Vision and Mission of the Department

Vision:

To become a world class renowned department where dissemination and application of knowledge in design and analysis of electronic circuits in the field of communication is delivered and to synergistically balance through relentless pursuit of student success towards the economic prosperity of the society and the world at large.

Mission:

- **M1:** Achieve excellence in teaching, learning, and educational activities which ensure that each student has the opportunity to attain his or her fullest potential.
- **M2:** Inculcate innovative skills, research aptitude, team-work, ethical practices in students so as to meet expectations of the industry as well as society.
- **M3:** Provide research and intellectual resources that address problems facing the industry and the world, while advancing the boundaries of disciplinary and multidisciplinary research and its applications.
- **M4:** Develop and support professional development opportunities for all faculty.
- **M5:** Foster a cooperative and healthy environment that enhances awareness and encourages open communication.
- **M6:** Integrate appropriate technology through interaction with the industry.
- **M7:** Provide an open and accessible learning and working environment.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To enable graduates to develop solutions to real world problems in the frontier areas of Applied Electronics.

2. To enable the graduates to adapt to the latest trends in technology through self-learning and to pursue research to meet out the demands in industries and Academia.

3. To enable the graduates to exhibit leadership skills and enhance their abilities through lifelong learning.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To critically evaluate the design and provide optimal solutions to problem areas in advanced signal processing, digital system design, embedded systems and VLSI design.

PSO2: To **e**nhance and develop electronic systems using modern engineering hardware and software tools.

PSO3: To work professionally and ethically in applied electronics and related areas.

Mapping of Programme Educational Objectives (PEOs) and the Program Outcomes (POs):

PEOs	PROGRAM OUTCOMES (POS)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	3	2	2	1	1	-	2	3	2	2
PEO2	3	2	2	2	2	-	-	2	3	3	3	3
PEO3	3	2	2	2	2	1	1	3	2	3	2	3

Mapping of Programme Specific Outcomes (PSOs) and the Program Outcomes (POs):

PSOs	PROGRAM OUTCOMES (POS)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PSO1	3	3	3	2	2	1	1	1	2	3	2	2
PSO2	3	2	3	2	3	-	-	2	3	3	2	2
PSO3	3	2	2	2	-	3	1	3	2	3	2	3

M.E APPLIED ELECTRONICS

CHOICE BASED CREDIT SYSTEM

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES:

A broad relation between the Course Outcomes and Programme Outcomes is given in the following table

SUBJECTS			PROGRAMME OUTCOMES										
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I YEAR	SEMESTER I	Applied Mathematics for Electronics Engineers	3	3	2	1				3	2	3		2
		Advanced Digital System Design	3	2	2	2	1			3	2	3		2
		Advanced Digital Signal Processing	3	2	2	2	1			3	2	3		2
		Embedded System Design	3	2	2	2	2			3	2	3		2
		Research Methodology and IPR	3	2	2	1				3	2	3		2
		Professional Elective I												
		Electronic System Design Lab I	3	2	2	2	2			3	3	3		2
		Professional Elective I												
		Digital Control Engineering	3	2	2	1				3	2	3		2
		Sensors, Actuators and Interface Electronics	3	2	2	1				3	2	3		2
		CAD for VLSI	3	2	2	2	1			3	2	3		2
		Electromagnetic Interference and Compatibility	3	2	2	1				3	2	3		2
	SEMESTER II	Solid State Device Modeling and Simulation	3	2	2	1				3	2	3		2
		ASIC and FPGA Design	3	2	2	2				3	2	3		2
		Advanced Digital Image Processing	3	2	2	2	1			3	2	3		2
		Open Elective												

		SUBJECTS	PROGRAMME OUTCOMES											
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		Professional Elective II												
		Professional Elective III												
		Audit Course												
		Electronic System Design Lab II	3	2	2	2	2			3	3	3		2
		Term Paper Writing and Seminar	3	2	2	1				3	3	3		3
		Professional Elective –II												
		VLSI Design Techniques	3	2	2	2	1			3	2	3		2
		RF System Design	3	2	2	1				3	2	3		2
		Wireless Adhoc and Sensor Networks	3	2	1					3	2	3		2
		High Performance Networks	3	2	1					3	2	3		2
		Professional Elective–III												
		DSP Architectures and Programming	3	2	2	2	2			3	2	3		2
		Hardware – Software Co-design	3	2	2	2				3	2	3		2
		Speech and Audio Signal Processing	3	2	2	1	1			3	2	3		2
		Artificial Intelligence and Optimization Techniques	3	2	2	2	1			3	2	3		2
II YEAR	**SEMESTER III**	IoT System Design and Security	3	2	2					3	2	3		2
		Professional Elective–IV												
		Non Linear Signal Processing	3	2	2	2	1			3	2	3		2
		Pattern Recognition and Machine learning	3	2	2	1	1			3	2	3		2
		Signal Processing for VLSI	3	2	2	2	1			3	2	3		2
		Nano Electronics	3	2	2	1				3	2	3		2
		Professional Elective V												
		Signal Integrity for High Speed Design	3	2	1					3	2	3		2
		MEMS and NEMS	3	2	1					3	2	3		2
		Secure Computing Systems	3	2	2	1				3	2	3		2
		Advanced Microprocessor and Microcontroller Architecture	3	2	2	2				3	2	3		2
		Project Work - Phase I	3	3	3	3	3	2	2	3	3	3	3	3
	SEMESTER IV	Project Work Phase –II	3	3	3	3	3	2	2	3	3	3	3	3

Mapping Criterion: Strong-3 Significant-2 Reasonable –1

M.E. Applied Electronics

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

I - IV SEMESTERS CURRICULUM AND SYLLABI SEMESTER I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	MA1152	Applied Mathematics for Electronics Engineers	FC	5	4	1	0	4
2	AP1102	Advanced Digital System Design	PC	4	3	1	0	3
3	AP1103	Advanced Digital Signal Processing	PC	5	3	2	0	4
4	AP1104	Embedded System Design	PC	3	3	0	0	3
5	RM1101	Research Methodology and IPR	PC	3	3	0	0	2
6		Professional Elective I	PE	3	3	0	0	3
PRACTICALS								
7	AP1111	Electronic System Design Laboratory-I	PC	4	0	0	4	2
Total				**27**	**19**	**4**	**4**	**21**

SEMESTER II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	AP1201	Solid State Device Modeling and Simulation	PC	3	3	0	0	3
2	AP1202	ASIC and FPGA Design	PC	4	4	0	0	4
3	AP1203	Advanced Digital Image Processing	PC	3	3	0	0	3
4		**Open Elective**	OE	3	3	0	0	3
5		**Professional Elective II**	PE	3	3	0	0	3
6		**Professional Elective III**	PE	3	3	0	0	3
7		**Audit Course**	AC	2	2	0	0	0
PRACTICALS								
7	AP1211	Electronic System Design Laboratory-II	PC	4	0	0	4	2
8	AP1212	Term Paper Writing and Seminar	EEC	2	0	0	2	1
Total				**27**	**21**	**0**	**6**	**22**

SEMESTER III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	AP1301	IOT System Design and Security	PC	3	3	0	0	3
2		**Professional Elective - IV**	PE	3	3	0	0	3
3		**Professional Elective - V**	PE	3	3	0	0	3
PRACTICALS								
4	AP1311	Project Work Phase-I	EEC	12	0	0	12	6
Total				**21**	**9**	**0**	**12**	**15**

SEMESTER IV

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
PRACTICALS								
1	AP1411	Project Work Phase-II	EEC	24	0	0	24	12
Total				**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 70

CATEGORIZATION OF COURSES

FOUNDATION COURSES (FC)

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	MA1152	Applied Mathematics for Electronics Engineers	FC	5	4	1	0	4

PROFESSIONAL CORE (PC)

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	AP1102	Advanced Digital System Design	PC	4	3	1	0	3
2.	AP1103	Advanced Digital Signal Processing	PC	5	3	2	0	4
3.	AP1104	Embedded System Design	PC	3	3	0	0	3
4.	RM1101	Research Methodology and IPR	PC	3	3	0	0	2
5.	AP1111	Electronic System Design Laboratory-I	PC	4	0	0	4	2
6.	AP1201	Solid State Device Modeling and Simulation	PC	3	3	0	0	3
7.	AP1202	ASIC and FPGA Design	PC	4	4	0	0	4
8.	AP1203	Advanced Digital Image Processing	PC	3	3	0	0	3
9.	AP1211	Electronic System Design Laboratory-II	PC	4	0	0	4	2
10.	AP1301	IOT System Design and Security	PC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	AP1212	Term paper Writing &Seminar	EEC	2	0	0	2	1
2	AP1311	Project Work Phase-I	EEC	12	0	0	12	6
3	AP1411	Project Work Phase-II	EEC	24	0	0	24	12

PROFESSIONAL ELECTIVES (PE)

SEMESTER I ELECTIVE I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	AP1121	Digital Control Engineering	PE	3	3	0	0	3
2	AP1122	Sensors, Actuators & Interface Electronics	PE	3	3	0	0	3
3	AP1123	CAD for VLSI	PE	3	3	0	0	3
4	AP1124	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3

SEMESTER II

ELECTIVE – II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	AP1221	VLSI Design Techniques	PE	3	3	0	0	3
2	AP1222	RF System Design	PE	3	3	0	0	3
3	AP1223	Wireless Adhoc and Sensor Networks	PE	3	3	0	0	3
4	AP1224	High Performance Networks	PE	3	3	0	0	3

