



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (A)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
ACCREDITED BY NAAC A+

Programme Structure
R25 M. Tech (CE &SP and (SP & C) Structure
M. Tech (CE &SP) and (SP & C) I – Semester

S. No.	Course Code	Course Title	L	T	P	C
1	Program Core -1	Mathematical Foundations for Communication Engineering	3	1	0	4
2	Program Core-2	Advanced Digital Communications	3	1	0	4
3	Program Core-3	ARM Controllers and Embedded 'C'	3	1	0	4
4	Program Elective- 1	1. FPGA based System Design 2. Detection and Estimation Theory 3. Cognitive Radio 4. Satellite Navigation Systems	3	0	0	3
5	Program Elective- 2	1. Software Defined Radio 2. Mobile Cellular Communications (Including 5G & B5G) 3. Radar Systems 4. Biomedical Signal Processing	3	0	0	3
6	Laboratory- 1	Advanced Digital Communications Lab	0	1	2	2
7	Laboratory- 2	Embedded System Design Lab	0	1	2	2
8		Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

List of Professional Elective Courses in I Semester (Electives – I & II)

S.No.	Course Code	Course Title
1		FPGA based System Design
2		Detection and Estimation Theory
3		Cognitive Radio
4		Satellite Navigation Systems
5		Software Defined Radio
6		Mobile Cellular Communications (Including 5G & B5G)
7		Radar Systems
8		Biomedical Signal Processing

@Minimum 2/3 themes per elective

BOS Members

1. Dr. B. Lecala Kumari *B. Lecala Kumari*

5. Prof. B.T. Krishna *B.T. Krishna*

2. Prof. Srinivas kumar *Srinivas Kumar*

6. Prof. Shaik Rafi Ahamed *Shaik Rafi Ahamed*

3. Prof. K. Padma raju *K. Padma raju*

7. Prof. P. Srihari *P. Srihari*

4. Prof. A.M. Prasad *A.M. Prasad*

8. Er. K V Sri ram

9. Mr. Seshu Venkat

10. Mrs. Geethika Praneeta *Geethika Praneeta*



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Programme Structure
R25 M. Tech (CE & SP and (SP & C) Structure
M. Tech(CE & SP and (SP & C) II – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	Program Core-4	System Design with RTOS & Embedded LINUX	3	1	0	4
2	Program Core-5	Advanced Signal and Image Processing	3	1	0	4
3	Program Core-6	Information Theory and Coding	3	1	0	4
4	Program Elective-3	1. Advanced C ⁺⁺ Programming 2. IoT & its Communication Protocols 3. AI in Signal Processing and Wireless Communication 4. Smart Antennas and Beam Forming Techniques	3	0	0	3
5	Program Elective-4	1. Mobile Networks 2. Radar Signal Processing 3. DSP Processors & Architectures 4. VLSI Signal Processing	3	0	0	3
6	Laboratory- 3	Wireless Communications Lab	0	1	2	2
7	Laboratory- 4	System Design with RTOS & Embedded Linux Lab	0	1	2	2
8		Seminar-II	0	0	2	1
		TOTAL	15	5	6	23

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Code	Course Title
1		Advanced C ⁺⁺ Programming
2		IoT & its Communication Protocols
3		AI in Signal Processing and Wireless Communication
4		Smart Antennas and Beam Forming Techniques
5		Mobile Networks
6		Radar Signal Processing
7		DSP Processors & Architectures
8		VLSI Signal Processing

@Minimum 2/3 themes per elective

BOS Members

1. Dr.B.Lecala Kumari *B.Lecala Kumari*

5. Prof.B.T.Krishna *B.T.Krishna*

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Programme Structure
R25 M. Tech (CE &SP and (SP & C) Structure
M. Tech(CE &SP and (SP & C) III – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR / Swayam 12weekMOOCcourse– RM&IPR	3	0	0	3
2		Summer Internship/Industrial Training (8-10 weeks)*	-	-	-	3
3		Comprehensive Viva [#]	-	-	-	2
4		Dissertation Part– A ^{\$}	-	-	20	10
		TOTAL	3	-	20	18

*Student attended during summer/ year break and assessment will be done in 3rdSem.

Comprehensive viva can be conducted courses completed up to second sem.

\$ Dissertation – Part A, internal assessment

R25 M. Tech (CE &SP and (SP & C) Structure
M. Tech(CE &SP and (SP & C) IV – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Dissertation Part– B [%]	-	-	32	16
		TOTAL	-	-	32	16

%External Assessment

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8. Er.K V Sri ram

9. Mr. Seshu Venkat

10.Mrs. Geethika Pranecta *Geethika Pranecta*

PG BOS Meeting - R25 Regulation (CE&SP)

12-09-25

A BOS meeting is conducted for PG R25 Regulation for CE&SP

The following are the Minutes of Meeting for PG (CE&SP)

✓ The course structure of R25 PG M.Tech (CE&SP) is finalized from the BOS panel members both external & internal.

