JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
COLLEGE OF ENGINEERING (AUTONOMOUS), PULIVENDULA
YSR (KADAPA) District 516 390, (A.P) INDIA

M.Tech. Digital Electronics & Communication Systems (DECS)

Semester-I							
S.No.	**Course Code**	**Course Name**	**Category**	**Hours per**			**Credits**
				L	**T**	**P**	
1.	21D38101	Advanced Digital System Design	PC	3	0	0	3
2.	21D38102	Wireless and Mobile Communications	PC	3	0	0	3
3.		**Program Elective– 1**	PE	3	0	0	3
	21D38103a	Design of Fault Tolerant Systems					
	21D38103b	CMOS Digital IC Design					
	21D38103c	Fuzzy Systems and Neural Networks					
4.		**Program Elective– 2**	PE	3	0	0	3
	21D38104a	Coding Theory and Techniques					
	21D38104b	Advanced Digital Signal Processing					
	21D38104c	5G Communications					
5.	21D38105	Advanced Digital System Design Lab	PC	0	0	4	2
6.	21D38106	Wireless and Mobile Communications Lab	PC	0	0	4	2
7.	21D38107	Research Methodology and IPR	MC	2	0	0	2
8.	21D38108	**Audit Course 1**	AC	2	0	0	0
		English for Research Paper Writing					
		Value Education					
		Pedagogy Studies					
				Total			**18**

Semester-II							
S.No.	**Course Code**	**Course Name**	**Category**	**Hours per**			**Credits**
				L	T	**P**	
1.	21D38201	Analog and Mixed Signal Design	PC	3	0	0	3
2.	21D38202	Advanced Communications and Networks	PC	3	0	0	3
3.		**Program Elective – 3**	PE	3	0	0	3
	21D38203a	Low Power VLSI Design					
	21D38203b	So C Architecture					
	21D38203c	Wireless Sensor Networks					
4.		**Program Elective – 4**	PE	3	0	0	3
	21D38204a	Software Defined Radio					
	21D38204b	Image and Video Processing					
	21D38204c	Transform Techniques					
5.	21D38205	Analog and Mixed Signal Design Lab	PC	0	0	4	2

6.	21D38206	Advanced Communications and Networks Lab	PC	0	0	4	2
7.	21D38207	Technical Seminar	PR	0	0	4	2
8.	21D38208	**Audit Course 2**	AC	2	0	0	0
		Disaster Management					
		Constitution of India					
		Personality Development through Life Enlightenment Skills.					
					Total		**18**

Semester-III							
S.No.	**Course Code**	**Course Name**	**Category**	**Hours per**			**Credits**
				L	T	**P**	
1.		**Program Elective –5**	PE	3	0	0	3
	21D38303a	Detection and Estimation Theory					
	21D38303b	Embedded Systems					
	21D38303c	Artificial Intelligence and Machine Learning					
2.		**Open Elective**	OE	3	0	0	3
	21D38304a	Business Analytics					
	21D38304b	Industrial Safety					
	21D38304c	Operation Research					
	21D38304d	Cost Management of Engineering Projects					
	21D38304e	Composite Materials					
	21D38304f	Waste to Energy					
3.	21D38308	Co-Curricular Activities	PR				02
4	21D38309	Dissertation Phase – I	PR	0	0	20	10
					Total		**18**

Semester-IV							
S.No.	**Course Code**	**Course Name**	**Category**	**Hours per**			**Credits**
				L	T	**P**	
1.	21D38409	Dissertation Phase – II	PR	0	0	32	16
			Total				**16**

Open Elective:

1. Business Analytics
2. Industrial Safety
3. Operation Research
4. Cost Management of Engineering Projects
5. Composite Materials
6. Waste to Energy

Audit course I:

1. English for Research Paper Writing
2. Value Education
3. Pedagogy Studies

Audit course II:

1 Disaster Management
2. Constitution of India
3. Personality Development through Life Enlightenment Skills.

Guidelines for Awarding Credits for Co-curricular Activities:

Name of the Activity	Maximum Credit Points Eligible / Activity
Participation in Seminar/Conference/Workshop/Symposium/ Training Programs within India (related to the specialization of the student)	1
Participation in Seminar/Conference/Workshop/Symposium/ Training Programs outside India (related to the specialization of the student)	2
Academic Award/Research Award from State Level/National Agencies	1
Academic Award/Research Award from International Agencies	2
Research / Review Publication in National Journals (Indexed in Scopus / Web of Science)	1
Research / Review Publication in International Journals (Indexed in Scopus / Web of Science)	2

Course Code		ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To understand processor arithmetic operations and basic binary codes.
- To learn and design different combinational logic circuits.
- To implement sequential logic circuit design.
- To design different subsystems using various combinational circuits.
- To design and analyze different subsystems using various sequential circuits.

Course Outcomes (CO): Student will be able to

- Understand processor arithmetic operations and basic binary codes.
- Design different combinational logic circuits.
- Implement sequential logic circuit design.
- Design different subsystems using various combinational circuits.
- Design and analyze different subsystems using various sequential circuits.

UNIT - I		Lecture Hrs:

Processor Arithmetic: Two's complement number system - Arithmetic operations; Fixed point number system; Floating point number system - IEEE 754 format, Basic binary codes.

UNIT - II		Lecture Hrs:

Combinational circuits: CMOS logic design, Static and dynamic analysis of Combinational circuits, timing hazards. Functional blocks: Decoders, Encoders, Three-state devices, Multiplexers, Parity circuits, Comparators, Adders, Subtractors, Carry look-ahead adder – timing analysis. Combinational multiplier structures.

UNIT - III		Lecture Hrs:

Sequential Logic: Latches and Flip-Flops, Sequential logic circuits - timing analysis (Set up and hold times), State machines - Mealy & Moore machines, Analysis, FSM design using D flip-flops, FSM optimization and partitioning; Synchronizers and metastability. FSM Design examples: Vending machine, Traffic light controller, Washing machine. Design and architecture of CPLD and FPGA.

UNIT - IV		Lecture Hrs:

Subsystem Design using Combinational Circuits: Design different logical blocks involving mostly combinational circuits: ALU, 4-bit combinational multiplier, Barrel shifter, Simple fixed point to floating point encoder, Dual Priority encoder, Cascading comparators.

UNIT - V		Lecture Hrs:

Subsystem Design using Sequential Circuits: Design different logical blocks involving mostly sequential circuits: Pattern (sequence) detector, Programmable Up-down counter, Round robin arbiter with 3 requesters, Process Controller, FIFO.

Textbooks:

1. M. Morris Mano, Michael D. Ciletti, "Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog", Pearson Education; 6th Edition, 2018.
2. John F. Wakerly, "Digital Design", Prentice Hall, 3rd Edition, 2002.

Reference Books:

1. N. N. Biswas, "Logic Design Theory", PHI.
2. Samuel C. Lee, "Digital Circuits and Logic Design", PHI.

Online Learning Resources:

Course Code		WIRELESS AND MOBILE COMMUNICATIONS	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To study about the channel planning for Wireless systems.
- To know about the large scale path loss in Mobile Radio Propagation.
- To learn about the small scale fading and multipath fading in Mobile Radio Propagation.
- To comprehend the concepts of Equalizers and Diversity techniques.
- To study about the Wireless networks and their standards.

Course Outcomes (CO): Student will be able to

- Know about the channel planning for Wireless systems.
- Learn about the large scale path loss in Mobile Radio Propagation.
- Understand the small scale fading and multipath fading in Mobile Radio Propagation.
- Comprehend the concepts of Equalizers and Diversity techniques.
- Know about the Wireless networks and their standards.

UNIT - I		Lecture Hrs:

The Cellular Concept: System design fundamentals: Introduction, Frequency reuse, Channel assignment Strategies, Handoff strategies- Prioritizing handoffs, Practical handoff considerations, Interference and system capacity – Co channel Interference and system capacity, Channel planning for wireless systems, Adjacent channel interference, Power control for reducing interference, Trunking and Grade of service, Improving coverage & capacity in Cellular systems- Cell splitting, sectoring.