ELECTIVE – III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	AP1225	DSP Architectures and Programming	PE	3	3	0	0	3
2	AP1226	Hardware – Software Co-design	PE	3	3	0	0	3
3	AP1227	Speech and Audio Signal Processing	PE	3	3	0	0	3
4	AP1228	Artificial Intelligence and Optimization Techniques	PE	3	3	0	0	3

SEMESTER III

ELECTIVE –IV

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	AP1321	Non Linear Signal Processing	PE	3	3	0	0	3
2	AP1322	Pattern Recognition and Machine learning	PE	3	3	0	0	3
3	AP1323	Signal Processing for VLSI	PE	3	3	0	0	3
4	AP1324	Nano Electronics	PE	3	3	0	0	3

ELECTIVE –V

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	AP1325	Signal Integrity for High Speed Design	PE	3	3	0	0	3
2	AP1326	MEMS and NEMS	PE	3	3	0	0	3
3	AP1327	Secure Computing Systems	PE	3	3	0	0	3
4	AP1328	Advanced Microprocessor and Microcontroller Architecture	PE	3	3	0	0	3

OPEN ELECTIVE

*(out of 6 courses one course must be selected)

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	OCP101	Business Data Analytics	OE	3	3	0	0	3
2.	OMF101	Industrial Safety	OE	3	3	0	0	3
3.	OPE101	Renewable Sources of Electrical Energy	OE	3	3	0	0	3
4.	OMB103	Cost Management of Engineering Projects	OE	3	3	0	0	3
5.	OMF102	Composite Materials	OE	3	3	0	0	3
6.	OCH105	Waste to Energy	OE	3	3	0	0	3

AUDIT COURSES

Registration for any of these courses is optional to students

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	AX1001	English for Research Paper Writing	AC	2	2	0	0	0
2.	AX1002	Disaster Management	AC	2	2	0	0	0
3.	AX1003	Value Education	AC	2	2	0	0	0
4.	AX1004	Constitution of India	AC	2	2	0	0	0
5.	AX1005	Pedagogy Studies	AC	2	2	0	0	0
6.	AX1006	Stress Management by Yoga	AC	2	2	0	0	0
7.	AX1007	Personality Development Through Life Enlightenment Skills	AC	2	2	0	0	0
8.	AX1008	Unnat Bharat Abhiyan	AC	2	2	0	0	0

DISTRIBUTION OF CREDITS

Sl. No.	Category	Credits as per Semester				Total Credits	Percentage
		I	II	III	IV		
1	FC	4	-	-	-	4	5.71
2	PC	15	11	3	-	29	41.43
3	EEC	-	1	6	12	19	27.14
4	PE	3	6	6	-	15	21.43
5	OE	-	3	-	-	3	4.29
6	AC	-	0	-	-	0	0
Total Credits		22	21	15	12	70	

MA1152	APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS	L	T	P	C
		4	1	0	4

OBJECTIVES:

- To demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in electronics engineering.
- To identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools from a variety of mathematical areas, including fuzzy logic, matrix theory, probability, dynamic programming and queuing theory

UNIT I FUZZY LOGIC 12

Classical logic – Multivalued logics – Fuzzy propositions – Fuzzy quantifiers

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 – Baye's 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 DYNAMIC PROGRAMMING 12

Dynamic programming – Principle of optimality – Forward and backward recursion – Applications of dynamic programming – Problem of dimensionality.

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

OUTCOMES:

At the end of the course, the student should be able to:

- Concepts of fuzzy sets, knowledge representation using fuzzy rules, fuzzy logic, fuzzy prepositions and fuzzy quantifiers and applications of fuzzy logic
- Apply various methods in matrix theory to solve system of linear equations
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming
- Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models
- Using discrete time Markov chains to model computer systems

REFERENCES:

1. Bronson, R., "Matrix Operations", Schaum's Outline Series, McGraw Hill, 2011Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 1983.
2. George, J. Klir. and Yuan, B., "Fuzzy sets and Fuzzy logic, Theory and Applications", Prentice Hall of India Pvt. Ltd., 1997
3. Gross, D., Shortle J. F., Thompson, J.M., and Harris, C. M., "Fundamentals of Queueing Theory", 4th Edition, John Wiley, 2014.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund"s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015
5. Taha, H.A., "Operations Research: An Introduction", 9th Edition, Pearson Education, Asia, New Delhi, 2016

AP1102	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
		3	1	0	3

OBJECTIVES:

- To introduce methods to analyze and design synchronous and asynchronous sequential circuits.
- To introduce the architectures of programmable devices.
- To introduce design and implementation of digital circuits using programming tools.

UNIT I SEQUENTIAL CIRCUIT DESIGN 9

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

UNIT II 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 – designing vending machine controller

UNIT III 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 IV 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

UNIT V SYSTEM DESIGN USING VERILOG 9

Hardware Modelling with Verilog HDL – Logic System, Data Types and Operators For Modelling in Verilog HDL - Behavioural 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 – Registers – counters – sequential machine – serial adder – Multiplier- Divider – Design of simple microprocessor.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Analyze and design sequential digital circuits
- Identify the requirements and specifications of the system required for a given application
- Design and use programming tools for implementing digital circuits of industry standards

REFERENCES:

1. Charles H.Roth Jr "Fundamentals of Logic Design" Thomson Learning 2004
2. M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999.
3. M.G.Arnold, Verilog Digital – Computer Design, Prentice Hall (PTR), 1999.
4. Nripendra N Biswas "Logic Design Theory" Prentice Hall of India,2001
5. Parag K.Lala "Digital system Design using PLD" B S Publications,2003
6. Parag K.Lala "Fault Tolerant and Fault Testable Hardware Design" B S Publications,2002
7. S. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003.

AP1103	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	2	0	4

OBJECTIVES:

- The student comprehends mathematical description and modelling of discrete time random signals.
- The student is conversant with important theorems and algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction and filtering concepts and techniques.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6

Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Auto-correlation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem–Finite Data records, Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.

UNIT II SPECTRUM ESTIMATION 9 +6

Bias and Consistency of estimators - Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation.

UNIT III SIGNAL MODELLING 9+6

Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method - Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion – Wiener filter - Discrete Wiener Hoff equations – Mean square error.

UNIT IV LINEAR ESTIMATION AND PREDICTION 9+6

Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT V ADAPTIVE FILTERS 9+6

FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter.

TOTAL: 45+30=75 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
- State Parseval’s theorem, W-K theorem, principle of orthogonality, spectral factorization theorem, Widrow-Hoff LMS algorithm and Shannon’s sampling theorem, and define linear prediction, linear estimation, sample auto-correlation, periodogram, bias and consistency.
- Explain various noise types, Yule-Walker algorithm, parametric and non-parametric methods, Wiener and Kalman filtering, LMS and RMS algorithms, Levinson Durbin algorithm, adaptive noise cancellation and adaptive echo cancellation, speed verses convergence issues, channel equalization, sampling rate change, sub band coding and wavelet transform.
- Calculate mean, variance, auto-correlation and PSD for WSS stochastic processes, and derive prediction error criterion, Wiener-Hoff equations, Parseval’s theorem, W-K theorem and normal equations.
- Design AR, MA, ARMA models, Weiner filter, anti aliasing and anti imaging filters, and develop FIR adaptive filter and polyphase filter structures.
- Simulate spectral estimation algorithms and basic models on computing platform

REFERENCES:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall of India, New Delhi, 2005.
2. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2006.
3. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.
4. S. Kay," Modern spectrum Estimation theory and application", Prentice Hall, Englehood Cliffs, NJ1988.
5. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
6. Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.

AP1104	EMBEDDED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Learn design challenges and design methodologies
- Study general and single purpose processor
- Understand bus structures

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, I^2C, 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 Datapath 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

OUTCOMES:

At the end of the course, the student should be able to:

- Explain different protocols
- Discuss state machine and design process models
- Outline embedded software development tools and RTOS

REFERENCES:

1. Bruce Powel Douglas, "Real time UML, second edition: Developing efficient objects for embedded systems", 3rd Edition 1999, Pearson Education.
2. Daniel W. Lewis, "Fundamentals of embedded software where C and assembly meet",
3. Pearson Education, 2002.
4. Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & sons, 2002.
5. Steve Heath, "Embedded System Design", Elsevier, Second Edition, 2004.

RM1101	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**2**

OBJECTIVES:

- To impart knowledge and skills required for research and IPR.
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I **RESEARCH PROBLEM FORMULATION** **6**

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

UNIT II **LITERATURE REVIEW** **6**

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

UNIT III TECHNICALWRITING /PRESENTATION 6

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

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

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

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

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

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Formulate research problem
- carry out research analysis
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
- Understand about IPR and filing patents in R & D.

