New Prince Shri Bhavani College Of Engineering and Technology

(An Autonomous Institution)

CURRICULUM
&
SYLLABUS
(1 to 4 SEMESTERS)

(REGULATION 2023)

FOR

M.E. – APPLIED ELECTRONICS
(CHOICE BASED CREDIT SYSTEM)

(Applicable to the students admitted from the Academic Year 2023 – 24)

SEMESTER – I								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
THEORY COURSES								
1	FC	P23MA101	Applied Mathematics for Electronics Engineering	3	1	0	4	4
2	PC	P23AE101	Statistical Signal Processing	3	0	0	3	3
3	PC	P23AE102	Artificial Intelligence and Optimization Techniques	3	0	0	3	3
4	PC	P23AE103	Embedded System Design for Real time Application	3	0	0	3	3
5	RM	P23RM101	Research Methodology and IPR	2	0	0	2	2
6	PC	P23AE104	Analog Integrated Circuit Design	3	0	0	3	3
7	HS	P23HS101	Constitution of India	2	0	0	2	1
PRACTICAL COURSES								
8	PC	P23AE105	Embedded Systems Laboratory	0	0	3	3	2
9	PC	P23AE106	Signal Processing Laboratory	0	0	3	3	2
10	HS	P23HS102	Communication Skills Enhancement	0	0	2	2	1
TOTAL CREDITS								**24**

SEMESTER – II								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
THEORY COURSES								
1	PC	P23AE201	Industrial Internet of Things	3	0	0	3	3
2	PC	P23AE202	Power Conversion Circuits for Electronics	3	0	0	3	3
3	PC	P23AE203	VLSI Design Techniques	3	0	0	3	3
4	PC	P23AE204	Advanced Digital System Design	3	0	0	3	3
5	PE	P23PEAEXX	Professional Elective - I	3	0	0	3	3
6	PE	P23PEAEXX	Professional Elective - II	3	0	0	3	3
7	HS	P23HS201	Essence of Indian Traditional knowledge	2	0	0	2	1
PRACTICAL COURSES								
8	PC	P23AE205	Electronic System Design Laboratory	0	0	3	3	2
9	PC	P23AE206	VLSI Design Laboratory	0	0	3	3	2
10	EEC	P23AE207	Technical Seminar and Report Writing	0	0	2	2	1
TOTAL CREDITS								**24**

SEMESTER – III								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
THEORY COURSES								
1	PE	P23PEAEXX	Professional Elective - III	3	0	0	3	3
2	PE	P23PEAEXX	Professional Elective - IV	3	0	0	3	3
3	PE	P23PEAEXX	Professional Elective - V	3	0	0	3	3
4	EEC	P23AE301	Project Work I	0	0	12	12	6
TOTAL CREDITS								**15**

SEMESTER – IV								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
THEORY COURSES								
1	EEC	P23AE401	Project Work II	0	0	24	24	12
TOTAL CREDITS								**12**

PROFESSIONAL ELECTIVES								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
PROFESSIONAL ELECTIVE-I								
1	PE	P23PEAE01	ASIC and SOC Design	3	0	0	3	3
2	PE	P23PEAE02	Quantum and Nano Electronics	3	0	0	3	3
3	PE	P23PEAE03	Automotive Electronics	3	0	0	3	3
4	PE	P23PEAE04	Soft Computing and Optimization Techniques	3	0	0	3	3
5	PE	P23PEAE05	Robotics for Industrial Automation	3	0	0	3	3
PROFESSIONAL ELECTIVE-II								
1	PE	P23PEAE06	RF System Design	3	0	0	3	3
2	PE	P23PEAE07	Electromagnetic Interference and compatibility	3	0	0	3	3
3	PE	P23PEAE08	VLSI for Wireless Communication	3	0	0	3	3
4	PE	P23PEAE09	MIMO Communication Systems	3	0	0	3	3
5	PE	P23PEAE10	Cyber Security in Electronics	3	0	0	3	3

PROFESSIONAL ELECTIVES								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
PROFESSIONAL ELECTIVE-III								
1	PE	P23PEAE11	Algorithms for VLSI Design Automation	3	0	0	3	3
2	PE	P23PEAE12	Quantum Computing	3	0	0	3	3
3	PE	P23PEAE13	Hardware and Software Co Design	3	0	0	3	3
4	PE	P23PEAE14	Scripting Languages and Verification	3	0	0	3	3
5	PE	P23PEAE15	Signal Integrity for High Speed Design	3	0	0	3	3
PROFESSIONAL ELECTIVE-IV								
1	PE	P23PEAE16	Micro Sensors and Actuators	3	0	0	3	3
2	PE	P23PEAE17	Edge Analytics and Internet of Things	3	0	0	3	3
3	PE	P23PEAE18	Biomedical Signal Processing	3	0	0	3	3
4	PE	P23PEAE19	Fibre optic sensors and photonics	3	0	0	3	3
5	PE	P23PEAE20	IoT Security and Trust	3	0	0	3	3

PROFESSIONAL ELECTIVES								
Sl. No.	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total Contact Periods**	**Credits**
PROFESSIONAL ELECTIVE-V								
1	PE	P23PEAE21	Consumer Electronics	3	0	0	3	3
2	PE	P23PEAE22	Deep Learning	3	0	0	3	3
3	PE	P23PEAE23	Electronic Product Design	3	0	0	3	3
4	PE	P23PEAE24	Green Technologies	3	0	0	3	3

P23MA101	APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERING	L	T	P	C
Prerequisites:	**Transforms and Random Processes**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

- To introduce the fundamentals of fuzzy logic and the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables and to understand about Markov chain
- To learn the fundamental concepts in queueing models

UNIT I FUZZY LOGIC 12

Classical logic – Multivalued logics – Fuzzy propositions – Fuzzy qualifiers.

UNIT II MATRIX THEORY 12

Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization – Least squares method - Singular value decomposition.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Bayes theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT IV RANDOM PROCESSES 12

Barkhausen criterion for oscillation – phase shift, Wien bridge - Hartley & Colpitt's oscillators –- crystal oscillators – oscillator amplitude stabilization.

UNIT V QUEUEING MODELS 12

Poisson process – Markovian queues – Single and multi server models – Little's Formula – Machine Interference model – Steady state analysis – Self service queue.

TOTAL: 60 PERIODS

REFERENCES:

1 Ganesh M, "Introduction to Fuzzy Sets and Systems, Theory and Applications", Academic Press, New York, 1997.

2 Arindama Singh, "Introduction to Matrix Theory", Springer Nature, 2021.

3 Devore J.L, "Probability and Statistics for Engineering and Sciences", Cengage learning, 9 th Edition, Boston, 2017.

4 Ibe, O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.

5 Trivedi, K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2nd Edition, John Wiley & Sons, 2002.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/108/104/108104157/.
2 https://www.edx.org/learn/matrix-math#featured.
3 https://onlinecourses.nptel.ac.in/noc21_ma74/preview.

COURSE OUTCOMES:

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

CO1 Apply the concepts of fuzzy sets, fuzzy logic, fuzzy prepositions and fuzzy quantifiers and in relate.

CO2 Apply various methods in matrix theory to solve system of linear equations.

CO3 Analyze the performance in terms of probabilities and distributions achieved by the determined solutions.

CO4 Explain various random processes and solve problems involving stochastic processes.

CO5 Use queuing models to solve practical problems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	-	-	-	-	-	-	1	2	1
CO2	3	2	1	2	-	-	-	-	-	-	-	1	2	1
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	1
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	1
CO5	3	2	1	2	-	-	-	-	-	-	-	1	2	1

P23AE101	STATISTICAL SIGNAL PROCESSING	L	T	P	C
Prerequisites:	**Transforms and Random Processes**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the fundamentals of random signal processing.
- To analyze the signal modeling, spectral estimation.
- To analyze the Linear Minimum Mean-Square Error (LMMSE) Filtering by linear estimation and adaptive filters

UNIT I INTRODUCTION TO RANDOM SIGNAL PROCESSING 9

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Auto covariance, Autocorrelation, Parseval's theorem, Wiener - Khintchine relation, White noise, Power Spectra Density, Spectral factorization, Filtering Random Processes.

UNIT II SIGNAL MODELING 9

ARMA (p,q), AR (p), MA (q) models, Forward Linear Prediction, Backward Linear Prediction: – Yule-Walker Method, Solution to Prony's normal equation, Levinson Durbin Algorithm.

UNIT III SPECTRAL ESTIMATION 9

Estimation of spectra from finite duration signals, Non parametric methods – Periodogram, Modified periodogram, Bartlett, Welch and Blackman – Tukey methods, Parametric method, AR (p) spectral estimation and detection of Harmonic signals.

UNIT IV LINEAR ESTIMATION 9

Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hopf Equation, FIR Wiener filter, Noise Cancellation, Causal IIR Wiener filter, Non-causal IIR Wiener filter.

UNIT V ADAPTIVE FILTERS 9

FIR adaptive filters – adaptive filter based on steepest descent method – Widrow - Hopf LMS algorithm, Normalized LMS algorithm, Adaptive channel equalization, Adaptive echo cancellation, Adaptive noise cancellation, RLS adaptive algorithm.

TOTAL: 45 PERIODS

REFERENCES:

1 Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002.

2 Dimitris G. Manolakis and Vinay K .Ingle, "Applied Digital Signal Processing", Cambridge University Press, 2011.

3 M.Kay's, "Fundamentals of Statistical Signal Processing: Estimation Theory(Vol 1), Detection Theory (Vol 2)", Prentice Hall Signal Processing Series,1993.

4 Kailath, Sayed and Hassibi, "Linear Estimation, Information and Sciences Series", Prentice Hall,1 st Edition, 2000.

5 S. J. Orfanidis, "Optimum Signal Processing", , McGraw-Hill 2nd Edition, 2007.

ONLINE RESOURCES:

1. https://www.mathworks.com/academia/books/statistical-signal-processing-in-engineering
2. https://onlinecourses.nptel.ac.in/noc20_ee53/preview
3. https://www.udemy.com/user/zeeshan-ahmad-13/

COURSE OUTCOMES:

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

CO1 Analyze discrete time random processes.
CO2 Analyze models for prediction and Estimation.
CO3 Analyze non-parametric methods and parametric methods for spectral Estimation.
CO4 Design different MMSE filters and adaptive filters for different applications.
CO5 Design a system for real time applications using any tool.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	2	1
CO2	3	3	2	2	-	-	-	-	-	-	-	1	2	1
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	1
CO4	3	3	3	3	2	-	-	-	-	-	-	1	2	1
CO5	3	3	3	3	2	-	-	-	-	-	-	1	2	1

P23AE102	ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES	L	T	P	C
Prerequisites:	**Transforms and Random Processes**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand and gain the knowledge of Neural Networks and Fuzzy Systems**.**
- To analyse about Genetic Algorithms.
- To Learn about Ant Colony and particle swarm optimization techniques

UNIT I NEURAL NETWORKS 9

Neural Networks: Back Propagation Network, generalized delta rule, Radial Basis Function Network, interpolation and approximation RBFNS, comparison between RBFN and BPN, Support Vector Machines: Optimal hyper plane for linearly separable patterns, optimal hyper plane for nonlinearly separable patterns, Inverse Modeling.

UNIT II FUZZY LOGIC SYSTEMS 9

Fuzzy Logic System: Basic of fuzzy logic theory , crisp and fuzzy sets, Basic set operation like union , interaction , complement , T-norm , T-conorm , composition of fuzzy relations, fuzzy if- then rules , fuzzy reasoning, Neuro - Fuzzy Modeling: Adaptive Neuro - Fuzzy Inference System (ANFIS), ANFIS architecture , Hybrid Learning Algorithm.

UNIT III EVOLUTIONARY COMPUTATION AND GENETIC ALGORITHMS 9

Evolutionary Computation (EC) – Features of EC – Classification of EC – Advantages – Applications. Genetic Algorithms: Introduction – Biological Background – Operators in GA-GA Algorithm – Classification of GA – Applications.

UNIT IV ANT COLONY OPTIMIZATION 9

Ant Colony Optimization: Introduction – From real to artificial ants - Theoretical considerations – Convergence proofs – ACO Algorithm – ACO and model based search – Application principles of ACO.

UNIT V PARTICLE SWARM OPTIMIZATION 9

Particle Swarm Optimization: Introduction – Principles of bird flocking and fish schooling – Evolution of PSO – Operating principles – PSO Algorithm – Neighborhood Topologies – Convergence criteria – Applications of PSO, Honey Bee Social Foraging Algorithms, Bacterial Foraging Optimization Algorithm.

TOTAL: 45 PERIODS

REFERENCES:

1 Wolfgang Ertel, “Introduction to Artificial Intelligence”, Springer, 2 Edition, 2017.

2 Nello Cristianini, John Shawe-Taylor, &quot , “An Introduction to Support Vector Machines and Other Kernel-based Learning Methods”, Cambridge University Press. 2013.

3 Engelbrecht, A.P., "Fundamentals of Computational Swarm Intelligence", Wiley, 2005.

4 Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi, 2004.

5 H.-J. Zimmermann, "Fuzzy Set Theory and its Applications", Springer Science +Business Media New York, 4 th edition, 2001.

ONLINE RESOURCES:

1 https://www.coursera.org/courses?query=optimization.
2 https://keylabs.ai/blog/optimizing-ai-models-strategies-and-techniques/
3 https://nptel.ac.in/courses/106106245.

COURSE OUTCOMES:

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

CO1 Design and train neural networks with different rules.
CO2 Design fuzzy logic rules.
CO3 Design genetic algorithms.
CO4 Design ANT colony optimization technique for various problems .
CO5 Analyze PSO technique.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	-	-	1	-	-	-	2	2	2
CO2	3	3	3	3	2	-	-	1	-	-	-	2	2	2
CO3	3	3	3	3	2	-	-	1	-	-	-	2	2	2
CO4	3	3	3	3	2	-	-	1	-	-	-	2	2	2
CO5	3	3	2	2	1	-	-	1	-	-	-	2	2	2

P23AE103	EMBEDDED SYSTEM DESIGN FOR REAL TIME APPLICATION	L	T	P	C
Prerequisites:	**Microprocessors and Microcontrollers**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To study design Challenges and design methodologies of embedded system.
- To understand various types of single processor and bus structure.
- To design the State machine and process models and to learn about embedded tools.