UNIT - II		Lecture Hrs:

Mobile Radio Propagation-Large-Scale Path Loss: Introduction to Radio wave propagation, Free space propagation model, relating power to electric field, Three basic propagation mechanisms, Reflection, Ground reflection (Two-Ray) model, Diffraction, Scattering, Outdoor propagation models, Indoor propagation models, Signal penetration into buildings, Ray tracing and Site specific modeling.

UNIT - III		Lecture Hrs:

Mobile Radio Propagation - Small Scale Fading and Multipath Fading : Small scale multipath propagation, factors influencing small scale fading, Doppler shift, Impulse response model of a multipath channel, relationship between bandwidth and received power, Small-scale multipath measurements, Parameters of mobile multipath channels, Types of Small-scale fading- fading effects due to multipath time delay spread, fading effects due to Doppler spread, statistical models for multipath fading channels, Clarke’s model for flat fading, spectral shape due to Doppler spread in Clarke’s model, Simulation of Clarke and Gans Fading Model, Level crossing and fading statistics, Two-ray Rayleigh fading model.

UNIT - IV		Lecture Hrs:

Equalization and Diversity: Introduction, Fundamentals of equalization, Training a generic adaptive equalizer, equalizers in a communication receiver, Linear equalizers, Non-linear equalization, Algorithms for adaptive equalization. Diversity techniques - Derivation of selection, diversity improvement, Derivation of maximal ratio combining improvement, Practical space diversity consideration, Polarization diversity, Frequency diversity, Time diversity, RAKE receiver.

UNIT - V		Lecture Hrs:

Wireless Networks: Introduction to wireless networks, Advantages and disadvantages of Wireless local area networks, WLAN topologies, WLAN standard IEEE 802.11, IEEE 802.11 Medium access control, Comparison of IEEE 802.11 a, b, g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, HiperLan, WLL.

Textbooks:
1. Wireless Communications, Principles, Practice – Theodore, S. Rappaport, 2nd Ed., 2002, PHI. 2. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press.
Reference Books:
1. Wireless Digital Communications – Kamilo Feher, 1999, PHI. 2. Wireless Communication and Networking – William Stallings, 2003, PHI. 3. Principles of Wireless Networks – KavehPah Laven and P. Krishna Murthy, 2002, PE. 4. Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012.
Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 1	L	T	P	C
Semester	I	DESIGN OF FAULT TOLERANT SYSTEMS	3	0	0	3

Course Objectives:

- To provide broad understanding of fault diagnosis and tolerant design approach.
- To illustrate the framework of test pattern generation using semi and fully automatic approach.
- To acquire the knowledge of scan architectures.
- To understand the design concepts of built-in-self test.
- To learn about various standard test access methods.

Course Outcomes (CO): Student will be able to

- Understand fault diagnosis and tolerant design approach.
- Illustrate the framework of test pattern generation using semi and fully automatic approach.
- Comprehend the knowledge of scan architectures.
- Understand the design concepts of built-in-self test.
- Learn about various standard test access methods.

UNIT - I		Lecture Hrs:

Fault Tolerant Design: Basic concepts: Reliability concepts, Failures & faults, Reliability and failure rate, Relation between reliability and mean time between failure, maintainability and availability, reliability of series, parallel and parallel-series combinational circuits. Fault tolerant design - Basic concepts - static, dynamic, hybrid, triple modular redundant system (TMR), 5MR reconfiguration techniques, Data redundancy, Time redundancy and software redundancy concepts.

UNIT - II		Lecture Hrs:

Self-Checking Circuits & Fail-Safe Design: Basic concepts of self-checking circuits, Design of totally self-checking checker, Checkers using m out of n codes, Berger code, Low-cost residue code. Fail safe design- Strongly fault secure circuits, fail safe design of sequential circuits using partition theory and Berger code, totally self-checking PLA design.

UNIT - III		Lecture Hrs:

Design for Testability: Design for testability for combinational circuits: Basic concepts of testability, Controllability and observability, The Reed Muller's expansion technique, use of control and syndrome testable designs.

Design for testability by means of scan: Making circuits testable, Testability insertion, Full scan DFT technique- Full scan insertion, flip-flop structures, Full scan design and test, Scan architectures-full scan design, Shadow register DFT, Partial scan methods, multiple scan design, other scan designs.

UNIT - IV		Lecture Hrs:

Logic Built – In - Self-Test (BIST) : Basics-Memory-based BIST, BIST effectiveness, BIST types, Designing a BIST, Test pattern generation- engaging TPGs, exhaustive counters, ring counters, twisted ring counter, Linear feedback shift register, Output response analysis-engaging ORA's, One's counter, transition counter, parity checking, Serial LFSRs, Parallel signature analysis, BIST architectures-BIST related terminologies, A centralized and separate board-level BIST architecture, Built-in evaluation and self-test (BEST), Random test socket(RTS), LSSD On-chip self-test, Self – testing using MISR and SRSG, Concurrent BIST, BILBO, Enhancing coverage, RT level BIST design-CUT design, simulation and synthesis, RTS BIST insertion, Configuring the RTS BIST, incorporating configurations in BIST, Design of STUMPS, RTS and STUMPS results.

UNIT - V		Lecture Hrs:

Standard IEEE Test Access Methods: Boundary scan basics, Boundary scan architecture- test access port, boundary scan registers, TAP controller, the decoder unit, select and other units, Boundary scan test instructions -Mandatory instructions, Board level scan chain structure-One serial scan chain, multiple-scan chain with one control test port, multiple-scan chains with one TDI,TDO but multiple TMS, Multiple-scan chain, multiple access port, RT Level boundary scan-inserting boundary scan test hardware for CUT, Two module test case, virtual boundary scan tester, Boundary Scan Description language.

Textbooks:
1. Fault Tolerant & Fault Testable Hardware Design- Parag K. Lala, PHI, 1984. 2. Digital System Test and Testable Design using HDL models and Architectures –Zainalabedin Navabi, Springer International Ed.
Reference Books:
1. Digital Systems Testing and Testable Design- Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, Jaico Books. 2. Essentials of Electronic Testing- Bushnell &Vishwani D. Agarwal, Springers. 3. Design for Test for Digital IC’s and Embedded Core Systems- Alfred L. Crouch, 2008.
Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 1	L	T	P	C
Semester	I	CMOS DIGITAL IC DESIGN	3	0	0	3

Course Objectives:

- To understand the fundamental properties of digital integrated circuits using MOSFET's .
- To learn the basics of CMOS Digital IC design using Combinational MOS logic circuits.
- To know the basics of CMOS Digital IC design using Sequential MOS logic circuits.
- To understand the fundamentals of Dynamic logic circuits.
- To analyze and compare different semiconductor memories.

Course Outcomes (CO): Student will be able to

- Learn the fundamental properties of digital integrated circuits using MOSFET's .
- Understand the basics of CMOS Digital IC design using Combinational MOS logic circuits.
- Know the basics of CMOS Digital IC design using Sequential MOS logic circuits.
- Understand the fundamentals of Dynamic logic circuits.
- Analyze and compare different semiconductor memories.

UNIT - I		Lecture Hrs:

MOS Design Pseudo NMOS Logic: Inverter, Inverter threshold voltage, output high voltage, Output low voltage, gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

UNIT - II		Lecture Hrs:

Combinational MOS Logic Circuits: MOS logic circuits with NMOS loads, Primitive CMOS logic gates–NOR & NAND gate, Complex Logic circuits design–Realizing boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

UNIT - III		Lecture Hrs:

Sequential MOS Logic Circuits: Behavior of bi-stable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.

UNIT - IV		Lecture Hrs:

Dynamic Logic Circuits: Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits.

UNIT - V		Lecture Hrs:

Semiconductor Memories: Types, RAM array organization, DRAM – Types, Operation, DRAM timing analysis, Leakage currents in DRAM cell and refresh operation, SRAM operation, SRAM timing analysis, Leakage currents in SRAM cells, Flash Memory-NOR flash and NAND flash.

Textbooks:

1. Neil Weste, David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson, 2010.
2. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Edition, 2011.