✓ Syllabus for M.Tech (CE&SP) for R25 regulation is discussed and the panel members suggested the following.

(i) The syllabus for TICT is too high, advised to reduce the syllabus and finalized according to the suggestions by the BOS member.

(ii) The mathematical foundation for Communicating Engineering subject syllabus is to be modified by including additional topics in optimization techniques viz. meta-heuristic algorithm namely GA, PSO and ACO etc.

✓ The COs are defined for all the subjects

✓ 3 PO's are defined

✓ CO-PO mapping has initiated.

BOS members -

1. Dr. B. Leela Kumari -

B. Leela Kumari

2. Prof. S. Srinivas Kumar -

S. Srinivas Kumar

3. Prof. K. Padma Raju -

K. Padma Raju

4. Prof. A. N. Prasad -

A. N. Prasad

5. Prof. B. T. Krishna -

B. T. Krishna



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Vision of the Department

To remain a symbol of pride in the fields of Electronics and Communication Engineering by producing holistic and diligent Engineers for industrial and societal needs.

Mission of the Department

- 1: To produce high quality learners who are globally competitive and professionally challenged in the field of electronics and communication engineering.
- 2: To offer educational programmes that imparts inventive knowledge with high levels of ethical and human values.
- 3: To provide a platform to acquire and implement innovative ideas in research and development.
- 4: To build up the state of art laboratories and centers of excellence in different areas of electronics and communication engineering.
- 5: To train the students and faculty to update their knowledge in pioneering technologies to meet industrial requirements.

Vision of the Institute

To be a premier institute of excellence developing highly talented holistic human capital that contributes to the nation through leadership in technology and innovation through engineering education

Mission of the Institute

1. To impart Personnel Skills and Ethical Values for Sustainable Development of the Nation.
2. To create Research & Industry oriented centers of excellence in all engineering disciplines.
3. To be a renowned IPR generator and repository for innovative technologies.
4. To develop Research and Industry oriented technical talent.
5. To benchmark globally the academic & research output.

Vision of the University

The University is primarily promoting quality of education in the areas of Science, Technology, Engineering and Mathematics (STEM) as four academic pillars of education, to excel in teaching, learning, research, consultancy and placements through innovative practices with global perspective.

Mission of the University

1. Design an Industry relevant curriculum from time to time with a Global perspective
2. Promoting quality education by embracing ICT delivery mechanism with continuous pedagogy through e-learning mechanism
3. Spread across for industry collaborations with a focus to pre-training and placements for technology transfer to society
4. Establishing centers of excellence to promote research and innovations in multidisciplinary areas to bring in patent culture and consultancy practices
5. International Collaborations for student outreach
6. Facilitating international students to study in JNTUK to infuse cross culture learning practices.



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Program Educational Objectives (PEOs)

PEO-1 To prepare quality Postgraduates in Electronics Engineering with specialization in VLSI and Embedded System design with in-depth knowledge of relevant subjects.

PEO-2 To create professionals who can formulate, analyze, synthesize and be able to pursue higher research for engineering problems.

PEO-3 To develop skillful manpower in the area of VLSI and Embedded Systems who can design and manufacture state-of-the art systems/products to meet the requirements of industry.

Programme Outcomes(POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: Postgraduates will apply knowledge acquired in Mathematics, Science and Engineering to solve *Communication System and Signal Processing Design* problems.

PO5: Postgraduates will function on multidisciplinary technological issues, assimilating advancements in *Communication Engineering and Signal Processing*, and apply reasoning for synthesis to make creative advances for conducting research.

PO6: Postgraduates will learn and apply the latest hardware and software tools/platforms, modern techniques and technologies, optimization methods to solve complex engineering problems.



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M.Tech (Communication Engineering & Signal processing and Signal processing & Communication) Programmes Course Structure & Syllabus



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I Semester	L	T	P	C
	3	1	0	4

MATHEMATICAL FOUNDATIONS FOR COMMUNICATION ENGINEERING

COURSE OBJECTIVES:

1. To introduce foundational concepts in probability, statistics, and hypothesis testing.
2. To develop understanding of stochastic processes and their applications.
3. To equip students with numerical methods for solving mathematical problems.
4. To explore optimization techniques for constrained and unconstrained problems.
5. To familiarize students with wavelet transforms and multi-resolution analysis.

Unit – I: Probability and Statistics:

Sampling distributions, Estimation of parameters (point estimation – unbiasedness & minimum variance, basics of interval estimation – confidence interval for mean), Testing of hypotheses (one and two sample tests for mean), Linear regression, Introduction to non-linear regression, optimization techniques viz., Meta-heuristic algorithms namely Genetic Algorithm, Particle Swarm Optimization, and Ant Colony Optimization algorithms, etc.