UNIT I EMBEDDED SYSTEM OVERVIEW 9

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT - Level Combinational and Sequential Components, Optimizing Custom Single - Purpose Processors.

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR 9

Basic Architecture, Pipelining, Superscalar and VLIW architectures, Programmer 's view, Development Environment, Application- Specific Instruction- Set Processors (ASIPs) Microcontrollers, Timers, Counters and watchdog Timer, UART, LCD Controllers and Analog- to- Digital Converters, Memory Concepts.

UNIT III BUS STRUCTURES 9

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus-Based I/O, Arbitration, Serial Protocols, I2C, CAN and USB, Parallel Protocols – PCI and ARM Bus, Wireless Protocols – IrDA, Bluetooth, IEEE 802.11.

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS 9

Basic State Machine Model, Finite-State Machine with Data path Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, Dataflow Model, Real –time Systems, Automation: Synthesis, Verification : Hardware/Software Co-Simulation, Reuse: Intellectual Property Cores, Design Process Models.

UNIT V EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS 9

Compilation Process – Libraries – Porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS – System design using RTOS.

TOTAL: 45 PERIODS

REFERENCES:

1 Jonathan W. Valvano," Embedded Microcomputer Systems:Real Time Interfacing", Cengage Learning, 3rd Edition,2011.

2 Steve Heath, "Embedded System Design", Elsevier, Second Edition, 2004.

3 Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & sons, 2002.

4 Daniel W. Lewis, "Fundamentals of embedded software where C and Assembly meet", Pearson Education, 2002.

5 Bruce Powel Douglas, " Real time UML, second edition : Developing Efficient Objects for Embedded systems", Pearson Education, 3rd Edition 1999.

ONLINE RESOURCES:

1 https://www.youtube.com/watch?v=0Nq_Aj-Z-9Q
2 https://nptel.ac.in/courses/108105057
3 https://www.udemy.com/course/mastering-microcontroller-with-peripheral-driver-development/

COURSE OUTCOMES:

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

CO1 Analyze the design methodologies.
CO2 Apply various types of single processor.
CO3 Discuss about the bus structure.
CO4 Design the State machine and process models.
CO5 Discuss the design of embedded tools.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	3	3
CO2	3	2	1	2	-	-	-	-	-	-	-	1	3	3
CO3	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO4	3	3	3	3	2	-	-	1	-	-	-	1	3	3
CO5	2	2	1	2	-	-	-	-	-	-	-	1	3	3

P23RM101 RESEARCH METHODOLOGY AND IPR L T P C

Prerequisites: Nil 2 0 0 2

COURSE OBJECTIVES:

- To gain adequate understanding of basic concepts of Research and Research Design Methods.
- To gain the fundamental knowledge of writing a report based on the interpretation.
- To understand the importance and types of IPR and benefits of patents and the patenting process.

UNIT I RESEARCH PROBLEM FORMULATION 6

Objectives of research, types of research, research process, approaches to research; conducting literature review - Information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap.

UNIT II RESEARCH DESIGN AND DATA COLLECTION 6

Statistical design of experiments - types and principles; data types & classification; data collection - methods and tools.

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 6

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis-concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for wring thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 30 PERIODS

REFERENCES:

1 Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11th Edition,2012.

2 Soumitro Banerjee, "Research methodology for natural sciences", IISc press, Kolkata, 2022.
3 Catherine J. Holland, "Intellectual property : Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4 David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & Techniques", Wiley, 2007.
5 The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

ONLINE RESOURCES:

1 https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview.
2 https://www.youtube.com/watch?v=LVBTSpqk4Xg.
3 https://onlinecourses.swayam2.ac.in/aic21_ge20/preview.

COURSE OUTCOMES:

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

CO1 Understand the basic concepts of Research.
CO2 Summarize Research Design Methods.
CO3 Analyze data and write report based on the interpretation.
CO4 Understand the importance and types of IPR.
CO5 Discuss the benefits of patents and the patenting process

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	1	-	2	-	-	-	1	2	2
CO2	2	2	1	2	-	1	-	2	-	-	-	1	2	2
CO3	3	3	2	2	-	1	-	2	-	-	-	1	2	2
CO4	2	2	1	2	-	2	1	2	-	-	-	1	2	2
CO5	2	2	1	2	-	2	1	2	-	-	-	1	2	2

P23AE104	ANALOG INTEGRATED CIRCUIT DESIGN	L	T	P	C
Prerequisites:	Linear Integrated Circuits	3	0	0	3

COURSE OBJECTIVES:

- To learn the concepts of Analog Design and MOS device models .
- To Understand about single stage MOS Amplifiers and operational amplifier.
- To Understand the methodologies for analysis and design of fundamental CMOS Analog and mixed signal Circuits like Data Converters and filters, Oscillators and PLLs.

UNIT I **INTRODUCTION TO ANALOG IC DESIGN** **9**

Concepts of Analog Design - General consideration of MOS devices – MOS I/V Characteristics – Second order effects – MOS device models. Common source stage-Source follower- Common gate stage- Cascode stage. Single ended and differential operation- Basic Differential pair- Common mode response-Differential pair with MOS loads- Gilbert Cell.

UNIT II **CURRENT MIRRORS, AMPLIFIERS AND FEEDBACK** **9**

Basic Concepts – Basic current mirrors - Cascode current mirrors - Active current mirrors Large and Small signal analysis -Common mode properties. Feedback -General Consideration of feedback circuits- Feedback topologies- Effect of loading- Effect of feedback on Noise.

UNIT III **FREQUENCY RESPONSE OF AMPLIFIERS AND NOISE** **9**

General considerations- Miller Effect and Association of Poles with Nodes, Common source stage- Source followers- Common gate stage- Cascode stage- Differential pair. Noise Statistical characteristics of noise- Types of noise- Representation of noise in circuits- Noise in single stage amplifiers- Noise in differential pairs- Noise Bandwidth.

UNIT IV **OPERATIONAL AMPLIFIER STABILITY AND FREQUENCY COMPENSATION** **9**

General Considerations- One and Two Stage Op Amps- Gain Boosting- Comparison Common mode feedback- Input range limitations- Slew rate- Power Supply Rejection- Noise in Op Amps- General consideration of stability and frequency compensation- Multipole system- Phase margin- Frequency compensation- Compensation of two stage op Amps Other compensation techniques

UNIT V **SWITCHED CAPACITOR CIRCUITS AND PLLS** **9**

General Considerations- Sampling switches- Switched Capacitor Amplifiers- Switched Capacitor Integrator- Switched Capacitor Common mode feedback. Phase Locked Loops Simple PLL- Charge pump PLLs - Non ideal Effects in PLLs- Delay locked loops- its Applications.

TOTAL: 45 PERIODS

REFERENCES:

1 Phillip Allen and Douglas Holmberg "CMOS Analog Circuit Design", Oxford University Press, Second Edition ,2004.

2 Grebene, "Bipolar and MOS Analog Integrated circuit design", John Wiley & sons, Inc., 2003.
3 YannisTsividis ."Operation and Modeling of the MOS Transistor" by, Oxford University Press; 2nd edition, June 26, 2003.
4 A.S. Sedra and K.C. Smith, "Microelectronic Circuits-Theory & Applications" Adapted by A.N. Chandorkar, 6th Edition, Oxford, 2013.

ONLINE RESOURCES:

1 https://ocw.tudelft.nl/courses/analog-integrated-circuit-design/
2 https://onlinecourses.nptel.ac.in/noc20_ee45/preview
3 https://onlinecourses.nptel.ac.in/noc21_ee07/preview

COURSE OUTCOMES:

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

CO1 Differentiate Analog, Digital and Mixed Signal CMOS Integrated Circuits.
CO2 Design current sources and voltage references for given specifications.
CO3 Design single stage MOS Amplifiers.
CO4 Design Operational Amplifiers.
CO5 Design data converter circuits.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO3	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO4	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO5	3	3	3	3	2	-	-	1	-	-	-	1	2	2

P23HS101 **CONSTITUTION OF INDIA** **L T P C**

Prerequisites: Nil **2 0 0 1**

COURSE OBJECTIVES:

- To gain adequate understanding of key aspects of the Indian Constitution and philosophy of the Constitution.
- To acquire knowledge of power and functions of various constitutional offices and institutions and citizen- oriented measures in a democracy.
- To acquire knowledge about significance of the constitution and statutory institutions.

UNIT I INDIAN CONSTITUTION: MAKING AND BASIC PREMISE 6

Meaning and Significance of Constitution. Constituent Assembly - Composition, Objectives, Preamble and Salient features of the Indian Constitution. Fundamental Rights, Fundamental Duties. Directive Principles.

UNIT II UNION AND STATE GOVERNMENT 6

President of India- Election, Powers and functions, Prime Minister and Cabinet – Structure and functions, Governor- Powers and functions, Chief Minister and Council of Ministers – Functions.

UNIT III LEGISLATURE AND JUDICIARY 6

Parliament – Lok Sabha and Rajya Sabha – Composition and powers, State Legislative Assembly and Legislative Council – Composition and powers, Judicial System in India – Structure and features, Supreme Court and High Court: Composition, Jurisdiction.

UNIT IV GOVERNANCE AND CONSTITUTION 6

Federalism in India – Features, Local Government -Panchayats –Powers and functions; 73rd and 74th amendments, Election Commission – Composition, Powers and Functions; Electoral Reforms, Citizen-oriented measures – RTI and PIL – Provisions and significance.

UNIT V RELATIONS BETWEEN THE UNION AND THE STATES 6

Legislative relation, administrative relation, financial Relations, Inter State council, finance commission. Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals.

TOTAL: 30 PERIODS

REFERENCES:

1 Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, (23rd ed.) 2018.

2 M.V. Pylee, India's Constitution, New Delhi; S.Chand Pub., 16th edition, 2017.

3 J.N. Pandey, The Constitutional Law of India, Allahabad; Central Law Agency, 55th edition, 2018.

4 Constitution of India (Full Text), India.gov.in., National Portal of India.
5 K B Merunandan, Bharatada Samvidhana Ondu Parichaya, Bangalore, Meragu Publications, 2015.

ONLINE RESOURCES:

1 https://www.constitutionofindia.net/videos/
2 https://www.udemy.com/course/constitution-of-india-and-democracy/
3 https://onlinecourses.nptel.ac.in/noc20_lw03/preview

COURSE OUTCOMES:

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

CO1 Understand the key aspects of the Indian Constitution.

CO2 Comprehend the structure and philosophy of the Constitution.

CO3 Understand the power and functions of various constitutional offices and institutions.

CO4 Realise the significance of the constitution and appreciate the role of the constitution and citizen- oriented measures in a democracy

CO5 Utilize the special provisions and statutory institutions.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	2	2	-	-	-	1	-	-
CO2	-	-	-	-	-	2	2	2	-	-	-	1	-	-
CO3	-	-	-	-	-	2	2	2	-	-	-	1	-	-
CO4	-	-	-	-	-	2	2	2	-	-	-	1	-	-
CO5	-	-	-	-	-	2	2	2	-	-	-	1	-	-

P23AE105 EMBEDDED SYSTEMS LABORATORY L T P C

Prerequisites: Microprocessor and Microcontroller Laboratory 0 0 3 2

COURSE OBJECTIVES:

- To learn Embedded design concepts in developing an embedded system.
- To design embedded devices using sensor, high power devices and motors effectively.
- To design suitable embedded systems using ARM Processor .

LIST OF EXPERIMENTS:

Design and analysis of the following circuits:

1. Programming with 8051 Microcontrollers : Assembly programming.
2. I/O Programming with 8051 Microcontrollers I/O Interfacing : Motor Control/ADC/DAC/ LCD Interfacing.
3. Push button, LED, LCD display and RTC interfacing with ARM Processor.
4. ARM based Microcontroller system design with Touch screen interfacing.
5. Motor (DC, stepper, servo) interfacing with ARM based Microcontroller.
6. Interfacing sensors and RFID with ARM based Microcontroller.
7. Implementing I2C, SPI, CAN and UART protocols with ARM 7 processor
8. Programming with PIC Microcontrollers : Assembly and C programming

TOTAL : 45 PERIODS

COURSEOUTCOMES:

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

CO1 Apply the hardware design concepts in developing an embedded system.

CO2 Apply the software aspects embedded system design

CO3 Apply networking principles in embedded devices using EDA tools, sensor, high power devices and motors effectively.

CO4 Use ARM processors in implementing embedded devices.

CO5 Design suitable embedded systems for real world applications and demonstrate competence in working with different Robot Operating Systems (ROS).

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	2		2	2	2	-	2	3	3
CO2	3	2	1	2	2	2		2	2	2	-	2	3	3
CO3	3	2	1	2	2	2	1	2	2	2	-	2	3	3
CO4	3	2	1	2	2	2	1	2	2	2	-	2	3	3
CO5	3	3	3	3	2	2	1	2	2	2	-	2	3	3

P23AE106 SIGNAL PROCESSING LABORATORY L T P C

Prerequisites: DIGITAL SIGNAL PROCESSING 0 0 3 2

COURSE OBJECTIVES:

- To Understand about audio signal analysis using filters and to design the filters.
- To gain understanding of the working of statistical method based approaches and to demonstrate the working of algorithms for different applications.
- To analyze the images and video.