Reference Books:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
2. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2ndEdition, PHI.
3. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 1 FUZZY SYSTEMS AND NEURAL NETWORKS	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To analyze basic neural computational models.
- To get in detail knowledge about supervised and un-supervised learning.
- To understand different types of associative memories.
- To study about different issues related probability and fuzziness.
- To learn about different types of fuzzy associative memories.

Course Outcomes (CO): Student will be able to

- Analyze basic neural computational models.
- Gain knowledge about supervised and un-supervised learning.
- Understand different types of associative memories.
- Analyze the issues related probability and fuzziness.
- Learn different types of fuzzy associative memories.

UNIT - I		Lecture Hrs:

Introduction: History of Neural networks, Structure and functions of biological and artificial neuron, Neural network architectures, learning methods, evaluation of neural networks. McCulloch-Pitt's neuron model, perception learning, Delta learning, Windrow-Hoff learning rules, linear separability, Adaline, Modifications.

UNIT - II		Lecture Hrs:

Supervised Learning: Architectures, Madalines, Back propagation algorithm, importance of learning parameter and momentum term, radial basis functions.
Unsupervised Learning: Winner – Take – all learning, out star learning, learning vector quantizers, Counter propagation networks, Kohonen self – organizing networks, Grossberg layer, adaptive resonance theory, Hamming net.

UNIT - III		Lecture Hrs:

Associative Memories: Hebbian learning rule, continues and discrete Hopfield networks, recurrent and associative memory, Boltzmann machines, Bi-directional associative memory.

UNIT - IV		Lecture Hrs:

Fuzziness vs Probability: Fuzzy Sets & Systems; The Geometry of Fuzzy sets; The Fuzzy Entropy Theorem; The Subset hood Theorem; The Entropy Subset Hood Theorem.

UNIT - V		Lecture Hrs:

Fuzzy Associative Memories: Fuzzy & Neural Function Estimators; Fuzzy Hebbian FAMs; Adaptive FAMs.

Textbooks:

1. J.M. Zurada, "Introduction to Artificial Neural Systems" - Jaico Publishing House, Bombay,2001.
2. Kishan Mehrotra, Chelkuri. K. Mohan, Sanjay Ranka, "Elements of Artificial Neural Networks", Penram International.

Reference Books:

1. S. N Sivanandham, S. Sumathi, S.N. Deepa, "Introduction to Neural networks using matlab6.0", Tata McGraw Hill, New Delhi, 2005.
2. B. Kosko, "Neural Networks & Fuzzy Systems", Prentice Hall (India) Ltd., 1992.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 2 CODING THEORY AND TECHNIQUES	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To learn the measurement of information and errors.
- To obtain knowledge in designing Cyclic codes.
- To construct tree and trellies diagrams for convolution codes.
- To design the Turbo codes and their applications.
- To analyze the Space time codes and their applications.

Course Outcomes (CO): Student will be able to

- Learn the measurement of information and errors.
- Obtain knowledge in designing Cyclic codes.
- Construct tree and trellies diagrams for convolution codes.
- Design the Turbo codes and their applications.
- Analyze the Space time codes and their applications.

UNIT - I | Lecture Hrs:

Coding for Reliable Digital Transmission and storage: Mathematical model of information, A logarithmic measure of information, Average and mutual information and entropy, Types of errors, Error control strategies.

Linear Block Codes: Introduction to Linear block codes, Syndrome and error detection, Minimum distance of a block code, Error detecting and Error correcting capabilities of a block code, Standard array and Syndrome decoding, Probability of an undetected error for Linear codes over a BSC, Hamming codes. Applications of block codes for error control in data storage system.

UNIT - II | Lecture Hrs:

Cyclic codes: Description, Generator and Parity-check matrices, Encoding, Syndrome computation and error detection, Decoding, Cyclic Hamming Codes, shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

UNIT - III | Lecture Hrs:

Convolutional Codes: Encoding of convolutional codes, Structural and distance properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of convolution codes. Application of Viterbi decoding and sequential decoding, Applications of convolutional codes in ARQ system.

UNIT - IV | Lecture Hrs:

Turbo Codes: LDPC Codes- Codes based on sparse graphs, decoding for binary erasure channel, Log-likelihood algebra, Brief propagation, Product codes, Iterative decoding of product codes, Concatenated convolutional codes- Parallel concatenation, The UMTS turbo code, Serial concatenation, Parallel concatenation, Turbo decoding.

UNIT - V | Lecture Hrs:

Space-Time Codes: Introduction, Digital modulation schemes, Diversity, Orthogonal space- time block codes, Alamouti's schemes, Extension to more than two transmit antennas, Simulation results, Spatial Multiplexing: General concept, Iterative APP preprocessing and per-layer Decoding, Linear multilayer detection, Original BLAST detection, QL Decomposition and interface cancellation, Performance of Multi –layer detection schemes, Unified description by linear dispersion codes.

Textbooks:

1. Error Control Coding- Fundamentals and Applications –Shu Lin, Daniel J. Costello, Jr, Prentice Hall, Inc.
2. Error Correcting Coding Theory-Man Young Rhee, McGraw-Hill, 1989.

Reference Books:

1. Digital Communications-Fundamental and Application - Bernard Sklar, PE.
2. Digital Communications- John G. Proakis, 5th ed. TMH, 2008.
3. Error Correction Coding- Mathematical methods & algorithms-Todd K. Moon, Wiley India,2006.
4. Information Theory, Coding and Cryptography – Ranjan Bose, 2nd Edition, TMH, 2009.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 2 ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To study about the digital signal processing algorithms.
- To learn about the multi rate signal processing.
- To gain knowledge about the power spectral estimation and their parametric methods.
- To study about the effects of finite word length in fixed-point DSP systems.
- To understand various applications of Digital signal processing.

Course Outcomes (CO): Student will be able to

- Learn about the digital signal processing algorithms.
- Know about the multi rate signal processing.
- Gain knowledge about the power spectral estimation and their parametric methods.
- Appreciate the effects of finite word length in fixed-point DSP systems.
- Understand various applications of Digital signal processing.

UNIT - I		Lecture Hrs:

DSP Algorithms: Fast DFT algorithms based on Index mapping, Sliding discrete fourier transform, DFT computation over a narrow frequency band, Split radix FFT, Linear filtering approach to computation of DFT using Chirp Z-Transform.

UNIT - II		Lecture Hrs:

Multi Rate Signal Processing: Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Filter design & Implementation for sampling rate conversion.

UNIT - III		Lecture Hrs:

Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, non-parametric methods: Bartlett, Welch & Blackmann , Tukey methods.

Parametric Methods for Power Spectrum Estimation: Relation between auto correlation & model parameters, Yule-Waker & Burg Methods, MA & ARMA models for power spectrum estimation.

UNIT - IV		Lecture Hrs:

Analysis of Finite Word length effects in Fixed-Point DSP Systems: Fixed, Floating-Point Arithmetic – ADC quantization noise & signal quality, Finite word length effect in IIR digital filters – Finite word-length effects in FFT algorithms.

UNIT - V		Lecture Hrs:

Applications of Digital Signal Processing: Dual tone multi-frequency signal detection, Spectral analysis of sinusoidal signals, Spectral analysis of Non-stationary Signals, Musical sound processing, Over sampling A/D Converter, Over sampling D/A Converter, Discrete-Time analytic signal Generation.

Textbooks:

1. Sanjit K Mitra, "Digital Signal Processing", Tata McGraw Hill Publications.
2. J G Proakis, D G Manolokis, "Digital Signal Processing Principles, Algorithms, Applications" PHI.

Reference Books:

1. A V Oppenhiem, R W Schafer, "Discrete-Time Signal Processing", Pearson Education.
2. Emmanuel C Ifeacher Barrie. W. Jervis, "DSP- A Practical Approach", Pearson Education.
3. S. M. Kay, "Modern spectral Estimation Techniques" PHI, 1997.