Unit II: Stochastic process:

Random processes, Random walk, Markov process with special emphasis on Markov chain

Unit – III: Numerical Analysis:

Introduction to Interpolation formulae [Bessel's & Sterling's], Roots of transcendental equations [Bisection, Regula-Falsi & Newton-Raphson] Solutions of simultaneous non-linear equations [Newton's method], Numerical solution of Ordinary Differential equation [Modified Euler's method, fourth order Runge-Kutta method], Matrix Eigen value and Eigen vector problems.

Unit IV: Optimization Technique:

Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Constrained Optimization, Lagrange multipliers, Gradient method – steepest descent method.

Unit V: Wavelet Transform:

Resolution problems, Multi-resolution analysis, Continuous & discrete wavelet transform

TEXT BOOKS:

1. A. Papoulis and S. Unnikrishnan Pillai, "Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill. (Indian Edition is available).



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REFERENCE BOOKS:

1. H.Stark and J. Woods, 'Probability and Random Processes with Applications to Signal Processing,' Third Edition, Pearson Education. (Indian Edition is available).
2. Steven M. Kay, "Intuitive Probability and Random Process using MATLAB", Springer Publications.
3. Todd K Moon, Wynn C. Stirling" Mathematical Methods and Algorithms for Signal Processing, Prentice Hall.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Apply statistical methods for estimation and hypothesis testing.
2. Analyze and model stochastic processes including Markov chains.
3. Solve equations and differential problems using numerical techniques.
4. Optimize multivariable functions using analytical and numerical methods.
5. Implement wavelet transforms for signal and data analysis.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	M	H	M	M
CO2	H	L	H	H	M	M
CO3	M	L	H	H	M	H
CO4	M	L	H	H	M	H
CO5	M	L	H	H	M	H



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I Semester	L	T	P	C
	3	1	0	4

ADVANCED DIGITAL COMMUNICATIONS

COURSE OBJECTIVES

1. To understand the components and models of digital communication systems.
2. To explore signal representation and various digital modulation techniques.
3. To analyse receiver performance in additive white Gaussian noise (AWGN) environments.
4. To study estimation techniques and design principles for band-limited channels.
5. To examine advanced receiver architectures, equalization methods, and multicarrier systems like OFDM.

UNIT I: Elements and Channels in Digital Communication Elements of a Digital Communication System, Mathematical Models for Communication Channels, Communication Channels and Their Characteristics

UNIT II: Signal Representation and Modulation Techniques Representation of Bandpass Signals and Systems, Signal Space Representations, Representation of Digitally Modulated Signals, Memoryless Modulation Methods: Pulse Amplitude Modulation, Phase Modulation Schemes, Quadrature Amplitude Modulation, Multi-dimensional Signaling, Spectral Characteristics of Digitally Modulated Signals

UNIT III: Optimum Receivers and Performance in AWGN Optimum Receiver for Signals Corrupted by AWGN, Performance of the Optimum Receiver for Memoryless Modulation, Optimum Receiver for CPM Signals and Signals with Random Phase in AWGN Channel

UNIT IV: Estimation and Band-limited Channel Design Signal Parameter Estimation, Carrier Phase Estimation, Symbol Timing Estimation, Joint Estimation of Carrier Phase and Symbol Timing, Performance Characteristics of ML Estimators, Characterization of Band-limited Channels, Signal Design for Band-limited Channels, Probability of Error in Detection of PAM, Modulation Codes for Spectrum Shaping

UNIT V: Advanced Receivers, Equalization, and Multicarrier Systems Optimum Receiver for Channels with ISI and AWGN, Linear Equalization, Decision Feedback Equalization, Reduced Complexity ML Detectors, Iterative Equalization and Decoding (Turbo Equalization), Multicarrier Systems: Multi Carrier Communications, Orthogonal Frequency Division Multiplexing (OFDM), Modulation and Demodulation of OFDM System, Algorithm Implementation IFFT/FFT of OFDM, Peak to Average Power Ratio in Multi Carrier Modulation

TEXTBOOKS:

1. J.G. Proakis, 'Digital communications', MGH, 4th edition, 2001
2. Upamanyu Madhow, 'Fundamentals of Digital Communication', Cambridge University Press



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REFERENCE BOOKS:

1. Michael Rice, Digital Communications: A Discrete-Time Approach, Prentice Hall,

COURSE OUTCOMES

1. Describe the structure and characteristics of digital communication channels.
2. Represent and analyse digitally modulated signals using signal space concepts.
3. Evaluate the performance of optimum receivers in noisy environments.
4. Apply estimation techniques for signal parameters and design signals for band-limited channels.
5. Implement equalization strategies and multicarrier modulation schemes including OFDM.

