the industrial laws, regulations and source models
CO3: Apply the methods of prevention of fire and explosions.4
CO4:Understand the relief and its sizing methods
CO5: Understand the methods of hazard identification and preventive measure
CO6: Follow safety and preventive maintenance of Industrial Engineering

INDUSTRIAL SAFETY

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 2348 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

FUNDAMENTALS OF MAINTENANCE ENGINEERING

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering,Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

WEAR AND CORROSION AND THEIR PREVENTION

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition,principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

FAULT TRACING

Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump, iii. Air compressor, iv. Internal combustion engine, v. Boiler vi. Electrical motors, Types of faults in machine tools and their general causes.

PERIODIC AND PREVENTIVE MAINTENANCE

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing,cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment,advantages of preventive maintenance. Repair cycle concept and importance.

Lecture:45 Tutorial:0 Total Periods:45

References

1. Higgins & Morrow "Maintenance Engineering Handbook,", THI, 6th Edition, 2002.
2. H. P. Garg, "Maintenance Engineering", S. Chand and Company, 2010.
3. Audels "Pump-hydraulic Compressors" , Mcgrew Hill Publication,2016.
4. Winterkorn, Hans "Foundation Engineering Handboo" , Chapman & Hall London,2375..

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4

CO1	1	3	2	2			2	3		
CO2	1	3	1	2			1	3		
CO3	2	3	3	1			1	2		
CO4	2	2	1	3			3	1		
CO5	1	2	3	3			3	2		
CO6	3	1	1	3			2	1		

232OE04	**DESIGN OF EXPERIMENTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Programme: M.E. Computer Science and Engineering **Sem: -** **Category: OE**

Aim: To design the experiments and analyze data collected from experiments

Course Outcomes: The Students will be able to

CO1: Familiarize the Fundamentals of design of experiments
CO2: Practice the various tools used in DOE
CO3: Conduct experiments based on factorial design
CO4: Impart the concepts of Taguchi technique
CO5: Apply for product/process optimization
CO6: Analyze the complex proposonal assessment of alternative in optimization

FUNDAMENTALS OF DESIGN OF EXPERIMENTS **9**

Basic principles of design of experiment – randomization – replication – interactions - simple comparative experiments - applications of experimental design - barriers in DOE - practical methodology

ANALYTICAL TOOLS OF DOE **9**

Main effects plot - Interactions plots - Cube plots - Pareto plot of factor effects - Normal Probability Plot of factor effects - Response surface plots and regression models - Model building – Analysis of variance

FACTORIAL DESIGNS **9**

Single factor experiments - Latin square designs and extensions –Introduction to factorial designs, two levels, 2^k factorial designs - Fractional factorial designs , two-level, three-level and mixed-level factorials

TAGUCHI APPROACH **9**

Overview of Taguchi approach - common experiments and methods of analysis. Orthogonal array-properties - Degrees of freedom-confidence level and interval – case study exercises.

PARAMETER OPTIMIZATION **9**

Regression models - parameter optimization – single and multi objective optimization - Response surface methodology – grey relational analysis – complex proportional assessment of alternatives (COPRAS) - case study exercises

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Douglas C. Montgomery, "Designand Analysis of Experiments", 5th edition., Wiley. 2001
2. Jiju Antony, " Design of Experiments for Engineers and Scientists", 2nd Edition, Elsevier, Londan, 2014.
3. Lennart Eriksson, " Design of Experiments: Principles and Applications", Umetrics Academy, Sweedan, 2008
4. Oehlert, GaryW. "First Course in Design and Analysis of Experiments", Freeman Publishers, New York, 2000
5. Ranjit K Roy, Design of Experiments using the Taguchi Approach, John Wiley & sons, Inc., 2001

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	1	3	2	2			2	2		
CO2	3	3	1	2			1	3		
CO3	2	2	3	1			3	2		
CO4	2	1	3	2			1	2		
CO5	3	2	1	2			3	1		
CO6	2	2	1	3			2	1		

AUDIT COURSES

232AC05	**CONSTITUTION OF INDIA**	**L-T-P**	**C**
		2-0-0	**0**
Programme:	M.E.(Applied Electronics) **Sem:**	**Category:**	**AC**

AIM: Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

COURSE OUTCOMES:

Students will be able to:

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2: Discuss the intellectual origins of the framework of argument

CO3: Inform the conceptualization of social reforms leading to revolution in India.