Online Learning Resources:

Course Code		**PROGRAM ELECTIVE – 2** **5G COMMUNICATIONS**	L	T	P	C
Semester	**I**		**3**	**0**	**0**	**3**

Course Objectives:

- To know about the evolution and advancements of mobile technologies.
- To learn about the channel models and their requirements.
- To understand the requirements of transmission over 5G and modulation techniques.
- To acquire knowledge on D2D and M2M communications.
- To gain the knowledge about millimeter wave communications.

Course Outcomes (CO): Student will be able to

- Know about the evolution and advancements of mobile technologies.
- Learn about the channel models and their requirements.
- Understand the requirements of transmission over 5G and modulation techniques.
- Acquire knowledge on D2D and M2M communications.
- Gain the knowledge about millimeter wave communications.

UNIT - I		Lecture Hrs:

Overview of 5G Broadband Wireless Communications: Evolution of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An overview of 5G requirements, Regulations for 5G, Spectrum analysis and sharing for 5G.

UNIT - II		Lecture Hrs:

The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mmWave MIMO Systems.

UNIT - III		Lecture Hrs:

Transmission and Design Techniques for 5G: Basic requirements of transmission over 5G, Modulation techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple accesses techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).

UNIT - IV		Lecture Hrs:

Device-to-Device (D2D) and Machine-to-Machine (M2M) type Communications: Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multihop and multi-operator D2D communications.

UNIT - V		Lecture Hrs:

Millimeter-wave Communications: Spectrum regulations, deployment scenarios, beamforming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with imperfect CSI, Multi-cell Massive MIMO, Pilot contamination, Spatial modulation (SM).

Textbooks:

1. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.
2. Afif Osseiran, Jose.F. Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks”, Cambridge University Press.

Reference Books:

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk “Essentials of LTE and LTE-A”, Cambridge University Press
3. Athanasios G. Kanatos, Konstantina S. Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
4. Theodore S. Rappaport, Robert W. Heath, Robert C. Danials, James N. Murdock “Millimeter

Wave Wireless Communications", Prentice Hall Communications.
Online Learning Resources:

Course Code		ADVANCED DIGITAL SYSTEM DESIGN LAB	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- To familiarize the HDL simulator / synthesis tool.
- To design and implement given combinational circuits on FPGA device.
- To design and implement given sequential circuits on FPGA device.

Course Outcomes (CO): Student will be able to

- Familiarize the HDL simulator / synthesis tool.
- Design and implement given combinational circuit on FPGA device.
- Design and implement given sequential circuit on FPGA device.

List of Experiments:

Student must design ANY TWELVE experiments using standard HDL simulator / Synthesis tool for target FPGA device.

1. HDL code to realize all the logic gates
2. Design and Simulation of adder, Serial Binary Adder, Multi Precession Adder, Carry Look Ahead Adder.
3. Design of 2-to-4 decoder, 8-to-3 encoder (without and with parity)
4. Design of 8-to-1 multiplexer
5. Design of 4 bit binary to gray converter
6. Design of Multiplexer/ Demultiplexer, comparator
7. Design of Full adder using 3 modeling styles
8. Design of flip flops: SR, D, JK, T
9. Design of 4-bit binary, BCD counters (synchronous/ asynchronous reset) or any sequence counter
10. Design of a N- bit Register of Serial- in Serial –out, Serial in parallel out, Parallel in Serial out and Parallel in Parallel Out.
11. Design of Sequence Detector (Finite State Machine- Mealy and Moore Machines).
12. Design of 4- Bit Multiplier, Divider.
13. Design of ALU to Perform – ADD, SUB, AND-OR, 1's and 2's Compliment,
14. Design of Finite State Machine.
15. Implementing the above designs on Xilinx/Altera/Cypress/equivalent based FPGA/CPLD kits.

Software Requirements:

Xilinx Vivado

Hardware Requirements: Xilinx Spartan 6 FPGA board.

References:

Online learning resources/Virtual labs:

Course Code		WIRELESS AND MOBILE COMMUNICATIONS LAB	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- To understand the concepts of GSM/CDMA technologies.
- To implement signal processing algorithms for the given specifications.
- To implement wireless communication algorithms for the given specifications.

Course Outcomes (CO): Student will be able to

- Understand the concepts of GSM/CDMA technologies.
- Implement signal processing algorithms for the given specifications.
- Implement wireless communication algorithms for the given specifications.

List of Experiments:

Student must do ALL TWELVE experiments using MATLAB/NetSim/Qualnet simulator.

1. Implementation of Convolutional Encoder and Decoder.
2. Simulation of the following Outdoor Path loss propagation models using MATLAB.
   a. Free Space Propagation model
   b. Okumura model
   c. Hata model
3. Simulation of Adaptive Linear Equalizer using MAT LAB software.
4. Measurement of call blocking probability for GSM network using Netsim software.
5. Measurement of call blocking probability for CDMA network using Netsim software.
6. Study of GSM handset for various signaling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
7. Study of transmitter and receiver section in mobile handset and measure frequency.
8. Band signal and GMSK modulating signal.
9. Simulation of RAKE Receiver for CDMA communication using MAT LAB software.
10. Simulate and test various types of PN codes, chip rate, spreading factor and processing gain on performance of DSSS in CDMA.
11. Simulate and test the 3G Network system features using GSM AT Commands. (Features of 3G Communication system: Transmission of voice, video calls, SMS, MMS, TCP/IP, HTTP, GPS).
12. Modelling of communication system using Simulink.

Software Requirements:

MATLAB/NetSim/Qualnet simulator

References:

Online learning resources/Virtual labs:

Course Code		ANALOG AND MIXED SIGNAL DESIGN	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To understand the design of circuit in IC form especially both analog and digital designs.
- To study about power amplifiers and different feedback concepts.
- To acquire knowledge on different design architectures in mixed signal mode.
- To analyze CMOS based switched capacitor circuits.
- To learn the basics of data converters.

Course Outcomes (CO): Student will be able to

- Understand the design of circuit in IC form especially both analog and digital designs.
- Learn about power amplifiers and different feedback concepts.
- Acquire knowledge on different design architectures in mixed signal mode.
- Analyze CMOS based switched capacitor circuits.
- Learn the basics of data converters.

UNIT - I		Lecture Hrs:

Current Sources and Sinks: General considerations, MOS I/V characteristics, Small-cignal model for the MOS transistor, Channel modulation, back gate effect, influence of body bias, Single stage amplifiers with differential loads, the cascode connection , sensitivity and temperature analysis, transient response , layout of simple current mirror , matching in MOSFET mirrors , other current sources or sinks. Voltage dividers, current source self-biasing, band gap voltage references, Beta multiplier referenced self-baising.

UNIT - II		Lecture Hrs:

Amplifiers: Gate drain connected loads, Current sources loads, Noise and distortion, Class AB Amplifier.

Feedback Amplifiers: Feedback equation, properties of negative feedback and amplifier design, feedback topologies, amplifiers employing the four types of feedback, Stability.

UNIT - III		Lecture Hrs:

Differential Amplifiers: The source coupled pair, the source cross –coupled pair, cascode loads, Wide-swing differential amplifiers.

Operational Amplifiers: Basic CMOS Op-Amp design, Operational transconductance amplifiers, Differential output Op-amp.

UNIT - IV		Lecture Hrs:

Non-Linear Circuits: Basic CMOS comparator design, Adaptive biasing, Analog multipliers.

Dynamic Analog Circuits: MOSFET Switch, Switched capacitor circuits, Switched capacitor integrator, dynamic circuits.

UNIT - V		Lecture Hrs:

Data Converter Fundamentals and Architectures : DAC & ADC specifications, Mixed signal layout issues. DAC architectures, ADC architectures. Floor planning methods, Global interconnect, Floor plan design, Off-chip connections.

Textbooks:

1. CMOS Circuits Design, Layout and Simulation – Baker, Li, Boyce, 1st ed., TMH
2. Rudy Van De Plassche, “CMOS Integrated Analog-to-Digital and Digital-to Analog converters,” Kluwer Academic Publishers, 2003 .

Reference Books:

1. R. Jacob Baker, “CMOS Mixed-Signal Circuit Design”, Wiley Interscience, 2009.
2. David A.Johns, Ken Martin, “Analog Integrated Circuit Design,” John-Wiley & Sons, 1997.
3. B. Razavi, “Design of Analog CMOS Circuits,” McGraw Hill, 2003.