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Describe the structure and characteristics of digital communication channels	L	–	M	H	L	L
CO2: Represent and analyse digitally modulated signals using signal space concepts	M	–	M	H	M	M
CO3: Evaluate the performance of optimum receivers in noisy environments	H	–	H	H	M	M
CO4: Apply estimation techniques for signal parameters and design signals for band-limited channels	M	–	H	H	H	M
CO5: Implement equalization strategies and multicarrier modulation schemes including OFDM	H	M	H	H	H	H



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I Semester

L	T	P	C
3	1	0	4

ARM CONTROLLERS AND EMBEDDED 'C'

COURSE OBJECTIVES

1. To introduce ARM processor architecture, instruction sets, and efficient programming techniques.
2. To explore exception handling, memory hierarchy, and management units in ARM systems.
3. To develop embedded system applications using ARM Cortex-M microcontrollers.
4. To implement peripheral interfacing techniques including UART, ADC/DAC, and GPIO.
5. To understand communication protocols like I²C and SPI through practical case studies.

UNIT- I: ARM Processor Fundamentals: ARM Design Philosophy, Registers, CPSR, Pipeline, Exceptions, Interrupts and Vector Table, Core Extensions.

Introduction to the ARM Instruction Set: Data Processing Instructions, Branch Instructions, Load Store Instructions, Software Interrupt Instruction, PSR Instructions.

Introduction to the Thumb Instruction Set: Thumb Register Usage, Branch Instructions, Data Processing Instructions, Load-Store Instructions, Stack instructions, Software Interrupt Instruction.

Efficient C Programming: Basic C Data Types, C Looping Structures, Register Allocation, Function Calls, Structure Arrangement.

Writing and Optimizing ARM Assembly Code: Writing Assembly Code, Profiling and Cycle Counting, Instruction Scheduling, Register Allocation, Conditional Execution, Looping Constructs.

UNIT- II:

Exception and Interrupt Handling: Exception Handling, Interrupts, Interrupt Handling Schemes

Caches: The Memory Hierarchy and Cache Memory, Cache Architecture, Cache Policy, Flushing and Cleaning Cache Memory.

Memory Protection Units: Protected Regions, Initializing the MPU, Caches and Write Buffer.

Memory Management Units: Moving from an MPU to an MMU, How Virtual Memory Works, Details of the ARM MMU, Page Tables, Translation Lookaside Buffer, Domains And Memory Access Permission, The Fast Context Switch Extension

UNIT- III:

Introduction: Definition of Embedded Systems, Real life examples of embedded systems, Basics of Developing for Embedded Systems

ARM Instruction set Architecture: ARM Cortex-M Organization, Arithmetic, Logical and Shift instructions, Data Movement Instructions, Branch instructions, Program Status register, Bitwise logic operations, Sign and Zero extension, Data Comparison, Memory addressing, Branch and conditional execution, Control structures, Subroutines, 64-bit data processing.

GPIO: GPIO Input Modes, GPIO Output Modes, Memory-mapped I/O, Push button, Programming exercises on GPIO and Push-button



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General-purpose Timers: Clock Configuration, Timer Organization, and Counting Modes, Timer Update Events, PWM Registers, Configuration and initialization of PWM block, Programming exercises on the selection of clock source, Timer's concept, and PWM

UNIT-IV:

UART: UART Block, UART Registers, UART baud rate calculation, Configuration and initialization of UART

ADC/DAC: ADC & DAC registers, pin configuration, ADC modes, Configuring ADC and DAC module, Programming exercises on ADC and DAC

Interfacing: Keypad, LCD, and Seven segment display interfacing with ARM Cortex-M3 Microcontroller

UNIT-V:

Inter-Integrated Circuit (I²C): I²C operating modes, Configuration of I²C, Interface a sensor using I²C protocol

Serial Peripheral Interface (SPI): SPI Modes, Master operation, Slave operation, Configuration of SPI

Case Study: Smart Home-Smart Door Locks and Interface a temperature sensor with an I²C Module to measure the room temperature.

TEXT BOOKS:

1. A.Sloss, D.Symes, C.Wright, "ARM system Developers Guide: Designing and Optimizing System Software", Morgan Kaufmann publishers, 2012.
2. Dr.Yifeng Zhu "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C" Third edition, 2018

REFERENCE BOOKS:

1. Steve Furber, "ARM System on Chip Architecture", 2nd ed., Addison Wesley Professional, 2000.
2. Valvano, J, "Embedded microcomputer systems: real time interfacing", 3rd Edition, Cengage Learning, 2011.
3. Frank Vahid, Tony Givargis, "Embedded System Design", J Wiley India, 2005.
4. Ariel Lutenberg, Pablo Gomez, Eric Pernia "A Beginner's Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers"
5. Qing Li, Caroline Yao "Real-time concepts for Embedded Systems" CMP books.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Demonstrate proficiency in ARM instruction sets and assembly code optimization.
2. Configure and manage exceptions, interrupts, and memory systems in ARM-based designs
3. Develop embedded applications using GPIO, timers, and control structures.
4. Interface and program peripherals such as UART, ADC/DAC, and display modules.
5. Apply I²C and SPI protocols in real-world scenarios like smart home systems