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

AP1111	ELECTRONICS SYSTEM DESIGN LABORATORY I	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To study different interfaces and implementation of system using DSP Processor
- Learn to analyze asynchronous and clocked synchronous sequential circuits
- To understand the concept of built in self test and fault diagnosis
- To understand the fundamentals of IoT and to apply the concept of IoT in the real World scenario

LIST OF EXPERIMENTS:

1. System design using PIC, MSP430, ‘51 Microcontroller and 16- bit Microprocessor - 8086.

2. Study of different interfaces (using embedded microcontroller)

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. Built in self test and fault diagnosis

7. Sensor design using simulation tools

8. Design and analysis of real time signal processing system – Data acquisition and signal processing

9. Web based hardware control

10.Connect IoT devices through cloud using IoT protocol such as MQTT

11.Controlling IoT devices using Arduino

12.Create Wireless network of sensors using Zigbee

TOTAL: 60 PERIODS

OUTCOMES:

Upon Completion of the course, the students will be able to:

- Use PIC, MSP430, ‘51 Microcontroller and 8086 for system design
- Implement DSP systems using DSP processor and Simulate QMF
- Design sensor using simulation tools
- Design and analyze real time signal processing system
- Analyse various protocols of IoT and deploy an IoT application and connect to the cloud

AP1201	SOLID STATE DEVICE MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concept of device modeling
- To learn multistep method
- To study device simulations

UNIT I MOSFET DEVICE PHYSICS MOSFET 9

capacitor, Basic operation, Basic modeling, Advanced MOSFET modeling, RF modeling of MOS transistors, Equivalent circuit representation of MOS transistor, High frequency behavior of MOS transistor and A.C small signal modeling, model parameter extraction, modeling parasitic BJT, Resistors, Capacitors, Inductors.

UNIT II DEVICE MODELLING 9

Prime importance of circuit and device simulations in VLSI; Nodal, mesh, modified nodal and hybrid analysis equations. Solution of network equations: Sparse matrix techniques, solution of nonlinear networks through Newton-Raphson technique, convergence and stability.

UNIT III MULTISTEP METHODS 9

Solution of stiff systems of equations, adaptation of multistep methods to the solution of electrical networks, general purpose circuit simulators.

UNIT IV MATHEMATICAL TECHNIQUES DEVICE SIMULATIONS 9

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

UNIT V SIMULATION OF DEVICES 9

Computation of characteristics of simple devices like p-n junction, MOS capacitor and MOSFET; Small-signal analysis.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Explain the importance of MOS Capacitor and Small signal modeling
- Apply and determine the drift diffusion equation and stiff system equation.
- Analyze circuits using parasitic BJT parameters and newton Raphson method.
- Model the MOS transistor using schrodinger equation and Multistep methods.

REFERENCES:

1. Arora, N., "MOSFET Modeling for VLSI Simulation", Cadence Design Systems, 2007
2. Chua, L.O. and Lin, P.M., "Computer-Aided Analysis of Electronic Circuits: Algorithms and Computational Techniques", Prentice-Hall., 1975
3. Fjeldly, T., Yetterdal, T. and Shur, M., "Introduction to Device Modeling and Circuit Simulation", Wiley-Interscience., 1997
4. Grasser, T., "Advanced Device Modeling and Simulation", World Scientific Publishing Company., 2003
5. Selberherr, S., "Analysis and Simulation of Semiconductor Devices", Springer- Verlag.,1984
6. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, "Device Modeling for Analog and RF CMOS Circuit Design", John Wiley & Sons Ltd.

AP1202	ASIC AND FPGA DESIGN	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To study the design flow of different types of ASIC.
- To familiarize the different types of programming technologies and logic devices.
- To learn the architecture of different types of FPGA.
- To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC

UNIT I OVERVIEW OF ASIC AND PLD 9

Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs – PLA –PAL. Gate Arrays – CPLDs and FPGAs

UNIT II ASIC PHYSICAL DESIGN 9

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning - placement – Routing: global routing - detailed routing - special routing – circuit extraction - DRC

UNIT III LOGIC SYNTHESIS, SIMULATION AND TESTING 9

Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools -EDIF- CFI design representation. Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation - automatic test pattern generation

UNIT IV FIELD PROGRAMMABLE GATE ARRAYS 9

FPGA Design : FPGA Physical Design Tools -Technology mapping - Placement & routing - Register transfer (RT)/Logic Synthesis - Controller/Data path synthesis - Logic minimization.

UNIT V SOC DESIGN 9

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies: Canonical Signed Digit Arithmetic, Knowledge Crunching Machine, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- To analyze the synthesis, Simulation and testing of systems.
- To apply different high performance algorithms in ASICs.
- To discuss the design issues of SOC.

REFERENCES:

1. David A.Hodges, Analysis and Design of Digital Integrated Circuits (3/e), MGH 2004
2. H.Gerez, Algorithms for VLSI Design Automation, John Wiley, 1999
3. Jan. M. Rabaey et al, Digital Integrated Circuit Design Perspective (2/e), PHI 2003
4. M.J.S. Smith : Application Specific Integrated Circuits, Pearson, 2003
5. J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley& Sons, New york.
6. P.K.Chan & S. Mourad, Digital Design using Field Programmable Gate Array, Prentice Hall.
7. Sudeep Pasricha and NikilDutt, On-Chip Communication Architectures System on Chip Interconnect, Elsevier, 2008
8. S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Pub.
9. S.Brown,R.Francis, J.Rose, Z.Vransic, Field Programmable GateArray, Kluwer Pub. 5. Richard FJinder , “Engineering Digital Design,”Academic press

AP1203	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To review image processing techniques for computer vision
- To understand shape and region analysis
- To understand Hough Transform and its applications to detect lines, circles, ellipses
- To understand three-dimensional image analysis techniques
- To understand motion analysis
- To study some applications of computer vision algorithms

UNIT I DIGITALIMAGE FUNDAMENTALS 9

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

UNIT II IMAGE TRANSFORMS 9

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

UNIT III SEGMENTATION OFGRAYLEVEL IMAGES 9

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

UNIT IV IMAGE ENHANCEMENTAND COMPRESSION 9

Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration. Lossy and lossless compression schemes, prediction based compression schemes, sub-band encoding schemes, JPEG compression standard, Wavelet compression scheme

UNIT V STEREO IMAGING AND DEPTH ESTIMATION 9

Imaging geometry, Depth from focus, Stereo matching and depth measurements, Global and Local matching approaches - Qualitative analysis, Texture analysis, Dynamic vision and Motion analysis

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand fundamentals of digital images
- Learn different image transforms
- Study the concept of segmentation
- Learn Image enhancement techniques & compression schemes
- Study the concept of stereovision

REFERENCES:

1. A.K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, Addison-Wesley, 1989.
2. B. Jähne, "Practical Handbook on Image Processing for Scientific Applications", CRC Press,1997.
3. Bernd Jähne, Digital Image Processing, Springer-Verlag Berlin Heidelberg 2005.
4. Bovik (ed.), "Handbook of Image and Video Processing", Academic Press, 2000.
5. Gonzalez and Woods, Digital Image Processing, Prentice-Hall.
6. J. C. Russ. The Image Processing Handbook. CRC, Boca Raton, FL, 4th edn., 2002.
7. J. S. Lim, "Two-dimensional Signal and Image Processing" Prentice-Hall, 1990.
8. M. Petrou, P. Bosdogianni, "Image Processing, The Fundamentals", Wiley, 1999.
9. RudraPratap, Getting Started With MATLAB 7. Oxford University Press, 2006
10. Stephane Marchand-Maillet, Yazid M. Sharaiha, Binary Digital Image Processing, A Discrete Approach, Academic Press, 2000.
11. W. K. Pratt. Digital image processing, PIKS Inside. Wiley, New York, 3rd, edn., 2001.
12. Larry Henry Matthies, " Dynamic Stereovision " , Published by Carnegie Mellon University Schenley Park Pittsburgh, PA United States, ACM digital library
13. AsimBhatti, "Stereovision", E book , 2008

AP1211	ELECTRONICS SYSTEM DESIGN LABORATORY II	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To study of 32 bit ARM7 microcontroller RTOS and its application
- To understand testing RTOS environment and system programming
- To learn wireless network design using embedded systems
- To learn System design using ASIC
- To know use of Verilog and VHDL in sequential digital system modelling
- To learn the advanced principles of VLSI circuit design in digital and analog domain
- To provide hands on design experience with professional design (EDA) platforms

LIST OF EXPERIMENTS:

1. Study of 32 bit ARM7 microcontroller RTOS and its application
2. Testing RTOS environment and system programming
3. Designing of wireless network using embedded systems
4. Implementation of ARM with FPGA
5. Design and Implementation of ALU in FPGA using VHDL and Verilog
6. Modeling of Sequential Digital system using Verilog and VHDL
7. Flash controller programming - data flash with erase, verify and fusing
8. System design using ASIC
9. Design, simulation and analysis of signal integrity
10. Logic simulation, power analysis and timing analysis of digital systems using Xilinx Vivado IDE.
11. Design and simulation of circuit using S-Edit in Mentor graphics TANNER EDA tool
12. Schematic driven Layout (SDL) synthesis using L-Edit in Mentor graphics TANNER EDA tool.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

At the end of this course, the students will be able to:

- Design system using ARM microcontroller and ASIC/FPGA
- Explain design, simulation and analysis of signal integrity
- Design, simulate and analyse power/area/timing details of digital circuits using EDA tools
- Design, simulate and extract the layout of designed circuit using EDA tools

AP1301	IOT SYSTEM DESIGN AND SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of IoT.
- To get an idea about the various services provided by IoT.
- To familiarize themselves with various communication techniques.
- To get an idea of some application area where IoT can be applied.
- To understand the various issues in IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – Physical design of IoT – Logical design of IoT – IoT enabling technologies – IoT levels and deployment templates – A panaromic view of IoT applications.