Online Learning Resources:

Course Code		ADVANCED COMMUNICATIONS AND NETWORKS	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To understand various spread spectrum communication techniques.
- To know about the different aspects related to OFDM.
- To study the basic concepts of MIMO systems.
- To learn about the protocols used in wireless networks.
- To study about the protocols used in broadband wireless networks.

Course Outcomes (CO): Student will be able to

- Understand various spread spectrum communication techniques.
- Know about the different aspects related to OFDM.
- Learn the basic concepts of MIMO systems.
- Gain information about the protocols used in wireless networks.
- Know about the protocols used in broadband wireless networks.

UNIT - I		Lecture Hrs:

Spread Spectrum Communications: Spreading sequences- Properties of spreading sequences, Pseudo- noise sequence, gold sequences, Kasami sequences, Walsh sequences, Orthogonal variable spreading factor sequences, Barker sequence, Complementary codes.

Direct sequence spread spectrum: DS-CDMA model, Conventional receiver, Rake receiver, Synchronization in CDMA, Power control, Soft handoff, Multiuser detection – Optimum multiuser detector, Liner multiuser detection.

UNIT - II		Lecture Hrs:

Orthogonal Frequency Division Multiplexing: Basic principles of orthogonality, Single vs Multicarrier systems, OFDM block diagram and its explanation, OFDM signal mathematical representation, Selection parameter for modulation, Pulse shaping in OFDM signal and spectral efficiency, Window in OFDM signal and spectrum, Synchronization in OFDM, Pilot insert in OFDM transmission and channel estimation, Amplitude limitations in OFDM, FFT point selection constraints in OFDM, CDMA vs OFDM, Hybrid OFDM.

UNIT - III		Lecture Hrs:

MIMO Systems: Introduction, Space diversity and system based on space diversity, Smart antenna system and MIMO, MIMO based system architecture, MIMO exploits multipath, Space – time processing, Antenna consideration for MIMO, MIMO channel modelling, MIMO channel measurement, MIMO channel capacity, Cyclic delay diversity (CDD), Space time coding, advantages and applications of MIMO in present context, MIMO Applications in 3G Wireless system and beyond, MIMO-OFDM

UNIT - IV		Lecture Hrs:

Wireless LANs/IEEE 802.11x: Introduction to IEEE802.11x technologies, Evolution of wireless LANs, IEEE 802.11 design Issues, IEEE 802.11 services, IEEE 802.11 MAC layer operations, IEEE 802.11 Layer1, IEEE 802.11 a/b/g Higher rate standards, Wireless LAN security, Computing wireless technologies, Typical WLAN hardware.

UNIT - V		Lecture Hrs:

Wireless PANs/IEEE 802.15x: Introduction to IEEE 802.15x technologies: Wireless PAN applications and architecture, IEEE 802.15.1 physical layer details, Bluetooth link controllers basics, Bluetooth link controllers operational states, IEEE 802.15.1 protocols and host control interface. Evaluation of IEEE 802.15 standards

Broad Band Wireless MANs/IEEE 802.16x: Introduction to WMAN/IEEE 802.16x technology, IEEE 802.16 Wireless MANs, IEEE 802.16 MAC layer details, IEEE 802.16 physical layer details, IEEE 802.16 physical layer details for 2-11 GHz, IEEE 802.16 common system operations.

Textbooks:
1.Gary J. Mullett, “Introduction to Wireless Telecommunications Systems and Networks”, CENGAGE 2. UpenaDalal, “Wireless Communication”, Oxford University Press, 2009
Reference Books:
1. Ke-Lin Du & M N S Swamy, “Wireless Communication System”, Cambridge University Press, 2010 2. Gottapu Sasibhusan Rao, “Mobile Cellular Communication”, 1st Edition, Pearson Education, 2012
Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 3	L	T	P	C
Semester	**II**	**LOW POWER VLSI DESIGN**	**3**	**0**	**0**	**3**

Course Objectives:

- To understand the basic concepts related to low power circuit design.
- To implement Low power design approaches for system level and circuit level measures.
- To design different types of low voltage low power adders.
- To design and analyze different types of low voltage multipliers.
- To gain knowledge on different types of memories for efficient design of systems.

Course Outcomes (CO): Student will be able to

- Understand the basic concepts related to low power circuit design.
- Implement Low power design approaches for system level and circuit level measures.
- Design different types of low voltage low power adders.
- Design and analyze different types of low voltage multipliers.
- Gain knowledge on different types of memories for efficient design of systems.

UNIT - I — Lecture Hrs:

Fundamentals: Need for low power circuit design, Sources of power dissipation – Static and dynamic power dissipation, Short circuit power dissipation, Glitching power dissipation, Short channel effects –Drain induced barrier lowering and punch through, Surface scattering, Velocity saturation, Impact ionization, Hot electron effect.

UNIT - II — Lecture Hrs:

Low-Power Design Approaches: Low-Power design through Voltage scaling – VTCMOS circuits, MTCMOS circuits, Architectural level approach –Pipelining and parallel processing approaches. Switched capacitance minimization approaches: System level measures, Circuit level measures, Mask level measures.

UNIT - III — Lecture Hrs:

Low-Voltage Low-Power Adders: Introduction, Standard adder cells, CMOS Adder's architectures – Ripple carry adders, Carry look ahead adders, Carry select adders, Carry save adders, Low-voltage low-power design techniques – Trends of technology and power supply voltage, low-voltage low-power logic styles.

UNIT - IV — Lecture Hrs:

Low-Voltage Low-Power Multipliers: Introduction, Overview of multiplication, Types of multiplier architectures, Braun multiplier, Baugh Wooley multiplier, Booth multiplier, Introduction to Wallace Tree Multiplier.

UNIT - V — Lecture Hrs:

Low-Voltage Low-Power Memories: Basics of ROM, Low-power ROM technology, future trends and development of ROMs, Basics of SRAM, Memory cell, Pre-charge and equalization circuit, Low-Power SRAM technologies, Basics of DRAM, Self-refresh circuit, Future trends and development of DRAM.

Textbooks:

1. CMOS Digital Integrated Circuits – Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.
2. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.

Reference Books:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
2. Low Power CMOS Design – Anantha Chandrakasan, IEEE Press/Wiley International, 1998.
3. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 3	L	T	P	C
Semester	II	SoC ARCHITECTURE	3	0	0	3

Course Objectives:

- To understand the basics of SoC architecture and different approaches related to SoC design.
- To select an appropriate robust processor for SoC design.
- To know about the memory requirements for SoC design.
- To learn about customization and configurability in SoC design.
- To realize real time case studies.

Course Outcomes (CO): Student will be able to

- Understand the basics of SoC architecture and different approaches related to SoC design.
- Select an appropriate robust processor for SoC design
- Know about the memory requirements for SoC design.
- Learn about customization and configurability in SoC design.
- Realize real time case studies.

UNIT - I		Lecture Hrs:

Introduction to the System Approach: Compare SoC, ASIC, SOP, SIP and MCM, System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory & Addressing. System level interconnection, An approach for SoC Design, System Architecture and Complexity.

UNIT - II		Lecture Hrs:

Processors: Introduction, Processor selection for SoC, Basic concepts in processor architecture, Basic concepts in processor micro-architecture, Basic elements in instruction handling. Buffers: minimizing pipeline delays, Branches, More robust processors, Vector processors and Vector instruction extensions, VLIW processors, Superscalar processors.

UNIT - III		Lecture Hrs:

Memory Design for SoC: Overview: SoC external memory, SoC internal memory, Size, Scratchpads and cache memory, Cache organization, Cache data, Write policies, Strategies for line replacement at miss time, Other types of Cache, Split – I, and D – Caches, Multilevel Caches, SOC memory system, Models of simple processor – memory interaction.

UNIT - IV		Lecture Hrs:

Interconnect, Customization and Configurability: Interconnect architectures, Bus: Basic architectures, SoC standard buses, Analytic bus models, Using the bus model, Effects of bus transactions and contention time.