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COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Demonstrate proficiency in ARM instruction sets and assembly code optimization	H	M	H	L	M	L
CO2: Configure and manage exceptions, interrupts, and memory systems in ARM-based designs	H	H	H	M	M	L
CO3: Develop embedded applications using GPIO, timers, and control structures	M	M	H	M	H	M
CO4: Interface and program peripherals such as UART, ADC/DAC, and display modules	M	H	H	M	H	M
CO5: Apply I ² C and SPI protocols in real-world scenarios like smart home systems	M	H	H	H	H	M



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I Semester	L	T	P	C
	3	0	0	3

FPGA based System Design

Unit – I: Combinational Logic, Boolean Algebra and Algebraic Simplification, Karnaugh Maps, Designing with NAND and NOR Gates, Hazards in Combinational Circuits, Flip-Flops and Latches, Mealy Sequential Circuit Design, Design of a Moore Sequential Circuit, Equivalent States and Reduction of State Tables, Sequential Circuit Timing, Tristate Logic and Busses

Unit-II: Verilog HDL: Basic Concepts, Modules and Ports, Gate Level Modeling, Dataflow Modeling, Behavioural Modeling, Timings and Delays. Modeling multiplexers, decoders, adders, encoders, latches, flipflops, registers, counters in Verilog HDL

Unit-III: Design Examples: BCD to 7-Segment Display Decoder, A BCD Adder, 32-Bit Adders, Traffic Light Controller, State Graphs for Control Circuits, Scoreboard and Controller, Synchronization and Debouncing, A Shift-and-Add Multiplier, Array Multiplier, A Signed Integer/Fraction Multiplier. State Machine Charts: Derivation of SM Charts, Realization of SM Charts

Unit-IV: Introduction to Programmable Logic Devices, Brief Overview of Programmable Logic Devices, Simple Programmable Logic Devices (SPLDs), Complex Programmable Logic Devices (CPLDs), Field-Programmable Gate Arrays (FPGAs). Designing with Field Programmable Gate Arrays: Implementing Functions in FPGAs, Implementing Functions Using Shannon's Decomposition, Carry Chains in FPGAs, Cascade Chains in FPGAs, Examples of Logic Blocks in Commercial FPGAs, Dedicated Memory in FPGAs, Dedicated Multipliers in FPGAs, Cost of Programmability, FPGAs and One-Hot State Assignment, FPGA Capacity: Maximum Gates versus Usable Gates

Unit-V: Introduction to SoC FPGAs: Xilinx FPGA devices overview, Xilinx SoC overview and history, Xilinx Zynq-7000 SoC family hardware features, Xilinx Zynq Ultrascale+ MPSoC family overview, On-chip buses and interconnects overview, ARM AMBA interconnect protocols suite, OCP interconnect protocol, DMA engines and data movements, Legacy off-chip interconnects overview, Introduction to the PCIe interconnect, Ethernet interconnect, Introduction to the Gen-Z protocol, CCIX protocol and off-chip data coherency

Text books :

1. Charles H. Roth Jr. Lizy Kurian John, Byeong Kil Lee, “**Digital Systems Design Using Verilog**”, CL Engineering, 1st edition, 2015.
2. Samir Palnitkar, “**Verilog HDL**”, Pearson Education, 2nd edition, 2004

Reference:

1. Charles H. Roth Jr, “**Fundamentals of Logic Design**”, CL Engineering, 7th edition, 2013.
2. John F. Wakerly, “**Digital Design - Principles and Practices**”, Pearson, 4th edition, 2008.
3. W. Wolf, “**FPGA- based System Design**”, Pearson, 1st edition, 2004.
4. D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, **Embedded System Design: Modeling, Synthesis, Verification**, Springer, 2009.
5. Steve Kilts, “**Advanced FPGA Design: Architecture, Implementation, and Optimization**”, Wiley-IEEE Press, 1st edition, 2007 .
6. J. Bhasker, “**A Verilog HDL Primer**”, Star Galaxy Publishing, 3rd edition, 2005.
7. **Xilinx FPGA user guides** and University Program Course materials



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CO1: Apply the principles of Boolean algebra, combinational logic design, sequential circuit design, and timing analysis to model and analyze digital systems.

CO2: Develop and implement digital system modules in Verilog HDL using gate-level, dataflow, and behavioral modeling approaches.

CO3: Design and simulate practical digital systems such as adders, multipliers, controllers, and state machines using state graphs and SM charts.

CO4: Analyze and implement logic functions on programmable logic devices (SPLDs, CPLDs, FPGAs) and evaluate the trade-offs in cost, capacity, and performance.

CO5: Demonstrate knowledge of SoC FPGAs, Xilinx Zynq families, interconnect protocols, and system-level integration concepts for modern high-performance digital systems.