UNIT II ARCHITECTURE OF IoT 9

Identification and Access to objects and services in the IoT environment(Current technologies for IoT naming-Solutions proposed by research projects-Research and Future development trends and forecast) – Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture Approach for IoT Systems-SOA-based IoT Middleware)Middleware architecture of RFID,WSN,SCADA,M2M–Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems-5G-based IoT Services and Applications Requirements-5G-based Challenges for IoT Middleware) - Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) – Resource management in IoT.

UNIT III SECURITY CONSIDERATIONS IN IOT SMART AMBIENT SYSTEMS 9

Security in Smart Grids and Smart Spaces for Smooth IoT Deployment in 5G (5G and the Internet of Things-Smart Spaces-Smart Grids Security and Privacy - Services that Need to Be Secure - Security Requirements -Security Attacks-Security Measures and Ongoing Research) - Security Challenges in 5G-Based IoT Middleware Systems(Security in 5G-Based IoT Middleware-Security Challenges Toward 5G).

UNIT IV IOT ENABLERS AND THEIR SECURITY AND PRIVACY ISSUES 9

Internet of Things layer wise Protocols and Standards- EPC global (architecture, specifications, industry adaptation, security and vulnerabilities , advantages and disadvantages)-Wireless HART-Zigbee-Near Field Communication-6LoWPAN-Dash7-Comparative Analysis.

UNIT V APPLICATIONS AND CASE STUDIES 9

Home automations - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style – Case study.

TOTAL: 45 PERIODS

OUTCOMES:

- Articulate the main concepts, key technologies, strength and limitations of IoT.
- Identify the architecture, infrastructure models of IoT.
- Analyze the core issues of IoT such as security, privacy and interoperability.
- Analyze and design different models for network dynamics.
- Identify and design the new models for market strategic interaction.

References

1. Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press 2012.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", VPT, 1st Edition, 2014.
3. Constandinos X. Mavromoustakis, George Mastorakis, Jordi Mongay Batalla, "Internet of Things (IoT) in 5G Mobile Technologies" Springer International Publishing, Switzerland, 2016.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of

a. Things", Springer-Verlag Berlin Heidelberg, 2011.

5. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html.

AP1121	DIGITAL CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The student learns the principles of PI,PD,PID controllers.
- The student analyses time and frequency response discrete time control system.
- The student is familiar with digital control algorithms.
- The student has the knowledge to implement PID control algorithms.

UNIT I CONTROLLERS IN FEEDBACK SYSTEMS 9

Review of frequency and time response analysis and specifications of first order and second order feedback control systems, need for controllers, continuous time compensations, continuous time PI, PD, PID controllers, digital PID controllers.

UNIT II MODELING OF SAMPLED DATA CONTROL SYSTEM 9

Sampling theorem, quantization, aliasing and quantization error, hold operation, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction.

UNIT III SEGMENTATION OFGRAYLEVEL IMAGES 9

Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems, stability of digital control systems, Jury's stability test, state space description, first companion, second companion, Jordan canonical models, discrete state variable models (elementary principles only).

UNIT IV DESIGN OF DIGITAL CONTROL ALGORITHMS 9

Review of principle of compensator design, Z-plane specifications, digital compensator design using frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in the Z-plane.

UNIT V PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS 9

Algorithm development of PID control algorithms, standard programmes for microcontroller implementation, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems, DSP implementation of motor control system.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Describe continuous time and discrete time controllers analytically.
- Define and state basic analog to digital and digital to analog conversion principles.
- Analyze sampled data control system in time and frequency domains.
- Design simple PI, PD, PID continuous and digital controllers.
- Develop schemes for practical implementation of temperature and motor control systems.

REFERENCES:

1. John J. D'Azzo, "Constantive Houpios, Linear Control System Analysis and Design", McGraw Hill,1995.
2. Kenneth J. Ayala, "The 8051 Microcontroller- Architecture, Programming and Applications", Penram International, 2nd Edition, 1996.
3. M.Gopal, "Digital Control and Static Variable Methods", Tata McGraw Hill, New Delhi, 1997

AP1122	SENSORS, ACTUATORS AND INTERFACE ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand static and dynamic characteristics of measurement systems.
- Study various types of sensors.
- Study different types of actuators and their usage.
- Study State-of-the-art digital and semiconductor sensors.

UNIT I INTRODUCTION TO MEASUREMENT SYSTEMS 9

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

UNIT II RESISTIVE AND REACTIVE SENSORS 9

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

UNIT III SELF-GENERATING SENSORS 9

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

UNIT IV ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS 9

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

UNIT V **DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS** **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Compare Actuators
- Evaluate digital sensors and semiconductor device sensors
- Discuss Self-generating sensors

REFERENCES:

1. Andrzej M. Pawlak Sensors and Actuators in Mechatronics Design and Applications, 2006.
2. D. Johnson, “Process Control Instrumentation Technology”, John Wiley and Sons.
3. D.Patranabis, “Sensors and Transducers”, TMH 2003.
4. E.O. Doeblin, “Measurement System : Applications and Design”, McGraw Hill publications
5. Graham Brooker, Introduction to Sensors for ranging and imaging, Yesdee, 2009.
6. Herman K.P. Neubrat, “Instrument Transducers – An Introduction to Their Performance and Design”, Oxford University Press. 22.
7. Ian Sinclair, Sensors and Transducers, Elsevier, 3rd Edition, 2011.
8. Jon Wilson , “Sensor Technology Handbook”, Newne 2004.
9. Kevin James, PC Interfacing and Data acquisition, Elsevier, 2011.
10. Ramon PallásAreny, John G. Webster, “Sensors and Signal Conditioning”, 2nd edition, John Wiley and Sons, 2000.
11. Sensors and Actuators: Control System Instrumentation, Clarence W. de Silva CRC Press, 2007.

AP1123	CAD FOR VLSI CIRCUITS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study various physical design methods in VLSI.
- To understand the concepts behind the VLSI design rules and routing techniques.
- To understand the concepts of various algorithms used for floor planning and routing techniques.

UNIT I INTRODUCTION TO VLSI DESIGN FLOW 9

Introduction to VLSI Design methodologies, Basics of VLSI design automation tools, Algorithmic Graph Theory and Computational Complexity, Tractable and Intractable problems, General purpose methods for combinatorial optimization.

UNIT II LAYOUT, PLACEMENT AND PARTITIONING 9

Layout Compaction, Design rules, Problem formulation, Algorithms for constraint graph compaction, Placement and partitioning, Circuit representation, Placement algorithms, Partitioning

UNIT III FLOOR PLANNING AND ROUTING 9

Floor planning concepts, Shape functions and floorplan sizing, Types of local routing problems, Area routing, Channel routing, Global routing, Algorithms for global routing.

UNIT IV SIMULATION AND LOGIC SYNTHESIS 9

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

UNIT V HIGH LEVEL SYNTHESIS 9

Hardware models for high level synthesis, internal representation, allocation, assignment and scheduling, scheduling algorithms, Assignment problem, High level transformations

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- To use the simulation techniques at various levels in VLSI design flow
- Discuss the concepts of floor planning and routing
- Outline high level synthesis

REFERENCES:

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
2. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.
3. Sadiq M. Sait, Habib Youssef, “VLSI Physical Design automation: Theory and Practice”, World scientific 1999.
4. Steven M.Rubin, “Computer Aids for VLSI Design”, Addison Wesley Publishing 1987.

AP1124	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The basics of EMI
- EMI sources.
- EMI problems.
- Solution methods in PCB.
- Measurements techniques for emission.
- Measurement techniques for immunity.

UNIT I BASIC THEORY 9

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

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, Gasketting 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, ACEC. 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

OUTCOMES:

At the end of the course, the student should be able to:

- Identify Standards
- Compare EMI test methods
- Discuss EMI mitigation techniques

REFERENCES:

1. Bemhard Keiser, "Principles of Electromagnetic Compatibility", 3rd Ed, Artech house, Norwood, 1986.
2. Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2006.
3. Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002
4. Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005.
5. Electromagnetic Compatibility by Norman Violette, Published by Springer, 2013
6. Electromagnetic Interference and Compatibility: Electrical noise and EMI specifications Volume 1of A Handbook Series on Electromagnetic Interference and Compatibility, Donald R. J. White Publisher-Don white consultants Original from the University of Michigan Digitized 6Dec 2007
7. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, New york, 2009
8. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, New york, 2001.
9. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., (Wiley Interscience Series) 1997

AP1221	VLSI DESIGN TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course deals comprehensively with all aspects of transistor level design of all the digital building blocks common to all CMOS microprocessors, DPSs, network processors, digital backend of all wireless systems etc.
- The focus will be on the transistor level design and will address all important issues related to size, speed and power consumption. The units are classified according to the important building and will introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures.

UNIT I **MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER** **9**

MOS (FET) Transistor Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, Process Variations, Technology Scaling, Internet Parameter and electrical wise models CMOS Inverter - Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters.

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

Propagation Delays, Stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation, Low Power Design principles.

UNIT III **SEQUENTIAL LOGIC CIRCUITS** **9**

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Speed and

Area Tradeoffs, Memory Architectures, and Memory control circuits.