SoC Customization: An overview, customizing instruction processor, reconfigurable technologies, Mapping design onto reconfigurable devices, Instance- specific design, Customizable soft processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable parallelism.

UNIT - V		Lecture Hrs:

Application Studies / Case Studies: SoC Design approach; AES-algorithms, Design and evaluation; Image compression–JPEG compression.

Textbooks:

1. "Computer System Design System-on-Chip", Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd.
2. "ARM System on Chip Architecture", Steve Furber, 2ndEdition, 2000, Addison Wesley Professional.

Reference Books:

1. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st Ed., 2004, Springer.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM.
3. System on Chip Verification – Methodologies and Techniques –Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 3 WIRELESS SENSOR NETWORKS	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To study about different types of sensor networks, their advantages and applications.
- To understand the concepts of localization and tracking control.
- To learn about the protocols used in routing of Wireless sensor networks.
- To know the mechanisms involved in routing of Wireless sensor networks.
- To study about the tools and simulators associated with Wireless sensor networks.

Course Outcomes (CO): Student will be able to

- To study about different types of sensor networks, their advantages and applications.
- To understand the concepts of localization and tracking control.
- To learn about the protocols used in routing of Wireless sensor networks.
- To know the mechanisms involved in routing of Wireless sensor networks.
- To study about the tools and simulators associated with Wireless sensor networks.

UNIT - I		Lecture Hrs:

Introduction: Sensor networks, advantages and applications, Sensor network applications – Habitat monitoring, Smart transportation, Collaborative processing.

UNIT - II		Lecture Hrs:

Localization and tracking: Sensing model, Distributed representation, Tracking multiple objects networking sensors- Medium access control, Energy-aware routing to a region, Attribute-based routing.

UNIT - III		Lecture Hrs:

Infrastructure Establishment: Clustering and time synchronizations, Localization and localization services, Sensor tracking and control - Task-driven sensing, Information-based sensor tasking, Sensor group management.

UNIT - IV		Lecture Hrs:

Sensor Network data bases: Sensor database challenges, Query interfaces, Data-centric storage, Multidimensional indices for orthogonal range searching, Locality-preserving hashing.

UNIT - V		Lecture Hrs:

Sensor Network Platforms and Tools: Sensor network hardware, Node level software, Node-level simulators, Wireless sensor networks positioning and location management.

Textbooks:

1. F. Zhao, C Guibas, “Wireless Sensor Networks”, Elsevier, Morgan Kaufmann, 2004.
2. Kazem Sohraby, Daniel Minoli, TaiebZnati, “Wireless Sensor Networks -Technology, Protocols and Applications”, John Wiley & Sons, 2007.

Reference Books:

1. P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitria, A.S. Pomportsis, “Wireless Networks”, John wiley & sons, 2003.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 4 SOFTWARE DEFINED RADIO	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To know the requirements, benefits and different models of Software Defined Radio.
- To learn about Software Defined Radio Architectures for performance optimization.
- To study in detail about flexible RF receiver architectures of Software Defined Radio.
- To understand the design of multiband flexible receiver and its performance.
- To study about the flexible transmitters receiver design.

Course Outcomes (CO): Student will be able to

- Know the requirements, benefits and different models of Software Defined Radio.
- Learn about Software Defined Radio Architectures for performance optimization.
- Study in detail about flexible RF receiver architectures of Software Defined Radio.
- Understand the design of multiband flexible receiver and its performance.
- Learn about the flexible transmitters receiver design.

UNIT - I		Lecture Hrs:

Introduction: Requirement for Software defined radio, Benefits of multi-standard terminals, Operational requirements, models for SDR, Smart antenna systems.

UNIT - II		Lecture Hrs:

Basic Architecture of a Software Defined Radio: Software defined radio architectures, Hardware specifications, Digital aspects of Software defined radio, Current technology limitations, minimum power consumption, AD performance trends.

UNIT - III		Lecture Hrs:

Flexible RF Receiver Architectures: Digital receiver, Single carrier and multi-carrier designs, under sampling, oversampling, Noise figure, Receiver sensitivity, ADC spurious signals.

UNIT - IV		Lecture Hrs:

Multi-Band and General Coverage Systems: Multiband Flexible receiver design, RF Transmit / receive switch, Image rejection mixing, Dynamic range enhancement, Feed forward techniques, cascaded non-linearity techniques.

UNIT - V		Lecture Hrs:

Flexible Transmitters and Power Amplifiers: Flexible transmitters, Power amplifiers, Analog quadrature up-conversion, interpolated bandpass up conversion, PLL based modulator transmitter, All-pass filtering, Polyphase filtering

Textbooks:

1. P Kenington, “RF and Baseband Techniques for Software Defined Radio”, Artec House, 2005
2.Wally H. W. Tuttlebee, “Software Defined Radio: Baseband Technologies for 3G Handsets and Base stations”, John Wiley &sons, 2003

Reference Books:

1. JoukoVanakka, “Digital Synthesizers and Transmitter for Software Radio”, Springer, 2005.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 4 IMAGE AND VIDEO PROCESSING	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To understand the fundamentals of image processing.
- To study about the different Image enhancement methods.
- To learn about the fundamentals concepts of Image Compression.
- To understand the representation of video and its basic principles.
- To gain the knowledge about different methods of motion estimation.

Course Outcomes (CO): Student will be able to

- Understand the fundamentals of image processing.
- Study about the different Image enhancement methods.
- Learn about the fundamentals concepts of Image Compression.
- Understand the representation of video and its basic principles.
- Gain the knowledge about different methods of motion estimation.

UNIT - I		Lecture Hrs:

Fundamentals of Image Processing and Image Transforms: Basic steps of Image processing system, Sampling and quantization of an image, Basic relationship between pixels.

Image Segmentation: Segmentation concepts, Point, Line and edge detection, Thresholding, region based segmentation.

UNIT - II		Lecture Hrs:

Image Enhancement: Spatial domain methods: Histogram processing, Fundamentals of spatial filtering, smoothing spatial filters, Sharpening spatial filters.

Frequency Domain Methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

UNIT - III		Lecture Hrs:

Image Compression: Image compression fundamentals, Coding redundancy, Spatial and temporal redundancy, Compression models: Lossy & lossless, Huffman coding, Bit plane coding, Transform coding, Predictive coding, Wavelet coding, Lossy predictive coding, JPEG Standards.

UNIT - IV		Lecture Hrs:

Basic Steps of Video Processing: Analog video, Digital video. Time-varying Image formation models: Three- dimensional motion models, Geometric image formation, Photometric image formation, Sampling of video signals, Filtering operations.

UNIT - V		Lecture Hrs:

2-D Motion Estimation: Optical flow, General methodologies, Pixel based motion estimation, Block- matching algorithm, Mesh based motion estimation, Global motion estimation, Region based motion estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in video coding.

Textbooks:

1. Digital Image Processing – Gonzaleze and Woods, 4th Ed., Pearson, 2018.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.

Reference Books:

1. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang. 1st Ed., PH Int.
2. Digital Image Processing – S. Jayaraman, S. Esakkirajan, T. Veera Kumar –TMH, 2009

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 4	L	T	P	C
Semester	II	TRANSFORM TECHNIQUES	3	0	0	3

Course Objectives:

- To study about different types of transforms for different types of signals.
- To understand the application of wavelets for different types of signals.
- To learn the need for scaling function.
- To study the applications of Multi rate systems and filter banks.
- To know the applications of transforms.

Course Outcomes (CO): Students will be able to

- Study about different types of transforms for different types of signals.
- Understand the application of wavelets for different types of signals.
- Learn the need for scaling function.
- Study the applications of Multi rate systems and filter banks.
- Know the applications of transforms.

UNIT - I		Lecture Hrs:

Review of Transforms: Signal spaces, concept of convergence, Hilbert spaces for energy signals, Orthogonality, Ortho normality, Fourier basis, FT-failure of FT-need for time-frequency analysis, spectrogram plot-phase space plot in time-frequency plane, Continuous FT, DTFT, Discrete fourier series and transforms, Z-Transform.