LIST OF EXPERIMENTS:

Design and analysis of the following circuits:

1 Write a program of Adaptive channel equalizer.
2 Realization of sub band filter using linear convolution.
3 Realization of STFT using FFT.
4 Demonstration of Bayes technique.
5 Demonstration of Min-max technique.
6 Realization of FIR Wiener filter.
7 Generation of Multivariate Gaussian generated data with desired mean vector and the required co-variance matrix.
8 Design and Realization of the adaptive filter using LMS algorithm (solved using steepest - descent algorithm).
9 Representation of the 2D image signal as the linear combinations of PCA (Eigen faces).
10 Image compression using Discrete cosine transformation (DCT).
11 Multiple-input Multiple output (MIMO).
12 Speech recognition using Support Vector Machine (SVM).
13 LMS filtering implementation using TMS320C6x processor.
14 Face detection and tracking in video using OpenCV.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Apply knowledge of linear algebra, random process and multirate signal processing in various signal processing applications.
CO2 Develop the student's ability on conducting engineering experiments, analyze experimental observations scientifically
CO3 Familiarize the fundamental principles of linear algebra.
CO4 Familiarize the basic operations of filter banks through simulations
CO5 Apply the principles of random process in practical applications

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO2	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO3	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO4	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO5	3	3	3	3	1	-	-	2	1	2	-	1	3	2

P23HS102	Communication Skills Enhancement	L	T	P	C
Prerequisites:	**Technical English II**	**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

- To learn the fundamental features of communicating in English.
- To develop the skills and sub skills of reading and writing the content.
- To listen and speak both short and longer texts in English.

LIST OF EXPERIMENTS:

Design and analysis of the following circuits:

1	**Listening** to individual phonemes in English, identification and practice of phonemes. **Reading**- Reading aloud of texts- short stories/ scenes from plays.
2	**Speaking**- Self-introduction in informal contexts- (necessary expressions to be given) **Writing**- Development of hints **Grammar**- Parts of Speech and Tenses, Subject verb Agreement and Idioms and Phrases.
3	**Listening**- Listening to announcements in public places such as those made on social media. **Reading**- Short texts and answering questions.
4	**Speaking**- Asking and answering questions of a personal kind (hobbies, home, favourite sports person, ambitions) **Writing**- Using given expressions/ keywords to develop a story.
5	**Listening**- Listening to lectures and summarizing information.
6	**Speaking**- Reporting flow of Events (Sequence)Reading – Reading summaries **Writing**-Writing a precis.
7	**Listening**- Listening to description of a place.
8	Speaking –Role play (practicing conversations) ; Reading - Newspaper Articles. Writing- Dialogue Writing.
9	**Grammar and Vocabulary-** Voices and Reported Speech, Simple, Compound and Complex and Transformation of Sentences, Types of Sentences and Synonyms and antonyms.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

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

CO1 Apply the concepts of reading in an effective way.
CO2 Analyze the different ideas from their listening context.
CO3 Write various types of reports.
CO4 Write types of dialogues and articles.
CO5 Write process description and essays..

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	2	-	-	-	-	1	-	-	-	-
CO2	-	-	-	-	2	3	2	-	-	1	-	-	-	-
CO3	-	-	-	-	2	3	2	-	-	1	-	-	-	-
CO4	-	-	-	-	2	3	2	-	-	1	-	-	-	-
CO5	-	-	-	-	2	3	2	-	-	1	-	-	-	-

P23AE201	INDUSTRIAL INTERNET OF THINGS	L	T	P	C
Prerequisites:	**Embedded Systems**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the fundamentals of Internet of Things in the real world scenario
- To learn about the basics of IOT protocols and also apply the concept of I0T in the real world scenario.
- To learn about IoT Security.

UNIT I INTRODUCTION AND ARCHITECTURE OF IoT 9

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Auto covariance, Autocorrelation, Parseval's theorem, Wiener - Khintchine relation, White noise, Power Spectra Density, Spectral factorization, Filtering Random Processes.

UNIT II INDUSTRIAL IoT 9

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking.

UNIT III IIOT ANALYTICS 9

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

UNIT IV IOT SECURITY 9

Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT.

UNIT V CASE STUDY 9

Industrial IOT - Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies : Milk Processing and Packaging Industries, Manufacturing Industries.

TOTAL: 45 PERIODS

REFERENCES:

1 Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017.

2 "Industrial Internet of Things: Cyber manufacturing Systems" by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat , Springer, 2017.

3 "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT" by Giacomo Veneri, Antonio Capasso, Packt, 2018.

ONLINE RESOURCES:

1 https://www.coursera.org/learn/industrial-internet-of-things.

2 https://explore.skillbuilder.aws/learn/course/external/view/elearning/402/internet-of-things.

3 https://onlinecourses.nptel.ac.in/noc20_cs69/preview.

COURSE OUTCOMES:

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

CO1 Understand the basic concepts and Architectures of Internet of Things.
CO2 Understand various IoT Layers and their relative importance.
CO3 Realize the importance of Data Analytics in IoT.
CO4 Study various IoT platforms and Security.
CO5 Understand the concepts of Design Thinking.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO2	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO3	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO4	2	2	1	2	1	-	-	1	-	-	-	1	3	3
CO5	2	2	1	2	1	-	-	1	-	-	-	1	3	3

P23AE202	POWER CONVERSION CIRCUITS FOR ELECTRONICS	L	T	P	C
Prerequisites:	**Electronic Circuits**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To Understand the working of different switching devices with respect to their characteristics.
- To analyze different converters with their applications.
- To learn advanced converters and switching techniques implemented in recent technology.

UNIT I **POWER ELECTRONIC DEVICES AND SEMICONDOR 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.

UNIT II **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.

UNIT III **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.

UNIT IV **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.

UNIT V **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: 45 PERIODS

REFERENCES:

1 Thomas E. Kissell, Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3 rd edition, 2003, Prentice Hall..

2 B. Paul, "Industrial Electronic and Control", Prentice Hall of India Private Limited (2004).

3 M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3 rd Edition, 2004.

4 Ned Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2008.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc20_ee12/preview
2 https://www.coursera.org/courses?query=power%20electronics
3 https://www.udemy.com/course/power_electronics/

COURSE OUTCOMES:

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

CO1 Explain the characteristics, operation of power switching devices and identify their ratings and applications.
CO2 Understand the requirements SCR Protection, Describe the Functioning of SCR.
CO3 Analyze and Design the Converter Based on SCR for various Industrial Applications.
CO4 Understand High Frequency, Heating Systems, Timers, relevant Sensors & Actuator and their Application in Industrial Setting.
CO5 Understand and apply Data Communication, Telemetry & SCADA System in Industrial Applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO4	2	2	1	2	1	-	-	1	-	-	-	1	2	2
CO5	2	2	1	2	1	-	-	1	-	-	-	1	2	2

P23AE203	VLSI DESIGN TECHNIQUES	L	T	P	C
Prerequisites:	**Digital Electronics**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn about MOS Transistor principles
- To design combinational logic circuits.
- To Understand the concepts of sequential logic circuits and clocking strategies and memory architecture.

UNIT I **MOS TRANSISTOR PRINCIPLES** **9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics,CMOS devices. MOS(FET) Transistor DC transfer Characteristics , small signal analysis of MOSFET.

UNIT II **COMBINATIONAL LOGIC CIRCUITS** **9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

UNIT III **SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES** **9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.

UNIT IV **INTERCONNECT, MEMORY ARCHITECTURE** **9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

UNIT V **DESIGN OF ARITHMETIC BUILDING BLOCKS** **9**

Arithmetic Building Blocks: Data Paths, Adders - Ripple Carry Adder, Carry -Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed trade offs.

TOTAL: 45 PERIODS

REFERENCES:

1 D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2 P. Rashinkar, Paterson and L. Singh, & System-on-a-Chip Verification- Methodology and Techniques&, Kluwer Academic Publishers, 2001
3 Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000.
4 M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits &, Kluwer Academic Publishers,2000

ONLINE RESOURCES:

1 https://www.maven-silicon.com/vlsi/free-vlsi-training-courses/
2 https://www.udemy.com/course/vlsi-design-mask/
3 https://onlinecourses.nptel.ac.in/noc21_cs96/preview

COURSE OUTCOMES:

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

CO1 Explain MOS Transistor principles.
CO2 Comprehend combinational logic circuit design.
CO3 Understand the concepts of sequential logic circuits and clocking strategies.
CO4 Understand the interconnect and memory architecture.
CO5 Design adders and multipliers.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO2	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO3	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO4	2	2	1	2	2	-	-	1	-	-	-	1	3	3
CO5	3	3	3	3	2	-	-	1	-	-	-	1	3	3

P23AE204	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
Prerequisites:	**Digital Electronics**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To design sequential digital circuits.
- To learn the requirements and specifications of the system required for a given application.
- To understand about fault diagnosis and testing algorithms.

UNIT I **SYSTEM DESIGN USING VERILOG HDL** **9**

Hardware Modeling with Verilog HDL – Logic System, Data Types and Operators for Modeling in Verilog HDL - Behavioral Descriptions in Verilog HDL – HDL Based Synthesis – Synthesis of Finite State Machines – Structural modeling – Compilation and Simulation of Verilog code –Test bench -Realization of combinational and sequential circuits using Verilog HDL.

UNIT II **SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN** **9**

Analysis of clocked synchronous sequential circuits and modeling - State diagram, state table, state assignment and reduction - Design of synchronous sequential circuits – Design of Iterative circuits - ASM chart and realization using ASM.

UNIT III **ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN** **9**

Analysis of asynchronous sequential circuit – flow table reduction – Races – state Assignment transition table and problems in transition table- Design of asynchronous sequential circuit - Static, dynamic and essential Hazards – Data synchronizers – Mixed operating mode asynchronous circuits..

UNIT IV **FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS** **9**

Fault table method- Path sensitization method – Boolean difference method - D algorithm - Tolerance techniques – The compact algorithm – Fault in PLA – Test generation - DFT schemes – Built in self test..

UNIT V **SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES** **9**

Programming logic device families – Designing a synchronous sequential circuit using PLA/PAL – Realization of finite state machine using PLD – FPGA – Xilinx FPGA-Xilinx 4000.

TOTAL: 45 PERIODS

REFERENCES:

1 Charles H.RothJr“Fundamentals of Logic Design” Thomson Learning 2004, 7th edition 2014.

2 Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2010.

3 Parag K. Lala“Fault Tolerant and Fault Testable Hardware Design” B S Publications, 2002.

4 M.D.Ciletti, “Modeling, Synthesis and Rapid Prototyping with the Verilog HDL”, Prentice Hall, 1999.

5 S. Palnitkar, “Verilog HDL – A Guide to Digital Design and Synthesis”, Pearson , 2003.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/106/105/106105185/
2 https://www.udemy.com/course/communicating-sequential-processes-with-coresync/
3 https://www.edx.org/learn/design/harvey-mudd-college-digital-design

COURSE OUTCOMES:

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

CO1 Explain digital system design using verilog HDL
CO2 Analyze synchronous sequential circuit design
CO3 Analyze of Asynchronous sequential circuit design
CO4 Apply fault diagnosis and testability algorithms
CO5 Evaluate synchronous design using programmable devices.

CO – PO – PSO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	-	-	-	-	-	-	-	1	3	3
CO2	3	3	2	2	-	-	-	-	-	-	-	1	3	3
CO3	3	3	2	2	-	-	-	-	-	-	-	1	3	3
CO4	3	2	1	2	1	-	-	1	-	-	-	1	3	3
CO5	3	3	2	3	1	-	-	1	-	-	-	1	3	3

P23HS201	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
Prerequisites:	**Nil**	**2**	**0**	**0**	**1**

COURSE OBJECTIVES:

- To Understand the basic concepts of traditional knowledge.
- To gain adequate knowledge about Legal Framework.
- To gain traditional knowledge of IPR Mechanism.

UNIT I **INTRODUCTION TO TRADITIONAL KNOWLEDGE** **6**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge.

UNIT II **PROTECTION OF TRADITIONAL KNOWLEDGE** **6**

The need for protecting traditional knowledge Significance of TK Protection, the value of TK in the global economy, Role of Government to harness TK.

UNIT III **LEGAL FRAMEWORK AND TRADITIONAL KNOWLEDGE** **6**

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

UNIT IV **TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY** **6**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT V **TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS** **6**

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

TOTAL: 30 PERIODS

REFERENCES:

1 Amit Jha ."Traditional Knowledge System in India", Atlantic publishers, 2002.
2 Kapil Kapoor, Michel Danino "Knowledge Traditions and Practices of India",2012.

ONLINE RESOURCES:

1 https://onlinecourses.swayam2.ac.in/imb23_mg53/preview
2 https://onlinecourses.nptel.ac.in/noc23_mg96/preview

3 https://www.udemy.com/topic/intellectual-property/

COURSE OUTCOMES:

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

CO1 Understand the basic concepts of traditional knowledge.
CO2 Understand the importance of protecting traditional knowledge.
CO3 Summarize the legal Framework
CO4 Explain IPR Mechanism in traditional knowledge
CO5 Understand the importance of traditional knowledge..

CO – PO – PSO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	2	1	-	-	-	-	-	-	2
CO2	-	-	-	-	-	2	1	-	-	-	-	-	-	2
CO3	-	-	-	-	-	2	1	2	-	-	-	-	-	2
CO4	-	-	-	-	-	2	1	2	-	-	-	1	-	2
CO5	-	-	-	-	-	2	1	2	-	-	-	1	-	2

P23AE106	ELECTRONIC SYSTEM DESIGN LABORATORY	L	T	P	C
Prerequisites:	**Linear Integrated Circuits and Digital Signal Processing.**	**0**	**0**	**3**	**2**

COURSE OBJECTIVES:

- To Design instrumentation amplifier and voltage regulator.
- To Design Sensor using simulation tools.
- To Analyse real time signal processing system.

LIST OF EXPERIMENTS:

Design and analysis of the following circuits:

1. Design the Instrumentation amplifier with the bridge type transducer.
2. Design a phase controlled voltage regulator using full wave rectifier and SCR, vary the conduction angle and plot the output voltage.
3. Implementation of Adaptive Filters and multistage multirate system in DSP Processor.
4. Simulation of QMF using Simulation Packages.
5. Analysis of Asynchronous and clocked synchronous sequential circuits.
6. Realization of Discrete Fourier transform/Fast Fourier Transform algorithm in HDL.
7. Sensor design using simulation tools.
8. Design and analysis of real time signal processing system – Data acquisition and signal processing.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Design and measure the performance of analog integrated circuits.