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Apply the principles of Boolean algebra, combinational logic design, sequential circuit design, and timing analysis to model and analyze digital systems.	H	M	H	H	M	M
CO2: Develop and implement digital system modules in Verilog HDL using gate-level, dataflow, and behavioral modeling approaches.	M	M	H	H	M	H
CO3: Design and simulate practical digital systems such as adders, multipliers, controllers, and state machines using state graphs and SM charts.	H	M	H	H	M	H
CO4: Analyze and implement logic functions on programmable logic devices (SPLDs, CPLDs, FPGAs) and evaluate the trade-offs in cost, capacity, and performance.	H	M	H	H	H	H
CO5: Demonstrate knowledge of SoC FPGAs, Xilinx Zynq families, interconnect protocols, and system-level integration concepts for modern high-performance digital systems.	H	M	H	H	H	H



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	L	T	P	C
I Semester	3	0	0	3

Detection and Estimation Theory
(ELECTIVE-I)

COURSE OBJECTIVES

1. To introduce the fundamentals of random processes and their classifications.
2. To explore detection theory and decision-making under uncertainty.
3. To study optimal filtering techniques including Wiener and Kalman filters.
4. To develop statistical tools for estimation and hypothesis testing.
5. To apply estimation techniques to analyze and model random processes from data.

UNIT –I:

Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

UNIT –II:

Detection Theory: Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)-minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

UNIT –III:

Linear Minimum Mean-Square Error Filtering: Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

UNIT –IV:

Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

UNIT –V:

Estimating the Parameters of Random Processes from Data: Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Spectral Density Functions.

TEXT BOOKS:

1. Steven M. Kay, "Fundamentals of Statistical signal processing, volume-1: Estimation theory". Prentice Hall 2011.
2. Steven M. Kay, "Fundamentals of Statistical signal processing, volume-2: Detection theory". Prentice Hall 2011.



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REFERENCE BOOKS:

1. Harry L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, Inc. 2011.
2. A. Papoulis and S. Unni Krishna Pillai, "Probability, Random Variables and stochastic processes, 4e". The McGraw-Hill 2010.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Analyze and model various types of random processes including Markov and Gaussian.
2. Apply Bayesian and Neyman-Pearson decision rules for signal detection problems.
3. Design and implement optimal filters for signal estimation in noisy environments.
4. Use statistical methods for parameter estimation and regression analysis.
5. Estimate characteristics of random processes using both model-free and model-based approaches.

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Analyze and model various types of random processes	H	–	H	H	M	M
CO2: Apply Bayesian and Neyman-Pearson decision rules	H	–	H	H	H	M
CO3: Design and implement optimal filters for signal estimation in noisy environments	H	M	H	H	H	H
CO4: Use statistical methods for parameter estimation and regression analysis	M	M	H	H	H	M
CO5: Estimate characteristics of random processes using model-free/model-based approaches	H	–	H	H	H	H



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I Semester

L	T	P	C
3	0	0	3

COGNITIVE RADIO
(ELECTIVE-I)

COURSE OBJECTIVES:

1. To introduce the fundamentals and characteristics of cognitive radio systems.
2. To explore spectrum sensing techniques and measurement methods.
3. To understand cognitive techniques for radio resource optimization.
4. To study the architecture and functional design of cognitive radio systems.
5. To analyze the role of cognitive radio in next generation wireless networks.

UNIT- I: Introduction to Cognitive Radio:

Definition and characteristics of cognitive radio, Cognitive radio vs. traditional radio systems, Cognitive cycle and functions, Dynamic spectrum access and spectrum holes, Regulatory aspects and spectrum policies, Applications and benefits of cognitive radio

UNIT- II: Spectrum Sensing and Measurement:

Spectrum sensing challenges, Energy detection, matched filter detection, cyclostationary feature detection, Cooperative spectrum sensing techniques, Wideband spectrum sensing, Sensing-throughput trade-off, Spectrum measurement and monitoring methods.

UNIT- III: Introduction to Cognitive Radios:

Marking Radio Self -aware, Cognitive techniques – Position Awareness, Environment Awareness in Cognitive Radios, Optimization of Radio Resources, Artificial Intelligence Techniques.

UNIT- IV: Cognitive Radio Architecture:

Cognitive Radio – Functions Components and Design Rules, Cognition Cycle – Orient, Plan Decide and act phases, Interface Hierarchy, Architecture Maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture.

UNIT- V: Next Generation Wireless Networks:

The XG Network Architecture, Spectrum Sensing, Spectrum Management, Spectrum Mobility, Spectrum Sharing, Upper Layer Issues, Cross Layer Design.

TEXT BOOKS:

1. Joseph Mitola III, Software Radio Architecture: Object-Oriented Approaches to Wireless Systems Engineering, Wiley-IEEE Press, 2000.
2. Bruce A. Fette (Ed.), Cognitive Radio Technology, 2nd Edition, Elsevier, 2009.
3. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, Cognitive Radio Communications and Networks: Principles and Practice, Academic Press, 2010.