CO4: Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO5: Discuss the passage of the Hindu Code Bill of 2356.

CO6: Understand the role of Election commission

HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History ,Drafting Committee, (Composition & Working)

PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES

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.

ORGANS OF GOVERNANCE

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

LOCAL ADMINISTRATION

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

ELECTION COMMISSION:

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

Lecture: 24 Tutorial:0 Total Periods:24

References

1. The Constitution of India, 2350 (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 Edn., Lexis Nexis, 2014.
4. D.D. Basu, "Introduction to the Constitution of India" , Lexis Nexis, 2015.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1						2				3
CO2						2				3
CO3						3				2
CO4						3				2
CO5						3				2
CO6						3				1

232AC02 **DISASTER MANAGEMENT** **L-T-P C**

2-0-0 0

Programme: M.E.(Applied Electronics) **Sem:** **Category:** **AC**

AIM: To through knowledge, experience and research build capacities that will reduce disaster risks and contribute to better and more targeted public health based relief following disasters.

Course Objectives:

Students will be able to:

CO1: learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2: critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3: develop an understanding of standards of humanitarian response and

CO4: Develop practical relevance in specific types of disasters and conflict situations.

CO5: critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

CO6: Explain more about disaster mitigation.

INTRODUCTION

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

REPERCUSSIONS OF DISASTERS AND HAZARDS

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

DISASTER PRONE AREAS IN INDIA

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.

DISASTER PREPAREDNESS AND MANAGEMENT

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.

RISK ASSESSMENT

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.

Disaster Mitigation

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Lecture: 24 Tutorial:0 Total Periods:24

References

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies " New Royal book Company, 2014.

2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi,2009.

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4

CO1						3				2
CO2						3				2
CO3						2				2
CO4						3				3
CO5						1				2
CO6						2				1

232AC03	REPORT PREPARATION TOOLS	L-T-P	C
		2-0-0	0

Programme: M.E.(Applied Electronics) **Sem:** **Category:** **AC**

AIM: To learn the tools required for Research paper writing

Course Objectives:

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: Keep the document's format consistent
CO5: Examine the writing skills
CO6: Format and design various layouts suitable for reports

LaTex

LaTex Insallation-Latex Editor -WinEdt IDE-Introduction to WinEdt IDE -TeXstudio IDE - Basic LaTex Document-Sections and subsections in LaTex-Font Size in Latex-Text alignment in LaTex-List-In-LaTex-Table-In-LaTex - Math-Mode-in-LaTex How to write Long equation and address different issues with it -Figure-in-LaTex- Insert-Figure-in-easy-way-Subfigures in Latex-Bibliography In LaTeX-ClassFile In LaTeX- Preparation of thesis or project report -use of Conference or Journal LaTex Template

MS-WORD

Formatting- Table- insert tables- editing inside a table- column and row insertion / deletion changing columns and rows spacing- converting existing text into table- converting table back to text Math Calculation-adding figures in columns or rows- inserting calculation result into your document- defining paragraph and character styles- editing styles- synchronising styles amongst documents - Add Section and Report Elements-Add a header, footer, or page number- Sections: The basics Use sections and odd/even pages- Add a report title page- Insert a table of contents- Insert a table of figures or table of authorities- Insert a footnote or endnote- Proof your report

Lecture: 24 Tutorial:0 Total Periods:24

References

1. Frank Mittelbach , " The LaTeX Companion" Third edition , 2022
2. Scientific approach for report writing using LaTex , Udemy 2022.
3. Creating Reports in Word 2016, Keep Learning , 2023

Course Outcomes	Program Outcomes (POs)						Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1						2				2
CO2						3				1
CO3						3				2
CO4						2				3
CO5						2				3
CO6						3				3

232AC09	ew;wkpo; ,yf;fpak;	L-T-P	C
		2-0-0	0

Programme: M.E.(Applied Electronics) **Sem:** **Category:** **AC**

AIM:

UNIT 1 rq;f ,yf;fpak;

1. jkpopd; Jtf;f E}y; njhy;fhg;gpak;
   - vOj;J,nrhy;,nghUs;
2. mfehD}W (82)
   - ,aw;if ,d;dpir muq;fk;
3. FwpQ;rpg; ghl;bd; kyu;f;fhl;rp
4. GWehD}W (95,195)
   - Nghiu epWj;jpa xsitahu;

UNIT 2 mwnewpj; jkpo;

1. rpWghzhw;Wg;gil
   - ghup Ky;iyf;Fj; Nju; nfhLj;J, Ngfd; kapYf;Fg; Nghu;it nfhLj;J, mjpakhd; xsitf;F ney;ypf;fdp nfhLj;J, muru; gz;Gfs;
2. ew;wpiz
   - md;idf;Fupa Gd;id rpwg;G
3. jpUke;jpuk; (617,618)
   - ,akk; epakk; tpjpfs;
4. ju;kr;rhiyia epWtpa ts;syhu;
5. GwehD}W
   - rpWtNd ts;syhdhs;
6. mfehD}W(4) - tz;L
   ew;wpiz(11) - ez;L
   fypj;njhif(11) - ahid,Gwh
   [e;jpid50(27) - khd;

Mfpait gw;wpa nra;jpfs

UNIT 3 etPd jkpo; ,yf;fpak;

1. cileilj; jkpo;
   - jkpopd; Kjy; Gjpdk;
   - jkpopd; Kjy; rpWfij
   - fl;Liu ,yf;fpak;
   - gaz ,yf;fpak;
   - ehlfk;
2. ehl;L tpLjiy Nghuhl;lKk; jkpo; ,yf;fpaKk;
3. rKjha tpLjiyAk; jkpo; ,yf;fpaKk;
4. ngz; tpLjiyAk; tpspk;G epiyapdupd; Nkk;ghl;by; jkpo; ,yf;fpaKk;
5. mwptpay; jkpo;
6. ,izaj;jpy; jkpo;
7. Rw;Wr;#oy; Nkk;ghl;by; jkpo; ,yf;fpaKk;

UNIT 4 ,ul;ilf; fhg;gpaq;fs;

1. fz;zfpapd; Gul;rp

- rpyg;gjpfhu tof;Fiu fhij

2. r%fNrit ,yf;fpak; kzpNkfiy

- rpiwf;Nfhl;lk; mwf;Nfhl;lkhfpa fhij

UNIT 5 etPd jkpo; ,yf;fpak; **6**

1. cileilj; jkpo;
    - jkpopd; Kjy; Gjpdk;
    - jkpopd; Kjy; rpWfij
    - fl;Liu ,yf;fpak;
    - gaz ,yf;fpak;
    - ehlfk;
2. ehl;L tpLjiy Nghuhl;lKk; jkpo; ,yf;fpaKk;
3. rKjha tpLjiyAk; jkpo; ,yf;fpaKk;
4. ngz; tpLjiyAk; tpspk;G epiyapdupd; Nkk;ghl;by; jkpo; ,yf;fpaKk;
5. mwptpay; jkpo;
6. ,izaj;jpy; jkpo;
7. Rw;Wr;#oy; Nkk;ghl;by; jkpo; ,yf;fpaKk;

jkpo; ,yf;fpa ntspaPLfs;/Gj;jq;fs; (References)

1. jkpo; ,iza fy;tpf;fofk; (Tamil Virtual University)- www.tamilvu.org
2. jkpo; tpf;fpg;gPbah (Tamil Wikipedia)- https://ta.wikipedia.org
3. ju;kGu MjPd ntspaPL
4. tho;tpay; fsQ;rpak;
    - jkpo;g; gy;fiyf;fofk;, jQ;rhT+u;
5. jkpo;fiyf; fsQ;rpak;
    - jkpo; tsu;r;rpj;Jiw (thamilvalarchithurai.com)
6. mwptpay; fsQ;rpak;
    - jkpo;g; gy;fiyf;fofk;, jQ;rhT+u;

Lecture:30 Tutorial:0 Total Periods:30