CO2 Implement Adaptive and QMF filters.

CO3 Analyze Asynchronous and synchronous sequential circuits.

CO4 Design sensor using simulation tools.

CO5 Design and analyze real time signal processing system.

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO2	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO3	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO4	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO5	3	3	3	3	1	-	-	2	1	2	-	1	3	2

P23AE206 **VLSI DESIGN LABORATORY** **L T P C**

Prerequisites: VLSI Design **0 0 3 2**

COURSE OBJECTIVES:

- To design adders, multipliers and SRAM.
- To analyze digital design and the CMOS circuits
- To Implement MAC unit,UART and USART.

LIST OF EXPERIMENTS:

Design and analysis of the following circuits:

1. Design 1-bit half adder using 90 nm technology and verify the circuit using transient analysis.
2. Design Full adder using 90 nm technology and verify the circuit using transient analysis.
3. Design a multiplexer using 90 nm technology and perform all the analysis to verify its characteristics
4. Design a MOS based SRAM cell using 90 nm technology and verify its characteristics.
5. Design NOR gate using Domino logic CMOS inverter and verify its characteristics.
6. Design CMOS transmission gate and perform all the analysis to verify its characteristics.
7. Design XOR and XNOR gate using dynamic CMOS logic circuits and verify its characteristics.
8. Synthesize and implement Combinational and Sequential Circuits in VERILOG / VHDL.
9. Synthesize and implement MAC unit and GCD unit in Verilog /VHDL.
10. Implementation of sampling of input signal and display in FPGA Synthesize and implement FIR filter and IIR filter Verilog /VHDL
11. Synthesize and implement 8 bit general purpose processor in Verilog/ VHDL.
12. Synthesize and implement UART and USART.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Write Program in Verilog/VHDL for combinational and sequential circuits and implement the program in FPGA.

CO2 Write Program to implement FIR and IIR filters in FPGA.

CO3 Write Program to implement data path design.

CO4 Write Program to implement UART and USART.

CO5 Write Program to interface the Arduino Boards using Embedded C.

CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO2	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO3	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO4	3	3	3	3	1	-	-	2	1	2	-	1	3	2
CO5	3	3	3	3	1	-	-	2	1	2	-	1	3	2

P23PEAE01	ASIC AND SOC DESIGN	L	T	P	C
Prerequisites:	Digital Electronics	3	0	0	3

COURSE OBJECTIVES:

- To gain adequate understanding of ASIC fundamentals and its design methods.
- To learn design management, algorithms, basics of System on Chip and platform based design.
- To understand the principles for highly integrated SoCs and high performance algorithms available for ASIC and SOC.

UNIT I TYPES OF ASIC 9

Design Flow, Economics of Asics, ASIC Cell Libraries, CMOS Logic Cell Data Path Logic Cells, I / O Cells, Cell Compilers.

UNIT II ASIC LIBRARY DESIGN 9

Transistors as Resistors, Parasitic Capacitance, Logical Effort Programmable ASIC Design Software: Design System, Logic Synthesis, Half Gate ASIC, ASIC Construction, Floor Planning & Placement, Routing.

UNIT III SYSTEM ON CHIP DESIGN PROCESS 9

A Canonical SoC Design, SoC Design Flow, Waterfall Vs. Spiral, Top-Down Vs. Bottom-Up, Specification Requirements, Types of Specifications, System Design Process, System Level Design Issues, Soft IP Vs. Hard IP, Design for Timing Closure, Logic Design Issues, Physical Design Issues, Verification Strategy, On- Chip Buses and Interfaces, Low Power, Manufacturing Test Strategies, MPSoCs, Techniques for Designing MPSoCs.

UNIT IV SOC VERIFICATION 9

Verification Technology Options, Verification Methodology, Verification Languages, Verification Approaches, and Verification Plans. System Level Verification, Block Level Verification, Hardware / Software Co-Verification, and Static Net List Verification.

UNIT V HIGH PERFORMANCE ALGORITHMS FOR ASICs/ SOCs. 9

High performance algorithms for ASICs / SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC. Case Studies: Digital camera, SDRAM, High speed data standards.

TOTAL: 45 PERIODS

REFERENCES:

1 Michael John Sebastian Smith, “Application Specific Integrated Circuits”, Pearson Education India, 2008.
2 Farzad Nekoogar , Faranak Nekoogar & Jeffrey Ebert, “From ASICs to SOCs: A Practical Approach”, Prentice Hall, 2003.
3 R. Rajsuman, System-on-a-Chip Design and Test. Santa Clara, CA: Artech House Publishers, 2000.

4 Pierre Bricaud, Reuse Methodology Manual for system-on-chip design." Spring science& business media, 09 march-2013.
5 F. Nekoogar, "Timing Verification of Application-Specific Integrated Circuits (ASICs)", Prentice Hall PTR, 1999.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/108/117108040/
2 https://www.udemy.com/course/soc-verification-systemverilog/
3 https://archive.nptel.ac.in/courses/112/105/112105293/

COURSE OUTCOMES:

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

CO1 Explain the fundamentals of ASIC and its design methods.
CO2 Explain the design management, tool-flow, algorithms used for ASIC construction, verification of ASIC ICs.
CO3 Explain the basics of System on Chip and platform based design.
CO4 Describe the co-design & co-verification principles for highly integrated SoCs.
CO5 Describe the high performance algorithms available for ASIC and SOC.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE02	QUANTUM AND NANO ELECTRONICS	L	T	P	C
Prerequisites:	**Engineering Physics**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn about fundamentals of Nano-Electronics and various methods.
- To Understand the concepts of nanostructures in quantum mechanical approaches.
- To explain the fabrication of nanostructures, nanoelectronic devices and nanosensors.

UNIT I **INTRODUCTION TO NANO-ELECTRONICS** **9**

Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moore's law and continued miniaturization Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale.

UNIT II **CHARACTERIZATION OF NANO-PARTICLES** **9**

Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques.

UNIT III **INORGANIC SEMICONDUCTOR NANOSTRUCTURES** **9**

Overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, and electronic density of states.

UNIT IV **FABRICATION TECHNIQUES** **9**

Verification Technology Options, Verification Methodology, Verification Languages, Verification Approaches, and Verification Plans. System Level Verification, Block Level Verification, Hardware / Software Co-Verification, and Static Net List Verification.

UNIT V **NANO-SENSORS** **9**

Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly techniques. Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems.

TOTAL: 45 PERIODS

REFERENCES:

1 Robert Kelsall, Ian Hamley and Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
2 Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology" John Wiley, Copyright 2006, Reprint 2011.
3 T Pradeep, "Nano: The essentials-Understanding Nanoscience and Nanotechnology" TMH.

4 Karl Goser, JanDienstuhl , "Nanoelectronics & Nanosystems : From Transistor to Molecular & Quantum Devices".
5 Rainer Waser ,"Nano Electronics and Information Technology:

ONLINE RESOURCES:

1 https://nptel.ac.in/courses/117108047
2 https://www.udemy.com/topic/inorganic-chemistry/?
3 https://www.edx.org/learn/nanotechnology

COURSE OUTCOMES:

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

CO1 Explain fundamentals of Nano-Electronics.
CO2 Explain the material characterization and various methods.
CO3 Enumerate the nanostructures in quantum mechanical approaches.
CO4 Explain the fabrication of nanostructures, nanoelectronic devices.
CO5 Describe the importance of Nanosensors and devices for various applications.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE03	AUTOMOTIVE ELECTRONICS	L	T	P	C
Prerequisites:	**Basic Electrical and Electronics Engineering, Linear Integrated Circuits.**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To explain the principle of electronic management system and different sensors used in the systems.
- To learn the concepts and develop basic skills necessary to diagnose automotive electronic problems and the components present in an Automotive electrical and electronics system.
- To Understand about charging, lighting systems, advanced automotive electrical systems .

UNIT I **FUNDAMENTALS** **9**

Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

UNIT II **MODERN SENSORS** **9**

Film sensors, micro-scale sensors, Particle measuring systems, Vibration Sensors, SMART sensors, Machine Vision, Multi-sensor systems Applications of Sensors: Applications and case studies of Sensors in Automobile Engineering, Aeronautics, Machine tools and Manufacturing processes.

UNIT III **CHARGING SYSTEM** **9**

Generation of Direct Current- Shunt Generator Characteristics- Armature Reaction- Third Brush Regulation- Cutout. Voltage and Current Regulators- Compensated Voltage Regulator Alternators Principle and Constructional Aspects and Bridge Rectifiers- New Developments.

UNIT IV **CHASSIS AND SAFETY SYSTEMS** **9**

Transmission control - Cruise control – Braking control – Traction control –Suspension Control – Steering control – Stability control – Integrated engine control - working of airbag and role of MEMS in airbag systems – centralized door locking system.

UNIT V **ELECTRONICS SYSTEMS** **9**

Current Trends in Automotive Electronic Engine Management System- Types of EMS Electromagnetic interference Suppression- Electromagnetic Compatibility- Electronic Dashboard Instruments- Onboard Diagnostic System- Security - Warning System infotainment and Telematics..

TOTAL: 45 PERIODS

REFERENCES:

1 Allan Bonnick, “Automotive Computer Controlled Systems”, Butterworth-Heinemann, Elsevier, Indian Edition, 2011.
2 Eric Chowanietz, “Automobile Electronics” by SAE Publications, 1995.

3 Tom Weather Jr and Cland C. Hunter, "Automotive Computers and Control System" Prentice Hall Inc.,1984 New Jersey.
4 R.K. Jurgen, "Automotive Electronics Handbook", McGraw Hill 2 nd Edition,1995.
5 William B Ribbens, "Understanding automotive electronics", 5th edition – Butter worth Heinemann Woburn, 1998.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_de02/preview.
2 https://www.edx.org/masters/micromasters.
3 https://www.udemy.com/topic/electronics/?p=7

COURSE OUTCOMES:

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

CO1 Explain the fundamentals, operation, function of various sensors and actuators in engine management systems.
CO2 Explain the Automotive Transmission Control Systems.
CO3 Enumerate the principles, application, construction and specification of different sensors and actuators usable in typical automobile by suitable testing.
CO4 Explain the principles and characteristics of charging system components and demonstrate their working with suitable tools.
CO5 Describe the principles and architecture of electronics systems and its Components present in an automobile related to instrumentation, control, security and warning systems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO2	2	2	1	2	-	1	-	1	-	-	-	1	2	2
CO3	2	2	1	2	-	1	-	1	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	1	-	-	-	1	2	2

P23PEAE04	SOFT COMPUTING AND OPTIMIZATION TECHNIQUES	L	T	P	C
Prerequisites:	**Random Process.**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To Understand about various soft computing frame works and to be familiar with the design of neural networks, fuzzy logic, and fuzzy systems.
- To learn the mathematical background involved in optimized genetic programming.
- To understand the various evolutionary optimization techniques.

UNIT I	ARTIFICIAL NEURAL NETWORK	9

Review of fundamentals – Biological neuron, artificial neuron, activation function, single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART7) based network – Radial basis function network – online learning algorithms, BP through time – RTRL algorithms – Reinforcement learning.

UNIT II	NEURAL NETWORKS FOR MODELING AND CONTROL	9

Modelling of non-linear systems using ANN – Generation of training data – Optimal architecture– Model validation – Control of non-linear systems using ANN – Direct and indirect neuro control schemes – Adaptive neuro controller – Familiarization with neural network toolbox.

UNIT III	FUZZY SET THEORY	9

Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection , complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions.

UNIT IV	FUZZY LOGIC FOR MODELLING AND CONTROL	9

Modelling of non-linear systems using fuzzy models – TSK model – Fuzzy logic Controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification – Adaptive fuzzy systems – Familiarization with fuzzy logic toolbox.

UNIT V	OPTIMIZATION TECHNIQUES	9

Genetic algorithms, Evolutionary Algorithm, Simulated Annealing, Ant colony optimization - Applications to Electrical engineering problems.

TOTAL: 45 PERIODS

REFERENCES:

1. Laurence Fausett, "Fundamentals of Neural Networks", Prentice HalL Englewood Cliffs, N.J., 1992
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill Inc., 2000.
3. Goldberg, "Genetic Algorithm in Search, Optimization and Machine learning", Addison Wesley Publishing Company Inc. 1989.

4	Millon W.T., Sutton R.S. and Webrose P.J., "Neural Networks for Control", MIT press, 1992
5	Ethem Alpaydin, "Introduction to Machine learning (Adaptive Computation and Machine Learning series)', MIT Press, Second Edition, 2010.

ONLINE RESOURCES:

1	https://www.udemy.com/course/deeplearning/
2	https://nptel.ac.in/courses/111102130
3	https://www.udemy.com/course/geneticalgorithm/

COURSE OUTCOMES:

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

CO1	Understand the concepts of ANN, different features of fuzzy logic and their modelling, control aspects and different hybrid control schemes.
CO2	Understand the basics of artificial neural network.
CO3	Understand on modelling and control of neural.
CO4	Summarize modelling and control of fuzzy control Schemes.
CO5	Comprehend knowledge on optimization techniques to solve Engineering problems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO3	2	2	1	2	1	-	-	1	-	-	-	1	2	2
CO4	2	2	1	2	1	-	-	1	-	-	-	1	2	2
CO5	2	2	1	2	1	-	-	1	-	-	-	1	2	2

P23PEAE05	ROBOTICS FOR INDUSTRIAL AUTOMATION	L	T	P	C
Prerequisites:	Engineering Mathematics	3	0	0	3

COURSE OBJECTIVES:

- To Introduce the concepts of Robotic systems.
- To understand the concepts of Instrumentation and control related to Robotics and the kinematics and dynamics of robotics.
- To gain knowledge about robotics in Industrial applications.

UNIT I	INTRODUCTION	9

Definitions, Types of Robots, Application of Robots, Representing Position and Orientation, Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions, Representing Orientation in 3-Dimensions, Combining Translation and Orientation.

UNIT II	TIME AND MOTION	9

Trajectories, Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi- Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion, Time Varying Coordinate Frames, Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems. Mobile Robot Vehicles, Mobility, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose. .