UNIT IV **ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES** **9**

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Speed and Area Tradeoffs, Memory Architectures, and Memory control circuits.

UNIT V **INTERCONNECT AND CLOCKING STRATEGIES** **9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.

TOTAL: 45 PERIODS

OUTCOMES:

- **At the end of the course, the student should be able to:**
- Carry out transistor level design of the most important building blocks used in digital CMOS VLSI circuits.
- Discuss design methodology of arithmetic building block
- Analyze tradeoffs of the various circuit choices for each of the building block.

REFERENCES:

1. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation, Third Edition", Wiley IEEE Press 2010.
2. Jan Rabaey, AnanthaChandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective". Prentice Hall of India 2nd Edition, Feb 2003,
3. M J Smith, "Application Specific Integrated Circuits", Addison Wesley, 1997
4. N.Weste, K. Eshraghian, " Principles of CMOS VLSI Design". Addison Wesley, 2nd Edition, 1993

AP1222	RF SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The CMOS RF Front End (RFE) is a very crucial building block and in all of wireless and many high frequency wire-line systems. The RFE has few important building blocks within ii including the Low Noise Amplifiers, Phase Locked Loop Synthesizers, Mixers, Power Amplifiers, and impedance matching circuits.
- The present course will introduce the principles of operation and design principles associated with these important blocks.
- The course will also provide and highlight the appropriate digital communication related design objectives and constraints associated with the RFEs

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 upconversion Transmitter, Two step upconversion Transmitter.

UNIT II IMPEDANCE MATCHING AND AMPLIFIERS 9

S-parameters with Smith chart, Passive IC components, Impedance matching networks, Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Power match and Noise match, Single ended and Differential LNAs, Terminated with Resistors and Source Degeneration LNAs.

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation, General model – Class A, AB, B, C, D, E and F amplifiers, Power amplifier Linearisation Techniques, Efficiency boosting techniques, ACPR metric, Design considerations.

UNIT IV 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.

UNIT V PLL AND FREQUENCY SYNTHESIZERS 9

Linearised Model, Noise properties, Phase detectors, Loop filters and Charge pumps, Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- The student after completing this course must be able to translate the top level wireless communications system specifications into block level specifications of the RFE.
- The student should be also able to carry out transistor level design of the entire RFE.

REFERENCES:

1. B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001
2. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
3. Jan Crols, MichielSteyaert, "CMOS Wireless Transceiver Design", Kluwer Academic

a. Publishers, 1997.

4. Recorded lectures and notes available at . http://www.ee.iitm.ac.in/~ani/ee6240/
5. T.Lee, "Design of CMOS RF Integrated Circuits", Cambridge, 2004.

AP1223	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

UNIT II ROUTING IN AD HOC NETWORKS 9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORK 9

Introduction – Architecture - Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues - Routing Protocols – Mobile Nodes and Mobile Robots - Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

UNIT IV SENSOR MANAGEMENT 9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time synchronization - Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS 9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Identify different issues in wireless ad hoc and sensor networks.
- To analyze protocols developed for ad hoc and sensor networks.
- To identify and address the security threats in ad hoc and sensor networks.
- Establish a Sensor network environment for different type of applications**.**

REFERENCES:

1. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2. Carlos De MoraisCordeiro, Dharma Prakash Agrawal “Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011

3. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.

4. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.

5. ErdalÇayırcı , ChunmingRong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.

6. Holger Karl, Andreas willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Inc .2005.

7. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks”, Auerbach Publications, 2008.

8. WaltenegusDargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.

AP1224	HIGH PERFORMANCE NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop a comprehensive understanding of multimedia networking.
- To study the types of VPN and tunneling protocols for security.
- To learn about network security in many layers and network management.

UNIT I INTRODUCTION 9

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET – DWDM – DSL – ISDN – BISDN,ATM.

UNIT II MULTIMEDIA NETWORKING APPLICATIONS 9

Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

UNIT III ADVANCED NETWORKS CONCEPTS 9

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS- operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks P2P connections.

UNIT IV TRAFFIC MODELLING 9

Little's theorem, Need for modeling, Poisson modeling and its failure, Non-poisson models, Network performance evaluation.

UNIT V NETWORK SECURITY AND MANAGEMENT 9

Principles of cryptography – Authentication – integrity – key distribution and certification – Access control and: fire walls – attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Discuss advanced networks concepts
- Outline traffic modeling
- Evaluate network security

REFERENCES:

1. Aunurag Kumar, D. M Anjunath, Joy Kuri, "Communication Networking", Morgan Kaufmann Publishers, 1st edition 2004.
2. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet", fifth edition, Pearson education 2006
3. HersentGurle& Petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education 2003
4. J.F. Kurose & K.W. Ross,"Computer Networking- A top down approach featuring the internet", Pearson, 2nd edition, 2003
5. Larry l.Peterson& Bruce S.David, "Computer Networks: A System Approach"- 1996
6. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2002.
7. Nader F.Mir ,Computer and Communication Networks, first edition 2010
8. Walrand .J. Varatya, High performance communication network, Morgan Kauffman – Harcourt Asia Pvt. Ltd. 2nd Edition, 2000

AP1225	DSP ARCHITECTURES ANDPROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objective of this course is to provide in-depth knowledge on

- Digital Signal Processor basics
- Third generation DSP Architecture and programming skills
- Advanced DSP architectures and some applications.

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II SPECIAL FUNCTIONS 9

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III LINEAR PROGRAMMING 9

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

UNIT IV ALGEBRAIC EQUATIONS 9

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation

UNIT V ORDINARY DIFFERENTIAL EQUATIONS 9

Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Become Digital Signal Processor specialized engineer
- DSP based System Developer

REFERENCES:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012
2. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
3. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005
4. User guides Texas Instrumentation, Analog Devices, Motorola**.**

AP1226	HARDWARE – SOFTWARE CO-DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire 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 SYSTEM SPECIFICATION AND MODELLING 9

Embedded Systems, Hardware/Software Co-Design, Co-Design for System Specification and Modeling , Co-Design for Heterogeneous Implementation - Single-Processor Architectures with one ASIC and many ASICs, Multi-Processor Architectures, Comparison of Co- Design Approaches, Models of Computation, Requirements for Embedded System Specification.

UNIT II HARDWARE / SOFTWARE PARTITIONING 9

The Hardware/Software Partitioning Problem, Hardware-Software Cost Estimation, Generation of the Partitioning Graph, Formulation of the HW/SW Partitioning Problem, Optimization ,

HW/SW Partitioning based on Heuristic Scheduling, HW/SW Partitioning based on Genetic Algorithms .

UNIT III HARDWARE / SOFTWARE CO-SYNTHESIS 9

The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Co-Synthesis Algorithm for Distributed System- Case Studies with any one application.

UNIT IV PROTOTYPING AND EMULATION 9

Introduction, Prototyping and Emulation Techniques , Prototyping and Emulation Environments, Future Developments in Emulation and Prototyping ,Target Architecture- Architecture Specialization Techniques ,System Communication Infrastructure, Target Architectures and Application System Classes, Architectures for Control-Dominated Systems, Architectures for Data-Dominated Systems, Mixed Systems and Less Specialized Systems

UNIT V DESIGN SPECIFICATION AND VERIFICATION 9

Concurrency, Coordinating Concurrent Computations, Interfacing Components, Verification, Languages for System-Level Specification and Design System-Level Specification, Design Representation for System Level Synthesis, System Level Specification Languages, Heterogeneous Specification and Multi-Language Co- simulation.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- To assess prototyping and emulation techniques
- To compare hardware / software co-synthesis.
- To formulate the design specification and validate its functionality by simulation

REFERENCES:

1. Giovanni De Micheli , Rolf Ernst Morgon," Reading in Hardware/Software Co-Design "Kaufmann Publishers,2001.
2. Jorgen Staunstrup, Wayne Wolf ,"Hardware/Software Co-Design: Principles and Practice" , Kluwer Academic Pub,1997.
3. Ralf Niemann , "Hardware/Software Co-Design for Data Flow Dominated Embedded Systems", Kluwer Academic Pub, 1998.

AP1227	SPEECH AND AUDIO SIGNALPROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study basic concepts of processing speech and audio signals
- To study and analyse various M-band filter-banks for audio coding
- To understand audio coding based on transform coders.
- To study time and frequency domain speech processing methods

UNIT I MECHANICS OF SPEECH AND AUDIO 9

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non-simultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS 9

Introduction - Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters - Tree-Structured QMF and CQF M-band Banks - Cosine Modulated “Pseudo QMF” M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Pre-echo Control Strategies

UNIT III AUDIO CODING AND TRANSFORM CODERS 9

Lossless Audio Coding – Lossy Audio Coding - ISO-MPEG-1A, 2A, 2A-Advaned, 4A Audio Coding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder –Brandenburg - Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding –Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

UNIT IV TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING 9

Time domain parameters of Speech signal – Methods for extracting the parameters :Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods Homomorphic Speech Analysis: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders

UNIT V PREDICTIVE ANALYSIS OF SPEECH 9

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method– Covariance method – Solution of LPC equations – Cholesky method – Durbin‟s Recursive algorithm– lattice formation and solutions – Comparison of different methods – Application of LPC parameters– Pitch detection using LPC parameters – Formant analysis – VELP – CELP

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Evaluate audio coding and transform coders
- Discuss time and frequency domain methods for speech processing
- Explain predictive analysis of speech

REFERENCES:

1. B.Gold and N.Morgan, “Speech and Audio Signal Processing”, Wiley and Sons, 2000.
2. L.R.Rabiner and R.W.Schaffer, "Digital Processing of Speech Signals", Prentice Hall, 1978.
3. Mark Kahrs, Karlheinz Brandenburg, Kluwer Applications of Digital Signal Processing to Audio And Acoustics, Academic Publishers,
4. UdoZölzer, "Digital Audio Signal Processing", Second Edition A John Wiley& sons Ltd

AP1228	ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the techniques of computational methods inspired by nature, such as neural networks, genetic algorithms and other evolutionary computation systems, ant swarm optimization and artificial immune systems.
- To present main rules underlying in these techniques.
- To present selected case-studies.
- To adopt these techniques in solving problems in the real world.