Advance Transforms: Relation between CFT-DTFT, DTFT-DFS, DFS-DFT, DCT (1D&2D), Walsh, Hadamard, Haar, Slant, KLT, Hilbert Transforms – definition, properties and applications.

UNIT - II		Lecture Hrs:

CWT and MRA: Time-frequency limitations, tiling of time-frequency plane for STFT, Heisenberg uncertainty principle, short time Fourier Transform (STFT) analysis, short comings of STFT.

Need for Wavelets: Wavelet Basis- Concept of scale and its relationship with frequency, Continuous time wavelet transform equation- Series expansion using Wavelets- CWT.

UNIT - III		Lecture Hrs:

Need for Scaling Function: Multi resolution analysis, Tiling of time scale plane for CWT. Important Wavelets: Haar, Mexican Hat Meyer, Shannon, Daubechies.

Special Topics: Wavelet packet transform, Bi-orthogonal basis- B-splines, Lifting scheme of wavelet generation-implementation

UNIT - IV		Lecture Hrs:

Multirate Systems, Filter Banks and DWT: Basics of Decimation and Interpolation in time & frequency domains, Two-channel filter bank, Perfect reconstruction condition, Relationship between filter banks and Wavelet basis, DWT filter banks for Daubechies wavelet function.

UNIT - V		Lecture Hrs:

Applications of Transforms: Signal de-noising, Sub-band coding of speech and music, Signal Compression - Use of DCT, DWT, KLT.

Textbooks:

1. Jaideva C Goswami, Andrew K Chan, “Fundamentals of Wavelets- Theory, Algorithms and Applications”, John Wiley & Sons, Inc, Singapore, 1999.
2. Raghuveer M. Rao and Ajit S. Bopardikar, “Wavelet Transforms-Introduction theory and applications” Pearson edu, Asia, New Delhi, 2003.

Reference Books:

1. Vetterli M. Kovacevic, “Wavelets and sub-band coding”, PJI, 1995.
2. C. Sydney Burrus, “Introduction to Wavelets and Wavelet Transforms”, PHI, 1st Edition, 1997.
3. S. Jayaraman, S. Esakkirajan, T. Veera Kumar, “Digital Image Processing”, TMH, 2009
4. Soman.K. P, Ramachandran K.I, “Insight into Wavelets from Theory to practice”, Prentice Hall India, First Edition, 2004.

Online Learning Resources:

Course Code		ANALOG AND MIXED SIGNAL DESIGN LAB	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- To understand the layout design rules and design a schematic & layout for Combinational and Sequential Circuits.
- To learn the implementation of Layout, Physical Verification and place & routing for complex designs.
- To verify the layouts, DRC and LVS.

Course Outcomes (CO): Students will be able to

- Understand the layout design rules and design a schematic & layout for Combinational and Sequential Circuits.
- Learn the implementation of Layout, Physical Verification and place & routing for complex designs.
- Verify the layouts, DRC and LVS.

List of Experiments:

Introduction to layout design rules. Layout, physical verification, placement & routing for complex design, static timing analysis and IR drop analysis for all following **TWELVE** experiments need to be done

1. Design and verify the CMOS inverter.
2. Design CMOS NAND and NOR gates.
3. Design CMOS XOR/XNOR by using NAND/NOR gates.
4. Design CMOS 1-bit full adder and verify the circuit using transient analysis.
5. Design CMOS 1-bit full Subtractor and verify the circuit using transient analysis.
6. Design a multiplexer and perform all the analysis to verify its characteristics.
7. Design and Implementation of RS –Latch.
8. Design and Implementation of D –Latch.
9. Design and Implementation of Asynchronous Counter.
10. Design and Implementation of Static SRAM Cell.
11. Analog Circuit simulation (AC analysis) – CS (Common Source) amplifier.
12. Analog Circuit simulation (AC analysis) – Differential amplifier.

Equipment/Software Required:

- ➢ EDA Tools - Industry Standard software-latest version like Mentor/ Synopsys /Equivalent.
- ➢ Personal computer with necessary peripherals.

References:

Online learning resources/Virtual labs:

Course Code		ADVANCED COMMUNICATIONS AND NETWORKS LAB	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- To implement digital filters for the given specifications.
- To design and simulate different modulation schemes for the given specifications.
- To design and implement demodulation schemes for the given specifications.

Course Outcomes (CO): Student will be able to

- Implement digital filters for the given specifications.
- Design and simulate different modulation schemes for the given specifications.
- Design and implement demodulation schemes for the given specifications.

List of Experiments:

Student must do ANY **TWELVE** experiments.

1. Implementation of Matched Filters.
2. Optimum receiver for the AWGN channel.
3. Design FIR (LP/HP/BP) filter using Window method.
4. Measurement of effect of Inter Symbol Interference.
5. Generation of constant envelope PSK signal wave form for different values of M.
6. Simulation of PSK system with M=4.
7. Simulation of DPSK system with M=4.
8. Design of FSK system.
9. Simulation of correlation type demodulation for FSK signal.
10. BPSK Modulation and Demodulation techniques.
11. QPSK Modulation and Demodulation techniques.
12. DQPSK Modulation and Demodulation techniques.
13. 8-QAM Modulation and Demodulation techniques.
14. DQAM Modulation and Demodulation techniques.
15. Verification of Decimation and Interpolation of a given signal.
16. Power spectrum estimation using AR model.

Software Requirements:

MATLAB, Qualnet simulator

References:

Online learning resources/Virtual labs:

Course Code		PROGRAM ELECTIVE – 5	L	T	P	C
Semester	III	DETECTION AND ESTIMATION THEORY	3	0	0	3

Course Objectives:

- To gain knowledge about various estimation and detection methods.
- To analyze different methods of minimum variance unbiased estimation techniques.
- To understand best linear unbiased estimators in detecting signals in the presence of noise.
- To learn about statistical decision theory and deterministic signals.
- To know about composite hypothesis testing and its approaches.

Course Outcomes (CO): Students will be able to

- Gain knowledge about various estimation and detection methods.
- Analyze different methods of minimum variance unbiased estimation techniques.
- Understand best linear unbiased estimators in detecting signals in the presence of noise.
- Learn about statistical decision theory and deterministic signals.
- Know about composite hypothesis testing and its approaches.

UNIT - I		Lecture Hrs:

Introduction to Estimation and Detection: Introduction, Detection and estimation in signal processing, the mathematical detection & estimation problem, Assessing estimator performance, Hierarchy of detection problems, Role of asymptotic.

UNIT - II		Lecture Hrs:

Minimum Variance Unbiased Estimation: Unbiased estimators, Minimum variance criterion, Existence of the minimum variance unbiased estimator, Finding the minimum variance unbiased estimator.

Cramer-Rao Lower Bound: Estimator of accuracy considerations, Cramer-Rao lower bound (CRLB), General CRLB for signals in white Gaussian noise, Transformation of parameters, Extension to a vector parameter, Vector parameter CRLB for transformations, CRLB for the general Gaussian case.

Linear Models: Definition and properties, Linear model examples, Extension to the linear model.

General Minimum Variance Unbiased Estimation: Introduction, Sufficient statistics, Finding sufficient statistics.

UNIT - III		Lecture Hrs:

Best Linear Unbiased Estimators: Definition of BLUE, Finding the BLUE, Extension to vector parameter.

Estimation Methods: Maximum likelihood estimation (MLE), Finding MLE, Properties of MLE, MLE for transformed parameters, Numerical determination of the MLE, Extension to a vector parameter, Least squares approach, Linear least squares, Method of moments, Extension to a vector parameter, Statistical evaluation of estimators.

The Basian Philosophy: Prior knowledge and estimation, Choosing a prior PDF, Properties of Gaussian PDF, Basian linear model, Minimum mean square error (MMSE) estimators, Maximum A posteriori estimators, Performance description, Linear basian estimators – Introduction, Linear MMSE estimation, Geometrical interpretations, Vector LMMSE estimator.

UNIT - IV		Lecture Hrs:

Statistical Decision Theory I: Introduction, Neyman-Pearson theorem, Receiver operating characteristics, Minimum probability of error, Bayes risk, Multiple hypothesis testing.