UNIT III	NAVIGATION	9

Reactive Navigation, Braitenberg Vehicles, Simple Automata, Map-Based Planning, Distance Transform, D*, Voronoi Roadmap Method, Probabilistic Roadmap Method Localization, Dead Reckoning, Modeling the Vehicle, Estimating Pose, Using a Map, Creating a Map, Localization and Mapping, Monte-Carlo Localization.

UNIT IV	ROBOT ARM KINEMATICS	9

Describing a Robot Arm, Forward Kinematics, A 2-Link Robot, A 6Axis Robot, Inverse Kinematics, Closed-Form Solution, Numerical Solution, Under-Actuated Manipulator, Redundant Manipulator, Trajectories, Joint-Space Motion, Cartesian Motion, Motion through a Singularity.

UNIT V	ROBOT PROGRAMMING	9

Using Sensors and Actuators with ROS, SCORBOT structure, joint movements, work envelop, motors, encoders, microswitch, transmission, gripper, SCORBOT programming, IS-14533 : 2005 Manipulating industrial robots - Performance criteria related test methods, Mobile Robot Programming, Industrial Robot Programming.

TOTAL: 45 PERIODS

REFERENCES:

1	Robotics for Engineers -YoramKoren, McGraw Hill International, 1st edition, 1985.
2	Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.

3	Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007.
4	Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.
5	Robotics, Vision and Control: Fundamental Algorithms in MATLAB® - Peter Corke, Springer Tracts in Advanced Robotics, Volume 73, 2011.

ONLINE RESOURCES:

1	https://onlinecourses.nptel.ac.in/noc24_ee56/preview
2	https://www.udemy.com/course/mastering-industrial-robotics-for-everyone/
3	https://www.edx.org/learn/robotics

COURSE OUTCOMES:

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

CO1	Understand the basic concepts related to Robots
CO2	Explain 3D translation and orientation representation &Illustrate the robot arm kinematics
CO3	Apply localization and mapping aspects of mobile robotics
CO4	Design / Simulate a robot which meets kinematic requirements.
CO5	Understand robot programming

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	3	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	2	-	-	2	-	-	-	1	2	2

P23PEAE06	RF SYSTEM DESIGN	L	T	P	C
Prerequisites:	**Transmission lines and RF System**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To analyze and design RF low noise amplifiers.
- To design integrated circuits using Passive components.
- Analyze and Design LNA RF power amplifiers ,RF mixers and oscillators.

UNIT I **CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES** **9**

Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise, Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise – Specification distribution over a communication link, Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct up conversion Transmitter, Two step up conversion Transmitter.

UNIT II **IMPEDANCE MATCHING** **9**

Small -signal model of bipolar transistor - high frequency effects - noise in bipolar transistors - base shot noise-noise sources in the transistor model - bipolar transistor design considerations-CMOS transistor.- impedance matching - tapped capacitors and inductors - the concept of mutual inductance - tuning a transformer - bandwidth of an impedance transformation network-quality factor of an LC resonator.

UNIT III **DESIGN OF PASSIVE CIRCUIT ELEMENTS IN IC TECHNOLOGIES** **9**

Technology backend and metallization in IC technologies - sheet resistance and skin effect – parasitic capacitance and inductance -current handling in metal lines-design of inductors and transformers -characterization of inductor-layout of spiral inductors - on-chip transmission lines - high frequency measurements of on-chip passives and common De-Embedding techniques-packaging.

UNIT IV **LNA AND POWER AMPLIFIER** **9**

Basic amplifiers - amplifiers with feedback - noise in amplifiers - linearity in amplifiers - differential pair and other differential amplifiers-low-voltage topologies for LNAs and the use of on-chip transformers - DC bias networks - temperature effects - broad band LNA design. Power amplifier: power capability -efficiency calculations - matching considerations - Class A,B,C.D.E.F,G,H and S amplifiers -summary of amplifier classes for RF Integrated circuits - AC load line - matching to achieve desired power - packaging -effects and implications of non-linearity - linearization techniques - CMOS power amplifier example.

UNIT V **MIXERS AND OSCILLATORS** **9**

Mixer characteristics, Non-linear based mixers, Quadratic mixers, Multiplier based mixers, Single balanced and double balanced mixers, subsampling mixers, Oscillators describing Functions, Colpitts oscillators Resonators, Tuned Oscillators, Negative resistance oscillators, Phase noise.

TOTAL: 45 PERIODS

REFERENCES:

1 B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill,2001
2 B.Razavi, "RF Microelectronics", Pearson Education, 1997.
3 Jan Crols, Michiel Steyaert, "CMOS Wireless Transceiver Design", Kluwer Academic Publishers, 1997.
4 T. Lee, "Design of CMOS RF Integrated Circuits", Cambridge,2004.

ONLINE RESOURCES:

1 https://www.edx.org/learn/electronics/purdue-university-primer-on-rf-design.
2 http://www.digimat.in/nptel/courses/video/108101112/L36.html
3 https://www.udemy.com/course/oscillators/.

COURSE OUTCOMES:

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

CO1 Explain user specifications for RF systems.
CO2 Analyze and design RF low noise amplifiers.
CO3 Design integrated circuits using Passive components.
CO4 Analyze and design LNA RF power amplifiers.
CO5 Analyze and design RF mixers and oscillators

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	3	1	-	-	1	-	-	-	1	2	2
CO4	3	3	2	2	-	-	-	1	-	-	-	1	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	1	2	2

P23PEAE07 Electromagnetic Interference and Compatibility L T P C
Prerequisites: Electromagnetic Fields and Waves 3 0 0 3

COURSE OBJECTIVES:

- To analyze Electromagnetic interference effects and EMI problems in PCBs.
- To analyze emission immunity level from different systems to couple with the prescribed EMC standards.
- To Understand the different types of EMI/EMC measurement techniques and measuring equipments.

UNIT I EMI/EMC CONCEPTS 9

EMI-EMC definitions and Units of parameters, Sources and victim of EMI, Conducted and Radiated EMI Emission and Susceptibility, Transient EMI, ESD, Radiation Hazards.

UNIT II COUPLING MECHANISM 9

Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

UNIT III EMI MITIGATION TECHNIQUES 9

Working principle of Shielding and Murphy‟s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasket ting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT IV STANDARD AND REGULATION 9

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, Department of Electronics and Communication Engineering 41ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.

UNIT V EMI TEST METHODS AND INSTRUMENTATION 9

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

TOTAL: 45 PERIODS

REFERENCES:

1 V Prasad Kodali, “Engineering Electromagnetic Compatibility”, IEEE Press, New York, 2001.
2 Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Edition, Artech house,

Norwood, 1986.
3 Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience,2006.
4 Daryl Gerkeand, William Kimmel,"EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002.
5 Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press, 2005.

ONLINE RESOURCES:

1 https://www.classcentral.com/course/swayam-electromagnetic-compatibility-emc.
2 https://onlinecourses.nptel.ac.in/noc24_ee67/preview.
3 https://www.edx.org/learn/electricity/graz-university-of-technology.

COURSE OUTCOMES:

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

CO1 Analyze electromagnetic interference effects in PCBs.
CO2 Analyze solution to EMI Sources, EMI problems in PCB level / Subsystem and system level design.
CO3 Explain the different types of shielding, grounding methods and material used for the same.
CO4 Apply emission immunity level from different systems to couple with the prescribed EMC standards.
CO5 Understand the different types of EMI/EMC measurement techniques and measuring equipments.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO3	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	3	2	1	2	-	-	-	1	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	1	-	-	-	1	2	2

P23PEAE08 VLSI for Wireless Communication L T P C

Prerequisites: Wireless Communication 3 0 0 3

COURSE OBJECTIVES:

- To understand basics of wireless system and different modules in receiver architectures .
- To analyze the issues and tools related to ASIC/FPGA and VLSI architectures for Wireless Systems.
- To understand basics of Mixer circuits and Analog to Digital Converters.

UNIT I COMMUNICATION CONCEPTS 9

Overview of Wireless Systems-access methods-modulation schemes- wireless channel description, path loss- multipath fading-channel model, envelope- frequency selective and fast fading.

UNIT II RECEIVER ARCHITECTURE 9

Receiver Front End - Motivations - General Design Philosophy- Heterodyne and Other architectures Filter Design - Band Selection Filter - Image Rejection Filter - Channel Filter - Non idealities and Design Parameters - Harmonic Distortion - Intermodulation - Cascaded Nonlinear Stages - Gain Compression Blocking - Noise - Noise Sources - Noise Figure - Design of Front end parameter for DECT.

UNIT III ACTIVE AND PASSIVE MIXER 9

Balancing low-frequency and high-frequency case analysis- switching mixer, distortion in unbalanced switching mixer, conversion gain, noise, sampling mixer, distortion, intrinsic and extrinsic noise in single-ended sampling mixer, design methodology.

UNIT IV ANALOG TO DIGITAL CONVERTERS & SYNTHESIZER 9

Demodulators - Delta Modulators - Low Pass Sigma Delta Modulators - High Order Modulators - One Bit DAC and ADC -Passive Low Pass Sigma Delta Modulator - Band pass Sigma Delta Modulators Comparison - PLL based Frequency Synthesizer.

UNIT V VLSI ARCHITECTURE FOR WIRELESS SYSTEMS 9

Implementations: VLSI architecture for Multi-tier Wireless System - Hardware Design Issues for a Next generation CDMA System - Efficient VLSI Architecture for Base Band Signal processing.

TOTAL: 45 PERIODS

REFERENCES:

1 Bosco Leung, "VLSI for wireless Communication", Springer, 2nd Edition, 2011.
2 Andreas F. Molisch, "Wideband wireless Digital Communication", Prentice Hall PTR, 2001.
3 George.V. Tsoulous, "Adaptive Antennas for wireless Communication", IEEE Press, Willey Publications, 2001.
4 Xiaodong Wang and H.Vincent Poor, "Wireless Communication System, Advanced Techniques for Signal Reception", Pearson Education. 2004.
5 Wolfgang Eberle, "Wireless Transceiver Systems Design", Springer, 2008.

ONLINE RESOURCES:

1 https://www.edx.org/learn/technology/university-of-notre-dame-understanding-wireless-technology-economics-and-policy
2 https://archive.nptel.ac.in/courses/117/106/117106034/
3 https://www.udemy.com/course/wireless-technologies-for-iot/

COURSE OUTCOMES:

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

CO1 Understand the concepts of wireless system.
CO2 Analyze different modules in receiver architectures.
CO3 Apply the different types of Mixer circuits in communication system.
CO4 Explain the working of Analog to Digital Converters and Synthesizers.
CO5 Analyze VLSI architectures for Wireless Systems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	2	3	3
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3	3
CO3	3	2	1	2	-	-	-	-	-	-	-	2	3	3
CO4	2	2	1	2	-	-	-	-	-	-	-	2	3	3
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	3

P23PEAE09	MIMO COMMUNICATION SYSTEMS	L	T	P	C
Prerequisites:	**Communication Systems**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To design MIMO communication transceivers and Spatial Multiplexing in MIMO communication system .
- To design space time codes for MIMO systems.
- To apply ST Trellis Codes in MIMO systems.

UNIT I **INFORMATION THEORETIC ASPECTS OF MIMO** **9**

Review of SISO communication - MIMO channel models - Classical. and extended channels – Frequency selective and correlated channel models - Capacity of MIMO channels - Ergodic and Outage Capacity - Capacity bounds - Influence of channel properties on capacity.

UNIT II **MIMO DIVERSITY AND SPATIAL MULTIPLEXING** **9**

Space Time Diversity Aspects - Sources and types of diversity - analysis under Rayleigh fading – Diversity and Channel knowledge - MIMO Spatial multiplexing - Space Time receivers - ML - MMSE - ZF – Sphere decoding - BLAST receivers - DMG trade off in MIMO systems.

UNIT III **SPACE TIME BLOCK CODES** **9**

Alamouti's code for two transmit antennas - Comparison with dual-branch receive diversity STBC based on real/complex orthogonal designs - Code Design Criteria for quasi-static Channels (Rank, Determinant and Euclidean Distance).

UNIT IV **ORTHOGONAL DESIGNS** **9**

Generalized Orthogonal Designs - Quasi-Orthogonal Designs - Performance Analysis. Representation of STTC- shift register, generator matrix, state-transition diagram, trellis Code.

UNIT V **SPACE TIME TRELLIS CODES** **9**

Diagram - Code construction. Delay diversity as a special case of STTC- Performance Analysis. Case study: MIMO in LTE, Code words to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beam forming in LTE.

TOTAL: 45 PERIODS

REFERENCES:

1 Paulraj R. Nabar and D. Gore, “Introduction to Space Time Wireless Communications,” Cambridge University Press, 2003.
2 B.Vucetic and J. Yuan, “Space-Time Coding,” John Wiley, 2003.
3 E.G. Larsson and P. Stoica, “Space-Time Block Coding for Wireless Communications,” Cambridge University press.
4 H. Jafarkhani, “Space-Time Coding: Theory and Practice,” Cambridge University Press.
5 D. Tse and P. Viswanath, “Fundamentals of Wireless Communication,” Cambridge University Press.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_ee65/preview.
2 http://www.digimat.in/nptel/courses/video/117104115/L39.html.

3 https://onlinecourses.nptel.ac.in/noc19_ee47/preview.

COURSE OUTCOMES:

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

CO1 Design MIMO communication transceivers with and without channel state information.
CO2 Analyze MIMO Diversity and Spatial Multiplexing in MIMO communication System.
CO3 Design space time codes for MIMO systems.
CO4 Analyze and design optimum MIMO Communication systems for OFDM.
CO5 Apply ST Trellis Codes in MIMO systems.

CO – PO – PSO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	1	-	-	1	-	-	-	2	3	3
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	1	-	-	1	-	-	-	2	3	3
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	3
CO5	3	2	1	2	-	-	-	-	-	-	-	2	3	3

P23PEAE10	CYBER SECURITY IN ELECTRONICS	L	T	P	C
Prerequisites:	**Computer Networks**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the concepts related to Cybersecurity, Cryptography and Embedded System Security.
- To understand the concepts of network security mechanism in Electronics.
- To explore data privacy and data Security.