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4. Simon Haykin, Cognitive Radio: Brain-Empowered Wireless Communications, IEEE Journal Article, 2005.

REFERENCE BOOKS:

1. Huseyin Arslan, *Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems*, Springer, 2007.
2. Kwang-Cheng Chen, Ramjee Prasad, *Cognitive Radio Networks*, Wiley, 2009.
3. Markus Dillinger, Kambiz Madani, Nancy Alonistioti, *Software Defined Radio: Architectures, Systems and Functions*, Wiley, 2003.
4. Timothy J. Brown, *Cognitive Radio Networks*, Wiley, 2015.
5. Jeffrey H. Reed, *Software Radio: A Modern Approach to Radio Engineering*, Prentice Hall, 2002.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Understand the fundamentals of cognitive radio and dynamic spectrum access.
2. Analyse spectrum sensing techniques and spectrum management policies.
3. Design the Wireless Networks Based on the Cognitive Radios.
4. Gives an Understanding of Cognitive Radio Architecture.
5. To Understand Concepts Behind Wireless Networks and Next Generation Networks.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Fundamentals of CR and DSA	H	—	H	H	M	M
CO2: Analyse spectrum sensing & management	H	—	H	H	H	M
CO3: Design wireless networks with CR	H	M	H	H	H	H
CO4: Cognitive radio architecture	M	—	H	H	M	M
CO5: Wireless & next generation networks	H	—	H	H	H	M



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SATELLITE NAVIGATION SYSTEMS

Course Outcomes (COs):

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

CO1: Explain orbital dynamics, satellite orbits, orbital elements, perturbations, and their impact on satellite communication performance.

CO2: Describe the architecture and functions of satellite space and ground segments, including subsystems and earth station equipment.

CO3: Analyze satellite link budgets by applying transmission theory, system noise concepts, and carrier-to-noise ratio calculations under different conditions.

CO4: Apply modulation and multiple access techniques for satellite communication, and evaluate link performance through case studies of practical systems (VSAT, DBS-TV, GPS, satellite telephony).

CO5: Assess the role of advanced satellite systems in modern applications such as navigation, internet, television, and small satellites.

UNIT 1.

Introduction and Orbital Dynamics: Overview of Satellite Communication, Historical background and current State, Kepler's three laws of planetary motion, orbit of satellite, Orbital elements, look angle determination, Placement of GEO satellite, orbital perturbation and orbital effects on Communication System performance.

UNIT 2.

Space and Ground Segment: Satellite subsystems: Attitude and orbit control system, Telemetry, Tracking, Commands and Monitoring, Power system, Communication system, Satellite antennas, Reliability. Equipment for the Earth station, Small earth station antennas.

UNIT 3.

Satellite Link Budget: Basic transmission theory, system noise temperature and G/T ratio, down link design, up-link design, overall carrier-to-noise ratio (CNR), effect of interferences and atmospheric attenuation.

UNIT4:

Modulation and Multiple Access Techniques: Digital modulation techniques, Frequency division multiple access, time division multiple access, code division multiple access, practical demand access systems, random access, multiple access with on-board processing Satellite .Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO. Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.

UNIT 5

Advanced Satellite Systems: Applications of Satellite Communication, Small satellites, Satellite television, Satellite internet, Satellite navigation system.



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1. T. Pratt, J. Alluntt, Satellite Communications, Wiley, 3rd. Edn.
2. G.D. Gordon and W.L. Morgan, Principles of Communication Satellites, John Wiley & Sons, Inc.
3. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition, 2010.
4. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.

REFERENCE BOOKS:

1. T T Ha, Digital Satellite Communications, McGraw Hill
2. William W Wu, Elements of Digital Satellite Communication, John Willey and Sons

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Explain orbital dynamics, orbits, perturbations & impact on performance	H	M	M	H	M	M
CO2: Describe space & ground segment, subsystems & earth stations	M	M	M	M	M	M
CO3: Analyze link budgets using transmission theory, noise concepts & C/N ratio	H	M	H	H	M	H
CO4: Apply modulation & multiple access techniques; evaluate through case studies	H	H	H	H	H	H
CO5: Assess advanced satellite systems for applications (navigation, internet, TV, small sats)	M	M	H	M	H	H



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I Semester

L	T	P	C
3	0	0	3

**SOFTWARE DEFINED RADIO
(ELECTIVE-II)**

COURSE OBJECTIVES:

1. To introduce the concepts, characteristics, and evolution of software radios.
2. To explore radio frequency implementation issues and RF front-end design.
3. To understand digital signal generation and synthesis techniques.
4. To study multirate signal processing methods and their applications in receivers.
5. To examine data conversion techniques and performance enhancement strategies.