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 hyperplane for linearly separable patterns, optimal hyperplane 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 & 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

OUTCOMES:

At the end of the course, the student should be able to:

- Design and train neural networks with different rules
- Devise fuzzy logic rules
- Implement genetic algorithms
- Implement ANT colony optimization technique for various problems
- Use PSO technique

REFERENCES:

1. Wolfgang Ertel, “Introduction to Artificial Intelligence”, Springer, 2nd Edition, 2017
2. NelloCristianini, John Shawe-Taylor, "An Introduction to Support Vector Machines and Other Kernel-based Learning Methods”, Cambridge University Press. 2013
3. Christopher M. Bishop, “Neural Networks for Pattern Recognition”, Oxford UniversityPress,1995
4. H.-J. Zimmermann, “Fuzzy Set Theory and its Applications”, Springer Science+Business Media New York, 4th edition, 2001
5. David E. Goldberg, “Genetic Algorithms in search, Optimization & Machine Learning”,
6. Kenneth A DeJong,“Evolutionary Computation A Unified Approach”, Prentice Hall of India, New Delhi, 2006.
7. Marco Dorigo and Thomas Stutzle, “Ant Colony optimization”, Prentice Hall of India, NewDelhi, 2004.
8. N P Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2005.
9. Engelbrecht, A.P., “Fundamentals of Computational Swarm Intelligence”, Wiley, 2005.

AP1321	NON LINEAR SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce statistical characteristics required for understanding nonlinear filters
- To introduce different types of nonlinear filters for image processing applications
- To teach adaptive filtering concepts and use of neural network nonlinear filtering
- To introduce varieties of sorting algorithms and architectures
- To understand the application of nonlinear filters in image processing

UNIT I INTRODUCTION TO NONLINEAR FILTERS AND STATISTICAL PRELIMINARIES 9

Nonlinear filters – measure of robustness – M estimators – L estimators – R estimators – order statistics – median filter and their characteristics – impulsive noise filtering by median filters – Recursive and weighted median filters – stock filters.

UNIT II NON LINEAR DIGITAL SIGNAL PROCESSING BASED ON ORDER STATISTICS 9

Time ordered nonlinear filters – rank ordered nonlinear filters – max/median filtering – median hybrid filters – characteristics of ranked order filters – L filters – M filters – R filters – comparison.

UNIT III ADAPTIVE NONLINEAR AND POLYNOMIAL FILTERS 9

Definition of polynomial filters – Wiener filters – robust estimation of scale – Adaptive filter based on local statistics – Decision directed filters – Adaptive L filters – Comparison of adaptive nonlinear filters – Neural networks for nonlinear filter.

UNIT IV ALGORITHMS AND ARCHITECTURES 9

Sorting and selection algorithm – running median algorithm – fast structures for median and order statistics filtering – systolic array implementation – Wave front array implementation – quadratic digital filters implementation.

UNIT V APPLICATIONS OF NONLINEAR FILTERS 9

Power spectrum analysis – Morphological image processing – nonlinear edge detection impulse noise rejection in image and bio signals – two component image filtering – speech processing.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Evaluate the characteristics of non linear filters
- Design and implement rank order filters
- Develop polynomial filters
- Design architectures for nonlinear filters
- Implement nonlinear filters for different types of signals

REFERENCES:

1. Ioannis Pitas, Anastarios. N.Venetsanopoulos, "Nonlinear Digital filters – Principles and Applications", Kluwer Academic Publishers, 1989.
2. Jaakko Astola, P Kuosmanen, "Fundamentals of Nonlinear Digital Filtering", CRC Press LLC 1997
3. Gonzalo R. Arce, "Nonlinear Signal Processing – A Statistical Approach", Wiley Publishers, 2005
4. Wing Kuen Ling, "Nonlinear Digital Filters: Analysis and Applications", Elsevier Science & Tech. 2007.

AP1322	PATTERN RECOGNITION AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the fundamentals of pattern recognition techniques
- To understand various clustering techniques
- To introduce sequential pattern recognition methods
- To introduce the concepts of support vector machines
- To introduce the fundamentals of neural network

UNIT I PATTERN CLASSIFICATION 9

Overview of pattern recognition, Supervised learning. Bayes decision theory, Minimum-error-rate classification, Classifiers, Discriminant functions, and Decision surfaces. Normal density(univariate and multivariate) and discriminant functions for the normal density. Discrete features. Parameter estimation methods: Maximum likelihood estimation, Maximum a posteriori estimation. Bayesian estimation: Gaussian case. Pattern classification by distance functions - minimum distance classifier

UNIT II CLUSTERING 9

Unsupervised learning and clustering - criterion functions for clustering. Algorithms for clustering - k-means and hierarchical clustering, Cluster validation. Expectation-maximization algorithm. Gaussian mixture models, model selection for latent variable models, high dimensional spaces, the curse of dimensionality, dimensionality reduction, factor analysis, Principal component analysis, probabilistic PCA, Independent component analysis

UNIT III PROBABILISTIC GRAPHICAL MODELS 9

Directed graphical models - Bayesian network. From distributions to graphs - examples-Markov Random fields-inference in graphical models - Markov model - Hidden Markov Models(HMMs) - building a hidden Markov model for multi-class pattern recognition, issues.

UNIT IV SUPPORT VECTOR MACHINES 9

Constrained optimization problems - linearly separable and non-separable patterns, hyperplane and margin - discriminant function of a hyperplane, maximum margin hyperplane. Kernel functions - vector kernels - linear, polynomial and Gaussian kernels, non-vector kernels. Building a support-vector machine for multi-class pattern recognition - architecture, choice of kernels, issues.

UNIT V ARTIFICIAL NEURAL NETWORKS 9

Models of a neuron - feed-forward neural networks - Perceptron learning, Multi-layer feedforward neural network, Gradient descent, back propagation algorithm - network pruning, limitations and convergence of back-propagation learning. Cover's theorem on the separability of patterns, Generalized radial-basis function networks, Auto encoder networks - autoassociation neural network - convolutional neural network

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Classify the data and identify the patterns

- Apply dimensionality reduction techniques
- Choose an appropriate pattern recognition system for the given data
- Solve linearly non-separable pattern recognition problems using SVMs
- Apply neural networks for suitable pattern recognition problems

REFERENCES:

1. Duda R.O, Hart P.E. and Stork D.G, Pattern Classification, John Wiley, Second Edition,2001
2. Bishop C.M, Pattern Recognition and Machine Learning, Springer, First Edition,2006
3. Theodoridis S and Koutroumbas K, Pattern Recognition, Academic Press, FourthEdition, 2009
4. Simon Haykin, Neural networks - a comprehensive foundation, Pearson Education,Second Edition, 2008
5. Goodfellow Y. Bengio and A. Courville, Deep Learning, MIT Press, First Edition, 2016

AP1323	SIGNAL PROCESSING FOR VLSI	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce pipelining and parallel processing techniques for the design of digital filters (FIR and IIR)
- To introduce algorithmic strength reduction techniques over the architectural realization of basic signal processing modules
- To explore on the bit level arithmetic architectures with the understanding of scaling and round off noise concepts
- To introduce numerical strength reduction techniques, synchronous and wave pipelining approaches

UNIT I PIPELINING AND PARALLEL PROCESSING OF DIGITAL FILTER 9

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs –critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power

UNIT II **ALGORITHMIC STRENGTH REDUCTION TECHNIQUE- I** **9**

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters

UNIT III **ALGORITHMIC STRENGTH REDUCTION TECHNIQUE- II** **9**

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power-of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters

UNIT IV **BIT-LEVEL ARITHMETIC ARCHITECTURES** **9**

Scaling and round off noise- scaling operation, round off noise, state variable description of digital filters, scaling and round off noise computation, round off noise in pipelined first-order filters; Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters

UNIT V **REDUNDANT ARITHMETIC AND NUMERICAL STRENGTH REDUCTION, WAVE AND ASYNCHRONOUS PIPELINING** **9**

Redundant arithmetic – Radix 2 addition and multiplication - Numerical strength reduction – subexpression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand the design of FIR filters with pipelining and parallel processing techniques
- Use various optimization techniques for the improved realization of FIR based DSP structures
- Use of different optimization techniques for the improved realization of IIR based DSP structures
- Design optimized bit level arithmetic structures
- Comprehend various numerical strength reduction techniques and clocking strategies ofDSP architectures

REFERENCES:

1. Keshab K, Parhi, VLSI Digital Signal Processing Systems, Design and implementation, Wiley Interscience, 2007
2. Meyer U – Baese, Digital Signal Processing with Field Programmable Gate Arrays, Springer, Second Edition, 2004
3. Kung S.Y, White House H.J, Kailath T., VLSI and Modern Signal Processing, Prentice Hall, 1985
4. Jose E. France, Yannis T sividis, Design of Analog & Digital VLSI Circuits for Telecommunication and Signal Processing, Prentice Hall, 1994
5. Chandrasetty, Vikram Arkalgud , VLSI Design: A Practical Guide for FPGA and ASIC Implementations, Springer, 2011, ISBN 978-1-4614-1120-8
6. Bayoumi, Magdy, VLSI Design Methodologies for Digital Signal Processing Architectures, The Springer International Series in Engineering and Computer Science,2005

AP1324	NANO ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand how transistor as Nano device
- To understand various forms of Nano Devices
- To understand the Nano Sensors

UNIT I **SEMICONDUCTOR NANO DEVICES** **9**

Single-Electron Devices; Nano scale MOSFET – Resonant Tunneling Transistor - Single-Electron Transistors; Nanorobotics and Nanomanipulation; Mechanical Molecular Nanodevices; Nanocomputers: Optical Fibers for Nanodevices; Photochemical Molecular Devices; DNA-Based Nanodevices; Gas-Based Nanodevices.