UNIT I INTRODUCTION TO CYBERSECURITY AND CRYPTOGRAPHY 9

Understanding cybersecurity concepts-Threat landscape and types of cyberattacks Importance of cybersecurity in electronics- Fundamentals of cryptography Encryption and decryption techniques-Implementing encryption in electronic systems.

UNIT II ELECTRONIC SYSTEM VULNERABILITIES 9

Identifying vulnerabilities in electronic systems-Common attack vectors in electronics-Case studies on real-world vulnerabilities.

UNIT III EMBEDDED SYSTEM SECURITY 9

Embedded System Trends- Software Security- Secret key cryptography, public key cryptography, hash functions, authentication techniques, etc. - Key management for embedded systems - Hardware trojans - Intellectual property (IP) piracy and integrated circuit (IC) overbuilding - Side-channel analysis

UNIT IV NETWORK SECURITY FOR ELECTRONICS 9

Services, mechanisms and attacks- The OSI security architecture- A model for network security- Web Security Consideration- Security socket layer (SSL) and Transport layer security- Secure Electronic Intruders- Intrusion Detection- Password Management.

UNIT V DATA PRIVACY AND DATA SECURITY 9

Defining data, meta-data, big data, nonpersonal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.

TOTAL: 45 PERIODS

REFERENCES:

1 Gregory White, Dwayne Williams, and Roger L. Davis. "Principles of Cybersecurity"
2 Simon Monk ."Hacking Electronics: Learning Electronics with Arduino and Raspberry Pi"
3 William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson Education.
4 David Kleidermacher and Mike Kleidermacher, “Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development”, 1st Edition, Newnes, 2012.
5 Natraj Venkataramanan and Ashwin Shriram, “ Data Privacy Principles and Practice”

CRC Press.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2 https://www.udemy.com/topic/embedded-systems/
3 https://www.edx.org/learn/data-privacy

COURSE OUTCOMES:

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

CO1 Analyze Electromagnetic interference effects in PCBs.

CO2 Analyze solution to EMI Sources, EMI problems in PCB level / Subsystem and system level design.

CO3 Explain the different types of shielding, grounding methods and material used for the same.

CO4 Apply emission immunity level from different systems to couple with the prescribed EMC standards.

CO5 Understand the different types of EMI/EMC measurement techniques and measuring equipments.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	1	-	-	-	1	2	2
CO2	3	3	2	2	-	-	-	1	-	-	-	1	2	2
CO3	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO4	3	2	1	2	-	-	-	1	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	1	-	-	-	1	2	2

P23PEAE11 ALGORITHMS FOR VLSI DESIGN AUTOMATION L T P C

Prerequisites: VLSI Design 3 0 0 3

COURSE OBJECTIVES:

- To Understand the basic concepts of VLSI Design flow and scheduling algorithms for any application.
- To Understand the design cycle of FPGAs.
- To gain adequate knowledge about algorithms for partitioning, floor planning, placement and routing the MCM modules

UNIT I INTRODUCTION 9

Introduction to Design Methodologies: Design Automation tools, Algorithmic Graph Theory, Computational Complexity, Tractable and Intractable Problems

UNIT II COMBINATIONAL OPTMIZATION 9

Backtracking, Branch and Bound, Dynamic Programming, Integer Linear Programming, Local Search, Simulated Annealing, Tabu search, Genetic Algorithms

UNIT III LAYOUT, MODELLING AND SIMULATION 9

Compaction, Placement, Floor planning and Routing Problems, Concepts and Algorithms Modeling: Gate Level Modeling and Simulation, Switch level modeling and simulation.

UNIT IV LOGIC SYNTHESIS AND VERIFICATION 9

Basic issues and Terminology, Binary – Decision diagram, Two – Level Logic Synthesis. Hardware Models: Internal representation of the input algorithm, Allocation, Assignment and Scheduling, Some Scheduling Algorithms, Some aspects of Assignment problem, High – level Transformations

UNIT V FPGA TECHNOLOGIES 9

Physical Design cycle for FPGA's partitioning and routing for segmented and staggered models. MCM technologies, MCM physical design cycle, Partitioning, Placement – Chip array based and full custom approaches, Routing –Maze routing, Multiple stage routing, Topologic routing, Integrated Pin – Distribution and routing, routing and programmable MCM's.

TOTAL: 45 PERIODS

REFERENCES:

1 S.H.Gerez, "Algorithms for VLSI Design Automation", John Wiley 1999.
2 Naveed Sherwani, "Algorithms for VLSI Physical Design Automation" 3rd edition, Springer International Edition.
3 Hill & Peterson, "Computer Aided Logical Design with Emphasis on VLSI" Wiley,1993.
4 Wayne Wolf, "Modern VLSI Design: Systems on silicon" Pearson Education Asia, 2nd Edition.

ONLINE RESOURCES:

1 https://www.udemy.com/course/vlsi-design-mask/?couponCode=NVDPRODIN35
2 https://onlinecourses.nptel.ac.in/noc21_cs12/preview.

3 https://www.udemy.com/course/fpga-design-and implementation.

COURSE OUTCOMES:

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

CO1 Summarize VLSI Design flow for any application.

CO2 Explain the algorithms for partitioning, floor planning, placement and routing the digital designs at frontend level & at backend VLSI Design level.

CO3 Compare the various scheduling algorithms.

CO4 Explain the design cycle of FPGAs.

CO5 Explain the algorithms for partitioning, floor planning, placement and routing the MCM modules.

CO – PO – PSO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	-	-	-	1	-	-	-	1	2	3
CO2	2	2	1	2	-	-	-	1	-	-	-	1	2	3
CO3	2	2	1	2	-	-	-	1	-	-	-	1	2	3
CO4	2	2	1	2	-	-	-	1	-	-	-	1	2	3
CO5	2	2	1	2	-	-	-	1	-	-	-	1	2	3

P23PEAE12	QUANTUM COMPUTING	L	T	P	C
Prerequisites:	**Engineering Mathematics**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To Understand the basics of Quantum measurements.
- To design quantum circuit model by applying simple quantum algorithms.
- To gain adequate knowledge about Quantum computing models.

UNIT I QUANTUM MEASUREMENTS 9

Introduction: Quantum Measurements Density Matrices, Positive-Operator Valued Measure, Fragility of quantum information: Decoherence, Quantum Superposition and Entanglement, Quantum Gates and Circuits

UNIT II QUANTUM BASICS AND PRINCIPLES 9

Quantum Basics and Principles: No cloning theorem & Quantum Teleportation, Bell's inequality and its implications, Quantum Algorithms & Circuits.

UNIT III QUANTUM ALGORITHMS 9

Quantum Basics and Principles: No cloning theorem & Quantum Teleportation, Bell's inequality and its implications, Quantum Algorithms & Circuits.

UNIT IV PERFORMANCE, SECURITY AND SCALABILITY 9

Performance, Security and Scalability: Quantum Error Correction: Fault tolerance; Quantum Cryptography, Implementing Quantum Computing: issues of fidelity; Scalability in quantum computing.

UNIT V QUANTUM COMPUTING MODELS 9

Quantum Computing Models: NMR Quantum Computing, Spintronics and QED MODEL, Linear Optical MODEL, Nonlinear Optical Approaches; Limits of all the discussed approaches, Future of Quantum computing.

TOTAL: 45 PERIODS

REFERENCES:

1 Chris Bernhardt, "Quantum Computing for Everyone",The MIT Press.
2 Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge ,2002.
3 Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd, 2012.
4 Scott Aaronson, "Quantum Computing since Democritus", Cambridge,2013.
5 P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing", Cambridge.

ONLINE RESOURCES:

1 https://www.udemy.com/course/introduction-to-quantum-computing-i/.
2 https://onlinecourses.nptel.ac.in/noc21_cs103/preview.
3 https://www.edx.org/learn/quantum-computing.

COURSE OUTCOMES:

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

CO1 Understand the basics of Quantum measurements.

CO2 Explain Quantum computing Principles.

CO3 Apply simple quantum algorithms and information channels in the quantum circuit model.

CO4 Analyze the performance of Quantum computing.

CO5 Compare Quantum computing models.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE13	HARDWARE AND SOFTWARE CODESIGN	L	T	P	C
Prerequisites:	**Embedded Systems**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn the knowledge about system specification and modelling.
- To learn the formulation of partitioning
- To study the different technical aspects about prototyping and emulation.

UNIT I **CO- DESIGN ISSUES** **9**

Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.
Co- Synthesis Algorithms: Hardware software synthesis algorithms: hardware – software partitioning distributed system co-synthesis.

UNIT II **PROTOTYPING AND EMULATION** **9**

Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping architecture specialization techniques, system communication infrastructure. Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.

UNIT III **COMPILATION TECHNIQUES AND TOOLS FOR EMBEDDED PROCESSOR ARCHITECTURES** **9**

Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment.

UNIT IV **DESIGN SPECIFICATION AND VERIFICATION** **9**

Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, interface verification.

UNIT V **LANGUAGES FOR SYSTEM – LEVEL SPECIFICATION AND DESIGN-II** **9**

System – level specification, design representation for system level synthesis, system level specification languages, Languages for System – Level Specification and Design-II: Heterogeneous specifications and multi-language co-simulation.

TOTAL: 45 PERIODS

REFERENCES:

1 Jorgen Staunstrup, “Hardware / Software Co- Design Principles and Practice”, Wayne Wolf – 2009, Springer.
2 Giovanni De Micheli, Mariagiovanna Sami, “Hardware / Software Co- Design”, 2002, Kluwer Academic Publishers
3 Patrick R. Schaumont, “A Practical Introduction to Hardware/Software Co- design”,2010, Springer

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc22_cs38/preview
2 https://www.udemy.com/topic/embedded-systems/
3 https://onlinecourses.nptel.ac.in/noc21_cs08/preview

COURSE OUTCOMES:

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

CO1 Analyze problem description, goals of co-design, co-design steps, existing co-design approaches, and present challenges.

CO2 Explain Single processor – target architecture, mixed-signal architectures,multiprocessor architectures, reconfigurable architectures, Systems on Chip.

CO3 Design the system - level performance modeling and compilation techniques.

CO4 Analyze the goals of co - design, co - design steps, existing co -design approaches, and present challenges.

CO5 Explain the languages for system and level specification.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	3	2	-	-	2	-	-	-	1	2	2
CO4	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE14 SCRIPTING LANGUAGES AND VERIFICATION L T P C

Prerequisites: Programming in C and Data Structures 3 0 0 3

COURSE OBJECTIVES:

- To Write scripts for VLSI design automation using PERL and TCL.
- To understand the verification methodology of VLSI systems.
- To Develop UVM test bench.

UNIT I LINUX 9

Introduction to Linux- File System of Linux-General usage of Linux Kernel and Basic Commands-Linux users and group- Permissions for file, directory and users- Searching a file and directory -zipping and unzipping concepts.

UNIT II PERL 9

History and Concepts of PERL - Scalar Data - Arrays and List Data - Control structures – Hashes - Basics I/O - Regular Expressions – Functions - Miscellaneous control structures - Formats. Directory access - File and Directory manipulation - Process Management - Packages and Modules.

UNIT III TCL 9

An Overview of TCL and Tk -Tcl Language syntax – Variables – Expressions – Lists - Control flow – procedures - Errors and exceptions - String manipulations. Accessing files- Processes. Applications - Controlling Tools - Basics of Tk.

UNIT IV VERIFICATION TECHNIQUES 9

Introduction to Verification – Testing Vs Verification Verification Technologies-Functional Verification-Code Coverage-Functional Coverage-Testbench-Linear Test Bench-Linear Random Test Bench-Self Checking Test Bench-Regression- RTL formal Verification

UNIT V UNIVERSAL VERIFICATION METHODOLOGY 9

Introduction to UVM - Verification components - Transaction level modelling - Developing reusable verification components - Using Verification components and functional coverage - Register classes.

TOTAL: 45 PERIODS

REFERENCES:

1 Regi Larry Wall, Tom Christiansen, John Orwant, Programming PERL, Oreilly Publications, Fourth Edition, 2012

2 Christian B Spear, "SystemVerilog for Verification: A guide to learning the Test bench language features", Springer publications, Third Edition, 2012

3 John K. Ousterhout, Ken Jones, "Tcl and the Tk Toolkit", Pearson Education, Second Edition, 2010.

4 Ray Salmei, "The UVM Primer : A Step – by - Step Introduction to the Universal Verification Methodology" ,First Edition Boston Light Press, 2013.

5 Vanessa R. Copper, "Getting started with UVM : A Beginner's Guide", Verilab Publishing, First Edition, 2013.ster classes.

ONLINE RESOURCES:

1 https://archive.nptel.ac.in/courses/117/106/117106113/
2 https://www.edx.org/learn/scripting
3 https://www.udemy.com/course/vsd-tcl-programming-from-novice-to-expert/

COURSE OUTCOMES:

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

CO1 Write scripts for VLSI design automation using PERL
CO2 Write scripts for VLSI design automation using TCL
CO3 Write scrips for a given task to develop verification environment
CO4 Understand the verification methodology of VLSI systems
CO5 Develop UVM test bench

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO2	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO3	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	3	3	3	3	2	-	-	1	-	-	-	1	2	2

P23PEAE15 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN L T P C

Prerequisites: Transmission lines and RF System. 3 0 0 3

COURSE OBJECTIVES:

- To identify signal integrity and impedance matching technique.
- To introduce methods to improve the signal transmission characteristics and differential signalling.
- To analyse the I/O system using Eye diagram and Jitter.

UNIT I FUNDAMENTALS 9

The importance of signal integrity: The Basics - Electromagnetic fundamentals for signal integrity: Maxwell's Equations, Common Vector Operators - Wave Propagations- Electrostatics – Magnetostatics - Power flow and the Poynting Vector - Reflections of Electromagnetic Waves.