Deterministic Signals: Matched filters, Development of detector, Performance of matched filter, Performance of generalized matched filters, Multiple signals – Binary case and its performance, M-ary case, Linear model.

Random Signals: Estimator correlator, Linear model

UNIT - V		Lecture Hrs:

Statistical Decision Theory II: Introduction, Summary of composite hypothesis, Composite hypothesis testing (CHT).

CHT Approaches: Bayesian approach, Generalized likelihood approach, Performance of GLRT for large data records, Equivalent large data records tests.

Textbooks:
1. Steven M. Kay, "Fundamentals of Statistical Signal Processing – Estimation Theory," Pearson, 2010. 2. Shanmugam and Breipohl, "Detection of Signals in Noise and Estimation", John Wiley& Sons, 2004.
Reference Books:
1. Mischa Schwartz, L. Shaw, "Signal Processing: Discrete Spectral Analysis, Detection, and Estimation," McGraw Hill.
Online Learning Resources:

Course Code		EMBEDDED SYSTEM DESIGN	L	T	P	C
Semester	**II**		**3**	**0**	**0**	**3**

Course Objectives:

- To know about the basics of embedded systems their classification and application.
- To provide knowledge on the building blocks of embedded system.
- To understand the requirement of embedded firmware and its role in API.
- To learn about the role of real time operating system in embedded design.
- To gain the knowledge about task level communication in an embedded system.

Course Outcomes (CO): Student will be able to

- Know the basics of embedded systems their classification and application.
- Gain knowledge on the building blocks of embedded system.
- Understand the requirement of embedded firmware and its role in API.
- Learn about the role of real time operating system in embedded design.
- Gain the knowledge about task level communication in an embedded system.

UNIT - I		Lecture Hrs:

Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

UNIT - II		Lecture Hrs:

Typical Embedded System: Core of the Embedded System, General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces. DDR, Flash, NVRAM

UNIT - III		Lecture Hrs:

Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

UNIT - IV		Lecture Hrs:

RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.

UNIT - V		Lecture Hrs:

Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

Textbooks:

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.
2. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.

Reference Books:

1. Embedded Systems - Raj Kamal, TMH.
2. Embedded Systems – Lyla, Pearson, 2013
3. An Embedded Software Primer - David E. Simon, Pearson Education.

Online Learning Resources:

Course Code		PROGRAM ELECTIVE – 5	L	T	P	C
Semester	III	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	0	3

Course Objectives:

- To learn the basics of AI and problem solving techniques.
- To understand concepts of logic programming.
- To study the phases in building expert systems and their applications.
- To gain knowledge on machine learning systems and artificial neural networks.
- To learn different knowledge representation techniques.

Course Outcomes (CO): Student will be able to

- To learn the basics of AI and problem solving techniques.
- To understand concepts of logic programming.
- To study the phases in building expert systems and their applications.
- To gain knowledge on machine learning systems and artificial neural networks.
- To learn different knowledge representation techniques.

UNIT - I		Lecture Hrs:

Introduction: History, Intelligent systems, Foundations of AI, Sub areas of AI, Applications.
Problem Solving – State Space Search and Control Strategies: Introduction, General problem solving, Characteristics of problem, Exhaustive searches, Heuristic search techniques, Iterative-deepening, Constraint satisfaction. Game playing, Bounded lsook-ahead strategy and use of evaluation functions, Alpha-Beta pruning

UNIT - II		Lecture Hrs:

Logic Concepts and Logic Programming: Introduction, Propositional calculus, Propositional logic, Natural deduction system, Axiomatic system, Semantic tableau system in propositional logic, Resolution refutation in propositional logic, Predicate logic, Logic programming.
Knowledge Representation: Introduction, Approaches to knowledge representation, Knowledge representation using semantic network, Extended semantic networks for KR, Knowledge representation using frames.

UNIT - III		Lecture Hrs:

Expert System and Applications: Introduction, Phases in building expert systems, Expert system architecture, Expert systems Vs Traditional systems, Truth maintenance systems, Application of expert systems, List of shells and tools.
Uncertainty Measure – Probability Theory: Introduction, Probability theory, Bayesian belief networks, Certainty factor theory, Dempster-Shafer theory.

UNIT - IV		Lecture Hrs:

Machine-Learning Paradigms: Introduction, Machine learning systems, supervised and unsupervised learning, Inductive learning, Learning decision trees, Deductive learning, Clustering, Support vector Machines.
Artificial Neural Networks: Introduction, Artificial neural networks, Single- layer feed-forward networks, Multi-layer feed-forward networks, Radial- Basis function networks, Design issues of artificial neural networks, Recurrent networks.

UNIT - V		Lecture Hrs:

Advanced Knowledge Representation Techniques: Case grammars, Semantic web natural language processing: Introduction, Sentence analysis phases, Grammars and parsers, Types of parsers, Semantic analysis, Universal networking knowledge.

Textbooks:

1. Saroj Kaushik. Artificial Intelligence. Cengage Learning, 2011.
2. Andreas C. Müller and Sarah Guido, “Introduction to Machine Learning with Python A Guide for Data Scientists”, O’Reilly, 1st Edition, 2016.

Reference Books:

1. Rich, Knight, Nair: Artificial intelligence, Tata McGraw Hill, Third Edition 2009.
2. Russell, Norvig: Artificial intelligence, A Modern Approach, Pearson Education, 2nd Edition, 2004.
3. Jason brownlee “Statistical methods for machine learning – Discover how to transform data into knowledge with python”, Machine learning mastery, 2018.

Online Learning Resources:

Course Code		RESEARCH METHODOLOGY AND IPR	L	T	P	C
Semester	**I**		**2**	**0**	**0**	**2**

Course Objectives:

- To know how to identify an appropriate research problem in their interesting domain.
- To understand the ethical issues in the preparation of a research report.
- To learn about different types of Intellectual property rights.
- To gain knowledge about the law of patent rights and copyrights.
- To know about the new developments in IPR.

Course Outcomes (CO): Student will be able to

- Know how to identify an appropriate research problem in their interesting domain.
- Understand the ethical issues in the preparation of a research report.
- Learn about different types of Intellectual property rights.
- Gain knowledge about the law of patent rights and copyrights.
- Know about the new developments in IPR.

UNIT - I		Lecture Hrs:

Research problem: 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		Lecture Hrs:

Literature study : Effective literature studies, approaches, analysis, Plagiarism, Research ethics, Effective technical writing, how to write report, Paper developing a research proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT - III		Lecture Hrs:

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 - IV		Lecture Hrs:

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

UNIT - V		

New Developments in IPR: Administration of patent system, New developments in IPR, IPR of biological systems, Computer software etc., Traditional knowledge Case Studies, IPR and IITs.

Textbooks:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

Reference Books:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.

Course Code		ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
Semester	I		2	0	0	0

Course Objectives:

- Understand the essentials of writing skills and their level of readability.
- Learn about what to write in each section.
- Ensure qualitative presentation with linguistic accuracy.

Course Outcomes (CO): Student will be able to

- Understand the significance of writing skills and the level of readability.
- Analyze and write title, abstract, different sections in research paper
- Develop the skills needed while writing a research paper

UNIT - I Lecture Hrs:10

Overview of a research paper, Planning and preparation, Word order, Useful phrases, Breaking up long sentences, Structuring paragraphs and sentences, Being concise and removing redundancy, Avoiding ambiguity.

UNIT - II Lecture Hrs:10

Essential components of a research paper, Abstracts , Building hypothesis, Research problem, Highlight findings, Hedging and criticizing, Paraphrasing and plagiarism, Cauterization.

UNIT - III Lecture Hrs:10

Introducing review of the literature, Methodology, Analysis of the data, Findings, Discussion, Conclusions, Recommendations.

UNIT - IV Lecture Hrs:9

Key skills needed for writing a Title, Abstract, and Introduction.

UNIT - V Lecture Hrs:9

Appropriate language to formulate methodology, Incorporate results, put forth Arguments and draw Conclusions.

Suggested Reading

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