UNIT II **ELECTRONIC AND PHOTONIC MOLECULAR MATERIALS** **9**

Preparation – Electroluminescent Organic materials - Laser Diodes - Quantum well lasers:- Quantum cascade lasers- Cascade surface-emitting photonic crystal laser- Quantum dot lasers - Quantum wire lasers:- White LEDs - LEDs based on nanowires - LEDs based on nanotubes - LEDs based on nanorods - High Efficiency Materials for OLEDs- High Efficiency Materials for OLEDs - Quantum well infrared photo detectors.

UNIT III **THERMAL SENSORS** **9**

Thermal energy sensors -temperature sensors, heat sensors - Electromagnetic sensors - electrical resistance sensors, electrical current sensors, electrical voltage sensors, electrical power sensors, magnetism sensors - Mechanical sensors - pressure sensors, gas and liquid flow sensors, position sensors - Chemical sensors - Optical and radiation sensors.

UNIT IV **GAS SENSOR MATERIALS** **9**

Criteria for the choice of materials - Experimental aspects – materials, properties, measurement of gas sensing property, sensitivity; Discussion of sensors for various gases, Gas sensors based on semiconductor devices.

UNIT V **BIOSENSORS** **9**

Principles - DNA based biosensors – Protein based biosensors – materials for biosensor applications - fabrication of biosensors - future potential.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand the fundamentals of RF IC design
- Design circuit level design of building blocks of RF transceivers using CMOS technology
- Analyze various performance parameters of RF transceivers

REFERENCES:

1. Razavi B, RF Microelectronics, Pearson Education, Second Edition, 2012
2. Thomas H.Lee, The Design of CMOS Radio –Frequency Integrated Circuits, Cambridge University Press, Second Edition, 2004
3. Bosco H Leung VLSI for Wireless Communication, Pearson Education, Second Edition,2011
4. Behzad Razavi, Design of CMOS Analog Integrated Circuits, McGraw Hill Publications, Second Edition, 2017
5. Hooman Darabi, Radio Frequency Integrated Circuits and Systems, Cambridge University Press, First Edition, 2015

AP1325	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES 9

Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stack ups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and strip line Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion

UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk (strip line and microstrip) Differential signaling, termination, balanced circuits ,S-parameters, Lossy and Lossles models.

UNIT III NON-IDEAL EFFECTS 9

Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic, SPICE, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Identify sources affecting the speed of digital circuits.
- Improve the signal transmission characteristics.

REFERENCES:

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR, 2003
2. Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.
3. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic,Prentice Hall, 1993.
4. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2000

AP1326	MEMS AND NEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of microelectromechanical devices.
- To know the fabrication process of Microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of quantum mechanics and nano systems.

UNIT I OVERVIEW **9**

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS, MEMS and NEMS – Applications, Devices and structures. Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT II MEMS FABRICATION TECHNOLOGIES **9**

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.

UNIT III MICRO SENSORS **9**

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor.

UNIT IV MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS 9

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Discuss micro sensors
- Explain micro actuators
- Outline nanosystems and Quantum mechanics

REFERENCES:

1. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006.
2. Marc Madou, “Fundamentals of Microfabrication”, CRC press 1997
3. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers,2001
4. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.
5. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture” ,Tata McGraw Hill, 2002

		L	T	P	C
AP1327	**SECURE COMPUTING SYSTEMS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To learn computer hardware, system software and data concepts from a security
- Perspective

UNIT I COMPUTER SECURITY AND MANAGEMENT 9

Overview of Computer Security, Threats, Malware, Vulnerabilities, Authentication, Access Control, Security Management Models, Security Management Practices, Protection Mechanisms, Legal aspects of security, Ethical Hacking.

UNIT II HARDWARE SECURITY 9

Need for Hardware Security, Computer Memory and storage, Bus and Interconnection, I/O and Network Interface, CPU; Side channel Analysis: Power Analysis Attack, Timing Attack, Fault attack. Countermeasures of Side Channel Attack, Secure Hardware Intellectual Properties, Physically Unclonable Functions (PUFs), Secure PUF.

UNIT III ASSEMBLY AND OPERATING SYSTEMS SECURITY 9

Opcode, Operands, Addressing Modes, Stack and Buffer Overflow, FIFO and M/M/1Problem, Kernel, Drivers and OS Security; Secure Design Principles, Trusted Operating Systems, Trusted System Functions

UNIT IV ADVANCED COMPUTER ARCHITECTURE 9

Security aspects : Multiprocessors, parallel processing, Ubiquitous computing, Grid, Distributed and cloud computing, Internet computing, Virtualization

UNIT V NETWORK AND WEBSECURITY 9

TCP/IP Protocol, Network switches, Routers, Gateways, Wireless Networks and Network Address Translation (NAT); Network Security Issues in TCP/IP, Threat Models, Denial of service Attacks, Firewalls, Intrusion Detection, Browser Attacks, Web Attacks Targeting Users, Email Attacks, Secure Shell (SSH), HTTPS

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Aware of Security aspects
- Appreciate security in hardware, OS and it future need
- Learn security issues in various types of computing networks

REFERENCES:

1. Charles B. Pfleeger, Shari Lawrence Pfleeger, “Security in Computing”, Fourth Edition, Pearson Education, 2007
2. Debdeep Mukhopadhyay, Rajat Subhra Chakraborty, “Hardware Security – Design Threats and Safeguards”, CRC Press, 2015
3. Michael Whitman, Herbert J. Mattord, “Management of Information Security”, Third Edition, Course Technology, 2010
4. Shuangbao Wang, Robert S.Ledley, Computer Architecture and Security, Wiley,2013
5. William Stallings, “Network Security Essentials, Applications and Standards”, Dorling Kindersley I P Ltd, Delhi, 2008.

AP1328	ADVANCED MICROPROCESSORS AND MICROCONTROLLERS ARCHITECTURES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize about the features, specification and features of modern microprocessors.
- To gain knowledge about the architecture of Intel 32 and 64 bit microprocessors and salient features associated with them.
- To familiarize about the features, specification and features of modern microcontrollers.
- To gain knowledge about the 32 bit microcontrollers based on ARM and PIC32 architectures

UNIT I FEATURES OF MODERN MICROPROCESSORS 9

Evolution of microprocessors - Data and Address buses – clock speed – memory interface - multi-core architectures – cache memory hierarchy – operating modes – super scaler execution – dynamic execution – over clocking – integrated graphics processing - performance benchmarks.

UNIT II HIGH PERFORMANCE CISC ARCHITECTURES 9

Introduction to IA 32 bit architecture – Intel Pentium Processors family tree – Memory Management – Branch prediction logic - Superscalar architecture – Hyper threading technology – 64 bit extension technology – Intel 64 bit architecture - Intel Core processor family tree – Turbo boost technology – Smart cache - features of Nehalem microarchitecture

UNIT III HIGH PERFORMANCE RISC ARCHITECTURE - ARM 9

RISC architecture merits and demerits – The programmer's model of ARM Architecture – 3-stage pipeline ARM organization - 3-stage pipeline ARM organization – ARM instruction execution – Salient features of ARM instruction set - ARM architecture profiles (A, R and M profiles)

UNIT IV FEATURES OF MODERN MICROPROCESSORS 9

Introduction to microcontrollers – microcontroller vs microprocessors – microcontroller architecture - Processor Core – Memory interfaces– Communication interfaces (SPI,I^2C, USB and CAN) – ADC - PWM – Watchdog timers – Interrupts – Debugging interfaces

UNIT V HIGH PERFORMANCE MICROCONTROLLER ARCHITECTURES 9

Introduction to the Cortex-M Processor Family - ARM 'Cortex-M3' architecture for microcontrollers – Thumb 2 instruction technology – Internal Registers - Nested Vectored Interrupt controller - Memory map - Interrupts and exception handling – Applications of Cotex-M3 architecture