UNIT II SIGNAL REFLECTION AND IMPEDANCE MATCHING TECHNIQUE 9

Phenomenon of signal reflection. Signal reflection at transmitting end. Signal reflection at branch point. Multiple reflection in transmission line. Prevention of signal reflection by using impedance matching technique.

UNIT III DIFFERENTIAL SIGNALING 9

Removal of Common Mode Noise - Differential Crosstalk - Virtual Reference Plane - Propagation of Modal Voltages - Common Terminology - Drawbacks of Differential Signaling.

UNIT IV EYE DIAGRAM AND JITTER 9

Jitter Definition and Types of Jitter; Jitter decomposition; Eye diagram analysis and related measurement

UNIT V CHANNEL AND I/O CIRCUITS MODELLING 9

Creating a Physical Transmission Line Model - I/O Design Considerations - Push-Pull Transmitters - CMOS Receivers - ESD Protection Circuits - On Chip Termination - Bergeron Diagrams.

TOTAL: 45 PERIODS

REFERENCES:

1 Mike Peng Li, Jitter, Noise, and Signal Integrity at High-Speed, Prentice Hall, First Edition, 2007.
2 Eric Bogatin, Signal and Power Integrity – Simplified, Prentice Hall, Second Edition,2004.
3 Samuel H Russ, Signal Integrity : Applied Electromagnetics and Professional Practice, Springer International publishing, 2016.
4 Stephen C. Thierauf, "Understanding Signal Integrity", Artech House, 2011.
5 Natraj Venkataramanan and Ashwin Shriram , "Data Privacy Principles and Practice", CRC Press.

ONLINE RESOURCES:

1 https://www.udemy.com/course/vlsi-academy-crosstalk.

2 https://onlinecourses.nptel.ac.in/noc24_ee67/preview.
3 https://onlinecourses.nptel.ac.in/noc21_ee82/preview.

COURSE OUTCOMES:

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

CO1 Summarize High speed design and related issues
CO2 Explain the concepts of critical design aspect
CO3 Design about Jitter and related measurements
CO4 Apply high speed differential signals
CO5 Analyze circuit modelling

CO – PO – PSO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	3	3	-	-	2	-	-	-	1	2	2
CO4	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	1	2	2

P23PEAE16 MICRO SENSORS AND ACTUATORS L T P C

Prerequisites: Basic Electrical and Electronics Engineering 3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge of sensor and actuators.
- To design measuring equipment's for the measurement of pressure force, temperature and flow.
- To gain knowledge of micro sensors, micro actuators and electronic control.

UNIT I SENSORS 9

Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer..

UNIT II VARIABLE AND OTHER SPECIAL SENSORS 9

Variable air gap type, variable area type and variable permittivity type - capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers- Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT III ACTUATORS 9

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.

UNIT IV MICRO SENSORS AND MICRO ACTUATORS 9

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Micro Actuators : Actuation principle, shape memory effects- one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.

UNIT V SENSOR MATERIALS AND PROCESSING TECHNIQUES 9

Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process..

TOTAL: 45 PERIODS

REFERENCES:

1 Patranabis.D, "Sensors and Transducers", Wheeler publisher, 1994.

2 Jacob Fraden, "Hand Book of Modern Sensors: Physics, Designs and Application" Fourth edition, Springer, 2010.

3 Robert H Bishop, “The Mechatronics Hand Book”, CRC Press, 2002.
4 Thomas. G. Bekwith and Lewis Buck.N, Mechanical Measurements, Oxford and IBH publishing Co. Pvt. Ltd.,
5 Massood Tabib and Azar, “Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures”, First edition, Kluwer academic publishers, Springer, 1997.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee32/preview.
2 https://www.udemy.com/course/exploring-sensors-and-actuators-theory-and-practice/.
3 https://onlinecourses.nptel.ac.in/noc23_ee95/preview.

COURSE OUTCOMES:

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

CO1 Explain common types of sensor and actuators used in vehicles.
CO2 Design measuring equipment’s for the measurement of pressure force, temperature and flow.
CO3 Design the sensors and actuators for automotive application
CO4 Describe the operation of the micro sensors, micro actuators and electronic control.
CO5 Explain Principles underlying various sensor types.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO3	3	3	3	3	2	-	-	1	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE17 EDGE ANALYTICS AND INTERNET OF THINGS L T P C

Prerequisites: Computer Networks 3 0 0 3

COURSE OBJECTIVES:

- To Understand the architectures of smart objects and operation of Networking Technologies In IoT.
- To analyze the IoT gateway.
- To analyze the various real time applications of IoT by case studies.

UNIT I SMART OBJECTS 9

The "Things" in IoT, Sensors, Actuators, and Smart Objects, Hardware Communications Criteria (Ethernet, Wi-Fi, Bluetooth, Zigbee) M2M To IO -M2M Vs IoT.

UNIT II COMMUNICATION AND NETWORKING TECHNOLOGIES IN INTERNET OF THINGS 9

Introduction Sensor Networks, Network Layer Model (OSI or TCP/IP), Network Topologies, Communication Models; Wired: RS232, RS485, CAN, Ethernet. Wireless: Bluetooth, WLAN, GPS, LoRa, Cellular.

UNIT III IoT GATEWAY INTRODUCTION 9

Gateway, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M, Data Exchange Formats (JSON, XML), MQTT Protocol, HTTP REST, CoAP, XMPP and AMQP, Protocol Interoperability & Bridging, Data Aggregation using Gateway.

UNIT IV REAL-TIME OPERATING SYSTEM 9

Introduction, Real-Time Systems Concepts, Kernel Structure, Task Management, Semaphores, Mutual Exclusion (MUTEX), Message Mailbox, Message Queue, Memory Management, Porting RTOS.

UNIT V CASE STUDIES 9

Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture. IoT Wearables, Health care systems, Agri and Allied sectors.

TOTAL: 45 PERIODS

REFERENCES:

1 Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, ISBN: 978-1-4302-5740-0, 2013

2 Architecting the Internet of Things, by Dieter Uckelmann, Mark Harrison and Florian Michahelles, ISBN: 978-3-642-19157-2, 2011 Arduino Yun", Packt Publishing, 2014.

3 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition by Perry Lea.

ONLINE RESOURCES:

1 https://www.edx.org/learn/iot-internet-of-things

2 https://onlinecourses.nptel.ac.in/noc21_cs17/preview

3	https://www.udemy.com/course/edge-computing-a-complete-guide-on-computing-at-the-edge/

COURSE OUTCOMES:

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

CO1 Understand the architectures of smart objects.
CO2 Describe the operation of Networking Technologies In Iot.
CO3 Analyze the IoT gateway.
CO4 Comprehends the various real-time operating systems.
CO5 Analyze the various real time applications of IoT by case studies

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	2	3	3
CO2	2	2	1	2	-	-	-	-	-	-	-	2	3	3
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	3
CO4	2	2	1	2	-	-	-	-	-	-	-	2	3	3
CO5	2	2	1	2	1	-	-	1	-	-	-	2	3	3

P23PEAE18	BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
Prerequisites:	Digital Signal Processing	3	0	0	3

COURSE OBJECTIVES:

- To describe the basics of biomedical signals and the concepts of signal averaging.
- To analyze EEG Signals and Non Stationary signal.
- To analyze Neurological signal processing techniques to analyze EEG rythms.

UNIT I **INTRODUCTION TO BIOMEDICAL SIGNALS** **9**

Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event- Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

UNIT II **SIGNAL AVERAGING** **9**

Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Adaptive Noise Cancelling: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering (Text-1) L1,L2,L3.

UNIT III **EEG SIGNAL PROCESSING AND EVENT DETECTION IN BIOMEDICAL SIGNALS** **9**

EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis and Coherence Analysis of EEG Channels.

UNIT IV **ANALYSIS OF NON STATIONARY SIGNALS** **9**

Heart Sounds and Murmurs, Characterization of Nonstationary Signals and Dynamic Systems, Short-Time Fourier Transform, Considerations in Short-Time Analysis and Adaptive Segmentation..

UNIT V **NEUROLOGICAL SIGNAL PROCESSING** **9**

The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection (Text-2) L1,L2, L3

TOTAL: 45 PERIODS

REFERENCES:

1 Rangayyan, R.M. “Biomedical signal analysis (Vol. 33)”. John Wiley & Sons, 2015
2 Reddy, D.C.,“Biomedical signal processing: principles and techniques”. McGraw-Hill Optional Materials, 2005
3 Tompkins, W.J., “Biomedical digital signal processing”. Prentice Hall Edition,1993.
4 Sörnmo, L. and Laguna, P., “Bioelectrical signal processing in cardiac and neurological applications (Vol. 8).” Academic Press, 2005.

ONLINE RESOURCES:

1 https://www.edx.org/learn/biomedical-imaging
2 https://archive.nptel.ac.in/courses/108/105/108105101/
3 https://www.edx.org/learn/nervous-system

COURSE OUTCOMES:

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

CO1 Describe the basics of biomedical signals.
CO2 Explain the concepts of signal averaging.
CO3 Analyze EEG Signals.
CO4 Analyze nonStationary signal.
CO5 Analyze neurological signal processing techniques to analyze EEG Rythms.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO4	3	3	2	2	1	-	-	1	-	-	-	1	2	2
CO5	3	3	2	2	1	-	-	1	-	-	-	1	2	2

P23PEAE19 FIBRE OPTIC SENSORS AND PHOTONICS L T P C

Prerequisites: Optical Communication 3 0 0 3

COURSE OBJECTIVES:

- To understand about optical waveguides and optical devices employed in optical sensors.
- To estimate the phase, charge distribution due to polarization effects and its application in optical sensing.
- To understand about Fibre based Chemical and Bio Sensors.

UNIT I THEORY OF OPTICAL WAVEGUIDES 9

Wave theory of optical waveguides, formation of guided modes, Slab waveguide, Rectangular waveguide, Radiation fields from waveguide, Effective index method, Marcatili's method, Beam propagation method. Basic characteristic of Optical Fiber Waveguides, Acceptance angle, Numerical aperture, skewrays- Electromagnetic Modes in Cylindrical Waveguides.

UNIT II ACTIVE AND PASSIVE OPTICAL COMPONENTS 9

Electro-optic and acousto optic wave guide devices, directional couplers, optical switch, phase and amplitude modulators, filters etc, Y junction, power splitters, arrayed waveguide devices, fiber pigtailing, end fiber prism coupling, FBG and fabrication of FBG, Tapered couplers.

UNIT III INTENSITY AND POLARIZATION SENSORS 9

Intensity sensor: Transmissive concept –Reflective concept-Micro bending concept– Transmission and Reflection with other optic effect- Interferometers – Mach Zehnder-Michelson-Fabry-Perot and Sagnac Phase sensor: Phase detection - Polarization maintaining fibers. Displacement and temperature sensors: reflective and Micro bending Technology-Applications of displacement and temperature sensors.

UNIT IV INTERFEROMETRIC SENSORS 9

Pressure sensors: Transmissive concepts, Microbending – Intrinsic concepts – Interferometric concepts, Applications. Flow sensors: Turbine flowmeters - Differential pressure flow sensors – Laser Doppler velocity sensors - Applications - Sagnac Interferometer for rotation sensing. Magnetic and electric field sensors: Intensity and phase modulation types – applications.

UNIT V FIBRE BASED CHEMICAL AND BIO SENSORS 9

Fiber based Chemical Sensing :Absorption, Fluorescence, Chemi-luminescence, Vibrational Spectroscopic, SPR. Fiber based Bio-molecules sensing: High Index, SPR, Hollow core fiber probes, Label Free biomolecules.

TOTAL: 45 PERIODS

REFERENCES:

1 David A. Krohn, Trevor W. MacDougall, Alexis Mendez, "Fiber Optic Sensors: Fundamentals and Applications" SPIE Press, 4th ed. 2015.

2 Eric Udd , William B. Spillman Jr., "Fiber Optic Sensors: An Introduction for Engineers and Scientists", Wiley, 2nd Ed., 2011. ISBN: 0470126841.

3 Zujie Fang & et. al., "Fundamentals of Optical Fiber Sensors" Wiley, 1st Ed., 2012.

4 Shizhuo Yin, Paul B. Ruffin, and Francis T.S. Yu, "Fiber Optic Sensors", CRC Press, 2 Ed, 2017.
5 F.Baldini&et.al.,"Optical Chemical Sensors", NATO Science Series II: Mathematics, Physics and Chemistry, Springer, 2008.

ONLINE RESOURCES:

1 https://www.edx.org/learn/engineering/purdue-university-fiber-optic-communications
2 https://onlinecourses.nptel.ac.in/noc22_ee67/preview
3 https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ee67/

COURSE OUTCOMES:

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

CO1 Understand about optical waveguides and optical devices employed in optical sensors.
CO2 Explain the working of active and passive optical components.
CO3 Estimate the phase, charge distribution due to polarization effects and its application in optical sensing.
CO4 Apply the knowledge in designing interferometric devices which is more effectively used in sensing.
CO5 Understand about Fibre based Chemical and Bio Sensors.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	3	1	-	-	1	-	-	-	1	2	2
CO4	3	3	1	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE20	IoT SECURITY AND TRUST	L	T	P	C
Prerequisites:	**Computer Networks**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the basics of securing Internet of Things.
- To analyze various privacy schemes related to IoT and to describe the authentication mechanisms for IoT security and privacy.
- To understand the security issues for various applications using case studies.

UNIT I INTRODUCTION: SECURING THE INTERNET OF THINGS 9

Introduction – Security Requirements in IoT architectures – Security in Enabling Technologies – IoT Security Life Cycle – Cryptographic Fundamentals for IoT Security Engineering - Security Concerns in IoT Applications – Basic Security Practices.

UNIT II SECURITY ARCHITECTURE IN THE INTERNET OF THINGS 9

Introduction – Security Requirements in IoT – Insufficient Authentication/Authorization – Insecure Access Control – Threads to Access Control, Privacy, and Availability – Attacks Specific to IoT – Malware Propagation and Control in Internet of Things.