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- To explain the features and important specifications of modern microprocessors
- To explain the salient features CISC microprocessors based on IA-32 bit and IA-64 bit architectures
- To explain the salient features RISC processors based on ARM architecture and different application profiles of ARM core
- To explain the features and important specifications of modern microcontrollers
- To explain about ARM – M3 architecture and its salient features

REFERENCES:

1. Barry. B. Breg," The Intel Microprocessors" , PHI,2008.
2. Gene .H.Miller ." Micro Computer Engineering ," Pearson Education , 2003.
3. Intel Inc, "Intel 64 and IA-32 Architectures Developer's Manual", Volume-I, 2016
4. Joseph Yiu, "The Definitive Guide to the ARM ® Cortex-M3", Newnes, 2010.
5. Scott Mueller, "Upgrading and Repairing PCs", 20th edition, Que.
6. Steve Furber, "ARM System –On –Chip architecture "Addison Wesley , 2000.
7. Trevor Martin, "The Designer's Guide to theCortex-M Processor Family", Newnes, 2013

		L	T	P	C
OCP101	**BUSINESS DATA ANALYTICS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of

MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable
- Statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce Use open source frameworks for modeling and storing data and
- Apply suitable visualization technique using R for visualizing voluminous data

REFERENCES:

1. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, "Business Analytics Using R – A Practical Approach", A press, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R.
5. Anderson, "Essentials of Business Analytics", Cengage Learning, second Edition, 2016.
6. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley, 2017.
7. A. Ohri, "R for Business Analytics", Springer, 2012

OMF101	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

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

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

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

UNIT IV FAULT TRACING 9

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

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Ability to summarize basics of industrial safety
- Ability to describe fundamentals of maintenance engineering
- Ability to explain wear and corrosion
- Ability to illustrate fault tracing
- Ability to identify preventive and periodic maintenance

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008.

OPE101	RENEWABLE SOURCES OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the energy scenario and various energy sources.
- To learn the solar photovoltaic and solar thermal systems.
- To impart knowledge on wind energy and bio-mass energy conversion systems.
- To provide knowledge about the Geothermal and Ocean energy conversion system.
- To design and implement hybrid energy conversion system.

UNIT I Introduction **9**

Renewable energy sources and its energy scenario - global and Indian; Environmental aspects and impacts of renewable energy generation on environment; Types of Renewable energy sources: solar - wind - Biomass - Ocean - Tidal - Geothermal and Fuel cell.

UNIT II Solar Energy Systems **9**

Solar radiation at the earth's surface - solar radiation measurements - estimation of average solar radiation - Introduction to Solar photo-voltaic (PV) system and Solar - thermal system; Equivalent circuit of a solar cell, solar array and its sizing. Solar thermal collectors: flat plate collectors - concentrating collectors; solar thermal applications - heating, cooling, desalination, drying, cooking - solar thermal electric power plant.

UNIT III Wind energy and Bio-Mass Energy **9**

Wind Sources: horizontal and vertical axis wind turbine - performance characteristics - types of wind turbine generators - Betz criteria; Bio-mass: Principles of Bio-Conversion - Anaerobic/aerobic digestion - types of Bio-gas digesters - gas yield - combustion characteristics of bio-gas - utilization for cooking.

UNIT IV Geothermal and Ocean Energy **9**

Geothermal: Resources - types of wells - methods of harnessing the energy. Ocean Energy: OTEC- Principles, utilization - setting of OTEC plants - thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques - mini-hydro power plants and their economics.

UNIT V Hybrid Renewable Energy Systems **9**

Need for Hybrid Systems - Types of Hybrid systems - Case studies of solar and Wind.

`TOTAL : 45 PERIODS

TEXT BOOKS

1. S. P. Sukhatme, Solar Energy Principle of Thermal Collection and Storage", Tata McGraw Hill, 1990.
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 2011.

REFERENCE BOOKS

1. G. L. Johnson, Wind energy systems, Prentice Hall Inc. New Jersey.

2. J. M. Kriender, Principles of Solar Engineering", McGraw Hill, 1987.

3. Twidell&Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011

4. V. S. Mangal, Solar Engineering", Tata McGraw Hill, 1992.

5. N. K. Bansal, Renewable Energy Source and Conversion Technology", Tata McGraw Hill, 1989.

6. P. J. Lunde, Solar Thermal Engineering", John Willey & Sons, New York, 1988.

7. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes", Wiley & Sons, 1990.

OUTCOMES

At the end of the course, the student should be able to:

- Understand the energy scenario and the various sources of non-conventional energy sources.
- Learn the physics of solar energy and to understand the solar photovoltaic, solar-thermal energy conversion system.
- Acquire knowledge in wind and bio-mass energy conversion system.
- Acquire knowledge in Geothermal and Ocean energy conversion system.
- Design and implement hybrid energy systems.

OMB103	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand the costing concepts and their role in decision making
- Understand the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Gain knowledge of costing techniques in service sector and various budgetary control techniques
- Become familiar with quantitative techniques in cost management

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991

2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011

4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

		L	T	P	C
OME102	**COMPOSITE MATERIALS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I **REINFORCEMENTS** **9**

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II **ADVANCES IN LINEAR PROGRAMMING9** **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III **MANUFACTURING OF METAL MATRIX COMPOSITES** **9**

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV **MANUFACTURING OF POLYMER MATRIX COMPOSITES** **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties

and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Know the characteristics of composite materials and effect of reinforcement in composite materials.
- Know the various reinforcements used in composite materials.
- Understand the manufacturing processes of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OCH105	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy

- Summarize the principles of bio-energy systems and their features

UNIT I **INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE** **9**

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

UNIT II **BIOMASS PYROLYSIS** **9**

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

UNIT III **BIOMASS GASIFICATION** **9**

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

UNIT IV **BIOMASS COMBUSTION** **9**

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

UNIT V **BIO ENERGY** **9**

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification

Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand the various types of wastes from which energy can be generated
- Gain knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Gain knowledge on biomass combustors and its applications on generating energy
- Understand the principles of bio-energy systems and their features

REFERENCES:

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

Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AX1001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

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

UNIT II PRESENTATION SKILLS 6

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

UNIT III TITLE WRITING SKILLS 6

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

UNIT IV RESULT WRITING SKILLS 6

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

UNIT V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title
- Understand the skills needed when writing the Conclusion
- Ensure the good quality of paper at very first-time submission

REFERENCES:

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

AX1002	L	T	P	C
DISASTER MANAGEMENT	**2**	**0**	**0**	**0**

OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

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

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

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

UNIT III DISASTER PRONE AREAS IN INDIA 6

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

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

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

UNIT V RISK ASSESSMENT 6

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

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Ability to summarize basics of disaster
- Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

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

2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.

3. Sahni, Pardeep et.al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi,2001.

AX1003	VALUE EDUCATION	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models
- Using discrete time Markov chains to model computer systems

REFERENCES:

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

		L	T	P	C
AX1004	**CONSTITUTION OF INDIA**	**2**	**0**	**0**	**0**

OBJECTIVES:

Students will be able to :

- Understand the premises informing the twin themes of liberty and freedom from a civil Rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism Let the should know about the importance of character
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I **HISTORY OF MAKING OF THE INDIAN CONSTITUTION**

History, Drafting Committee, (Composition & Working)

UNIT II **PHILOSOPHY OF THE INDIAN CONSTITUTION**

Preamble, Salient Features

UNIT III **CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**

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

ORGANS OF GOVERNANCE

UNIT IV

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

LOCAL ADMINISTRATION

UNIT V

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

ELECTION COMMISSION

UNIT VI

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

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

REFERENCES:

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX1005	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DFLD, other agencies and researchers
- Identify critical evidence gaps to guide the development

UNIT I INTRODUCTION AND METHODOLOGY 5

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching

UNIT II INTRODUCTION AND METHODOLOGY 5

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching

UNIT III THEMATIC OVERVIEW 5

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT IV EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 5

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies

UNIT V PROFESSIONAL DEVELOPMENT 5

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT VI RESEARCH GAPS AND FUTURE DIRECTIONS 5

Research design – Contexts – Pedagogy. - Teacher education - Curriculum and assessment - Dissemination and research impact

TOTAL: 60 PERIODS

COURSE OUTCOMES

At the end of the course, the student should be able to:

- Understand What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- Understand What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- Understand How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, ‘learning to read’ campaign.

		L	T	P	C
AX1006	**STRESS MANAGEMENT BY YOGA**	**2**	**0**	**0**	**0**

OBJECTIVES:

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

REFERENCES:

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

		L	T	P	C
AX1007	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTNMENT SKILL**	**2**	**0**	**0**	**0**

OBJECTIVES:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES:

- Students will be able to
- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

REFERENCES:

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

AP1212	TERM PAPER WRITING AND SEMINAR	L	T	P	C
		0	0	2	1

OBJECTIVES

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic

2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained. Activities to be carried Out

Activity	**Instructions**	**Submission**	**Evaluation**
Selection of area of interest and Topic Stating an objective	You are requested to select an area of interest, topic and state an objective	2 nd week	3 % Based on clarity of thought, current relevance and clarity Stating an in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3 rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	You have to provide a complete list of references you will be using- Based on your objective - Search various digital libraries and Google Scholar When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences,	4 th week	6% (the list of standard papers and reason for selection)

	• Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/ categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)	5 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

Reading and notes for next5 papers	Repeat Reading Paper Process	6 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11th week	10% (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	10% (based on presentation and Viva voce)