UNIT III PRIVACY PRESERVATION 9

Privacy Preservation Data Dissemination - Privacy Preservation for IoT used in Smart Building – Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles – Lightweight and Robust Schemes for Privacy Protection in Key personal IOT Applications: Mobile WBSN and Participatory Sensing.

UNIT IV TRUST, AUTHENTICATION AND DATA SECURITY 9

Trust and Trust Models for IoT – Emerging Architecture Model for IoT Security and Privacy– preventing Unauthorized Access to Sensor Data – Authentication in IoT – Computational Security for the IoT – Secure Path Generation Scheme for real-Time Green IoT – Security Protocols for IoT Access Networks.

UNIT V SOCIAL AWARENESS AND CASE STUDIES 9

User Centric Decentralized Governance Framework for Privacy and Trust in IoT – Policy Based Approach for Informed Consent in IoT - Security and Impact of the IoT on Mobile Networks – Security Concerns in Social IoT – Security for IoT Based Healthcare – Smart cities.

TOTAL: 45 PERIODS

REFERENCES:

1 Shancang Li, Li Da Xu, “Securing the Internet of Things,” Syngress (Elsevier) publication, 2017.
2 Fei Hu, “Security and Privacy in Internet of Things (IoTs) : Models, Algorithms, and Implementations,” CRC Press (Taylor & Francis Group), 2016.
3 Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A Hands-on approach,” VPT Publishers, 2014,
4 Alasdair Gilchris, “Iot Security Issues,” Walter de Gruyter GmbH & Co, 2017.
5 Sridipta Misra, Muthucumaru Maheswaran, Salman Hashmi, “Security Challenges and Approaches in Internet of Things,” Springer, 2016.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2 https://www.udemy.com/course/iot-security-beginners/?
3 https://www.edx.org/learn/amazon-web-services-aws/amazon-web-services-aws-iot-developing-and-deploying-an-internet-of-things

COURSE OUTCOMES:

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

CO1 Describe the basics of securing Internet of Things.
CO2 Explain architecture and threats in IoT.
CO3 Analyze various privacy schemes related to IoT.
CO4 Describe the authentication mechanisms for IoT security and privacy.
CO5 Explain security issues for various applications using case studies.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO3	3	3	2	2	1	-	-	1	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	1	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	1	-	-	-	1	2	2

P23PEAE21	CONSUMER ELECTRONICS	L	T	P	C
Prerequisites:	**Electron Devices**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To apply the fundamentals of electronics to construct the audio and video systems.
- To analyze and make use of the technology for smart home.
- To understand about basic functional blocks of home based communication.

UNIT I **CONSUMER ELECTRONICS FUNDAMENTALS** **9**

History of Electronic Devices, Semiconductor Devices, Diodes, Rectifiers, Transistors, Integrated Circuits, Logic Gates, Combinational Circuits, ADC, DAC andMicroprocessors, Microcontrollers in consumer electronics, Energy management,Intelligent Building Perspective. Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor.

UNIT II **AUDIO SYSTEM, VIDEO SYSTEMS AND DISPLAYS** **9**

Microphones, loudspeakers baffle and enclosure, Acoustics, mono, stereo, Quad,Amplifying System, Equalizers and Mixers Synthesizers, Commercial Sound, TheaterSound System. Video Systems and Displays: Monochrome, Color TV standards, TFT, Plasma, HDTV, LCD, LED TV, Direct-To- Home (DTH- Set Top Box), Video Telephone and Video Conferencing.

UNIT III **SMART HOME** **9**

Technology involved in Smart home, Home Virtual Assistants-Alexa and Google Home, Home Security Systems - Intruder Detection, Automated blinds, Motion Sensors, Thermal Sensors and Image Sensors, PIR, IR and Water Level Sensors.

UNIT IV **DOMESTIC AND CONSUMER APPLIANCES** **9**

Washing machines, Microwave ovens, Air-conditioners and Refrigerators, Computers office System, Telephone & Mobile Radio System.

UNIT V **COMMUNICATION SYSTEMS** **9**

Cordless Telephones, Fax Machines, PDAs-Tablets, Smart Phones and Smart Watches, Introduction to Smart OS-Android and iOS, Video Conferencing Systems- Web/IP Camera, Video security, Internet Enabled Systems, Wi-Fi, IoT, Li-Fi, GPS and Tracking Systems.

TOTAL: 45 PERIODS

REFERENCES:

1 Bali, “Consumer Electronics”, S.P Pearson Education India, Delhi, 2007;
2 Gupta, R.G , “Audio video systems principles, maintenance and troubleshooting “ Mcgraw Hill, New Delhi, India 2010.
3 Bali, Rajeev “Audio video system:principle practices and troubleshooting” S.P. Khanna Book Publishing Co. (P) Ltd., 2014 Delhi.
4 Gulati, R.R , “Modern Television Practice: Transmission, Reception and Applications” New Age International, New Delhi Year 2015.
5 Dhake, A.M , “Television and video Engineering” McGraw- Hill, New Delhi, India 2006.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_ee55/preview
2 https://onlinecourses.nptel.ac.in/noc21_ee10/preview
3 https://www.edx.org/learn/electronics

COURSE OUTCOMES:

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

CO1 Apply the fundamentals of electronics to construct the audio and video systems.
CO2 Explain working of various color Television system.
CO3 Analyze and make use of the technology for smart home.
CO4 Describe the working principles of various home appliances.
CO5 Describe the basic functional blocks of home based communication systems.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE22	DEEP LEARNING	L	T	P	C
Prerequisites:	**Random Process**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the main fundamentals that drive Deep Learning and to implement efficient CNN or RNN.
- To understand the key features in a neural network's architecture.
- To understand the theoretical basis underlying neural networks and deep learning.

UNIT I **INTRODUCTION TO NEURAL NETWORKS** **9**

Linear Classifiers and Gradient Descent, Neural Networks, Optimization of Deep Neural Networks, Data Wrangling

UNIT II **CONVOLUTIONAL NEURAL NETWORKS** **9**

Convolution and Pooling Layers, Convolutional Neural Network Architectures, Visualization, PyTorch and Scalable Training , Advanced Computer Vision Architectures, Bias and Fairness.

UNIT III **STRUCTURED NEURAL REPRESENTATIONS** **9**

Introduction to Structured Representations, Language Models, Embeddings, Neural Attention Model, Neural Machine Translation, Advanced Topics.

UNIT IV **ADVANCED TOPICS** **9**

Deep Reinforcement Learning, Unsupervised and Semi Supervised Learning, Generative Models, Placeholders in Tensorflow, Defining placeholders, Feeding placeholders with data, Variables ,Constant, Computation graph, Visualize graph with Tensor Board.

UNIT V **CLASIFYING IMAGES WITH CONVOLUTIONAL NEURAL NETWORKS(CNN)** **9**

Introduction to CNN, Train a simple convolutional neural net, Pooling layer in CNN, Building, training, and evaluating our first CNN, Model performance optimization.

TOTAL: 45 PERIODS

REFERENCES:

1 Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017.
2 Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018.
3 Deep Learning Projects Using TensorFlow 2,Vinita Silaparasetty, Apress, 2020.
4 Deep Learning with Python,François Chollet,Manning Shelter Island,2017.
5 Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017.

ONLINE RESOURCES:

1 https://www.edx.org/learn/neural-network
2 https://onlinecourses.nptel.ac.in/noc23_bt64/preview
3 https://www.udemy.com/course/deep-learning-cnn/

COURSE OUTCOMES:

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

CO1 Understand the main fundamentals that drive Deep Learning.
CO2 Build, train and apply fully connected deep neural networks.
CO3 Understand about efficient CNN or RNN.
CO4 Understand the key features in a neural network's architecture.
CO5 Understand the theoretical basis underlying neural networks and deep learning.

CO – PO – PSO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO2	3	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO4	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO5	2	2	1	2	-	-	-	-	-	-	-	1	2	2

P23PEAE23	ELECTRONIC PRODUCT DESIGN	L	T	P	C
Prerequisites:	**Embedded System**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To gain adequate knowledge about the concept behind Electronic product design, hardware, software and and PCB design.
- To understand various software design and testing models, PCB design methodologies
- To know fundamentals of documentation

UNIT I **INTRODUCTION TO ELECTRONIC PRODUCT DESIGN** **9**

Overview of Electronic Product Design, Top-Down and Bottom -Up Approach, Considering Power Supply Design as an example, Ergonomic and Aesthetics. Definition with Example, issues in Designing Electronic Products. Event - Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer- Aided Diagnosis.

UNIT II **INDUSTRIAL DESIGN** **9**

Man machine dialog and Industrial design, user-centered design, five element of successful design, cognition, ergonomics. Packaging and factors, design for manufacture, assembly and disassembly, wiring, temperature, vibration and shock Safety, noise, energy coupling, grounding, filtering and shielding.

UNIT III **SOFTWARE DESIGN AND TESTING METHODS** **9**

Types of Software. Waterfall model of software development. Models, metrics and software limitations. Risk abatement and failure preventions. Software bugs and testing. Good programming practice. User interface. Embedded, Real time software.

UNIT IV **PCB DESIGN** **9**

Fundamental Definitions, Standards. Routing Topology Configurations, Layer Stack Up assignment, Grounding Methodologies, Aspect Ratio, Image Planes, Functional Partitioning, Critical frequencies, Bypassing and decoupling. Design techniques for ESD Protection, Guard Band implementation.

UNIT V **DOCUMENTATION** **9**

Definition, need, and types of documentation. Records, Accountability, and Liability. Audience. Preparation, Presentation, and Preservation of documents. Methods of documentation, Visual techniques, Layout of documentation, Bill of material.

TOTAL: 45 PERIODS

REFERENCES:

1 Kim Fowler, Electronic Instrument Design Oxford university press.
2 Robert J. Herrick, Printed Circuit board design Techniques for EMC Compliance, Second edition, IEEE press.
3 James K. Peckol, Embedded Systems – A Contemporary Design Tool, Wiley publication.
4 J C Whitakar, The Electronics Handbook, CRC press.

ONLINE RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc21_me83/preview
2 https://www.edx.org/learn/product-design
3 https://www.udemy.com/course/learning-complete-pcb-design-from-an-idea-to-a-product/

COURSE OUTCOMES:

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

CO1 Explain the concept behind Electronic product design.
CO2 Analyze the various stages of hardware, software and PCB design.
CO3 Understand various software design and testing models.
CO4 Apply PCB design methodologies.
CO5 Understand the importance of documentation.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	-	-	-	1	-	-	-	2	3	2
CO2	3	3	2	2	-	-	-	1	-	-	-	2	3	2
CO3	2	2	1	2	-	-	-	1	-	-	-	2	3	2
CO4	3	2	1	2	-	-	-	1	-	-	-	2	3	2
CO5	2	2	1	2	-	-	-	1	-	-	-	2	3	2

P23PEAE24	GREEN TECHNOLOGIES	L	T	P	C
Prerequisites:	**Environmental Science**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To analyze the importance of green technologies in sustainable growth of industry and safety.
- To design the cleaner production and treatment mechanism for pollution prevention and for suitable energy efficient processes.
- To analyze the use of selective materials for green buildings.

UNIT I INTRODUCTION TO GREEN CHEMISTRY AND TECHNOLOGY 9

Twelve principles of green chemistry, Green technology - definition, importance, factors affecting green technology. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology.

UNIT II GREEN SYNTHESIS AND SOLVENTS 9

Green methods of synthesis- microwave assisted synthesis, solvent free techniques- Reaction on solid supports. Alternative solvents Ionic liquids - general synthesis, applications; super critical fluids- extraction, process and applications.

UNIT III CLEANER DEVELOPMENT TECHNOLOGIES 9

Cleaner development mechanisms, role of industry; reuse, reduce and recycle, raw material substitution; wealth from waste; carbon credits, carbon trading, carbon sequestration, eco labelling. Oxidation technology for waste water treatment - Cavitation, Fenton chemistry, photocatalysis and hybrid processes.

UNIT IV ENERGY EFFICIENT SYSTEMS AND PROCESSES 9

Energy efficient motors, energy efficient lighting, control and selection of luminaries; bio-fuels, fuel cells- working, selection of fuels, Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems..

UNIT V GREEN BUILDINGS 9

Definition- Features and benefits, Fundamental planning decisions for energy efficient building-site selection, buildings forms and orientations, building fabrics and insulation, ventilation, passive solar features. Eco friendly and cost effective materials, Energy management, roof top solar photovoltaic system and solar tracking system, alternating roofing systems.

TOTAL: 45 PERIODS

REFERENCES:

1 Khan B.H, Non conventional energy resources, Tata McGraw-Hill, New Delhi 2006.
2 Rashmi Sanghi and M.M. Srivastava, Green Chemistry-Environment Friendly Alternatives, Narosa Publishing House, New Delhi 2009.
3 Paul L. Bishop, Pollution prevention –Fundamentals and Practices, McGraw-Hill-international 2000.

4 N. Vinutha bai, R. Ravindra, "Energy efficient and green technology concepts", International Journal of Research in Engineering and Technology p 253-258, Volume: 03 Special Issue: 06 ,2014, eISSN: 2319-1163 pISSN: 2321-7308.
5 F.Baldini & et.al.,"Optical Chemical Sensors", NATO Science Series II: Mathematics, Physics and Chemistry, Springer, 2008. ISBN: 1402046103

ONLINE RESOURCES:

1 https://www.udemy.com/course/electrolysis/
2 https://www.udemy.com/course/clean-technology-fundamentals-distributed- generation
3 https://onlinecourses.nptel.ac.in/noc19_ce40/preview

COURSE OUTCOMES:

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

CO1 Analyze the importance of green technologies in sustainable growth of Industry and society.
CO2 Explain the alternative methods and solvents for green synthesis.
CO3 Design the cleaner production and treatment mechanims for pollution prevention.
CO4 Design of suitable energy efficient processes.
CO5 Analyze the use of selective materials for green buildings.

CO – PO – PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	3	3	-	-	-	-	-	-	-	1	2	2
CO4	3	3	3	3	-	-	-	-	-	-	-	1	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	1	2	2