UNIT- I:

Introduction to Software radio concepts: Introduction, need, characteristics, benefits and design principles of Software Radios. Traditional radio implemented in hardware (first generations of 2G cell phones), Software controlled radio (SCR), Software defined radio (SDR), Ideal software radio (ISR), Ultimate software radio (USR)

UNIT -II:

Radio frequency implementation issues: The purpose of RF Front-End, Dynamic range, RF Receiver Front-End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Importance of Components to Overall performance, Transmitter Architecture and their issues, Noise and Distortion in RF Chain.

UNIT- III:

Digital generation of signals: Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis, Analysis of Spurious Signals, Spurious components due to Periodic Jitter.

UNIT – IV:

Multirate Signal Processing: Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital receivers Using Multirate Digital Filters.

UNIT – V:

A/D & D/A Conversion: Introduction, Parameters of Ideal Data Converters, Parameters of Practical data Converters, Techniques to improve Data Converter performance, JTRS.

TEXT BOOKS and REFERENCE BOOKS:

1. Jeffery H. Reed, “Software Radio, (A modern approach to radio engineering)”, PHI PTR, 2002
2. John J. Roupheal, “RF and Digital Signal Processing for Software Defined Radio” Elsevier, Newness Publications.
3. C. Richard Johnson, Jr., and William A. Sethares, Telecommunication Breakdown, Prentice Hall, ISBN 0-13-143047-5, 2004



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COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the design principles and types of software radios from SCR to USR.
2. Analyse RF front-end architectures and assess their impact on system performance.
3. Compare digital and analog signal synthesis methods and evaluate spurious effects.
4. Apply multirate signal processing techniques for timing recovery and filtering.
5. Evaluate A/D and D/A converter parameters and techniques for performance.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Explain design principles & types of software radios	M	–	H	H	M	M
CO2: Analyse RF front-end architectures & system performance	H	–	H	H	H	M
CO3: Compare digital vs analog synthesis & spurious effects	H	–	H	H	M	M
CO4: Apply multirate processing for timing recovery & filtering	H	–	H	H	H	H
CO5: Evaluate A/D & D/A converter parameters & performance	H	M	H	H	M	H



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	L	T	P	C
I Semester	3	1	0	4

MOBILE CELLULAR COMMUNICATIONS (INCLUDING 5G & B5G)
(ELECTIVE-II)

COURSE OBJECTIVES:

1. To introduce the fundamentals and evolution of mobile and cellular communication systems.
2. To understand cellular geometry, frequency reuse, and techniques for coverage enhancement.
3. To explore multiple access techniques and evaluate their spectral efficiencies.
4. To study wireless technologies from 2G to 4G, including their features and limitations.
5. To examine the principles, specifications, and innovations in 5G communication systems.

UNIT 1: Introduction to Mobile and Cellular Communication Systems

Introduction to Mobile and Cellular Communication Systems, Generations of wireless mobile systems, Cellular Geometry, Introduction to cellular concept, Principle of Operation of a Cellular Mobile system, Call transfer operation to/from one mobile phone to another mobile, Analog and Digital Cellular Mobile Systems, Multiple Access Schemes, Existing Mobile Communication Technologies.

UNIT 2: Cellular Geometry, Frequency Reuse, Cell Splitting and Sectoring

Introduction, Cellular Geometry, Frequency Reuse, Improving Coverage and Capacity in Cellular Systems, Cell Splitting, Sectoring, Range Extension by the use of Repeaters, Microcell Zone concept, Picocell Zone Concept

UNIT 3: MAC Techniques and Spectral Efficiencies

Multiple Access Techniques for Wireless Communication and Advanced Transceiver Schemes, capacity and spectral Efficiency of FDMA, TDMA and CDMA.

UNIT 4: Wireless Generations Technologies up to 3G and 4G

3G Air interface technologies, 3G spectrum, Internet Speeds of 2G, 2.5G and 3G Technologies, Limitations of 3G, CDMA, CDMA2000, WCDMA, Comparison of WCDMA and CDMA2000. 4G Evolution, Objectives of the projected 4G, Advantages of 4G network technology over 3G, Applications of 4G, 4G Technologies, Smart Antenna Techniques and Limitations of 4G.

UNIT 5: 5G Communications

Introduction, Principle of operation of 5G Technology, Key parameters and Technical Specifications of 5G, Description of 5G technologies, 5G cellular system Error Correction Techniques

TEXT BOOK:

1. Gottapu Sasibhushana Rao, Raj Kumar Goswami, M.N.V.S.S Kumar
 “Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas)”,
 Paramount Book Distributors, 2025



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REFERENCE BOOKS:

1. "Wireless Communications: From Fundamentals to Beyond 5G" by Andreas F. Molisch, published by Wiley (IEEE Press) 8 December 2022
2. N. Ojaroudi Parchin, Ed., 'Advanced Wireless Communications and Mobile Networks - Current Status and Future Directions'. Intech Open, May 29, 2025. doi: 10.5772/intechopen.1006224.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Describe the architecture and operation of analog and digital cellular mobile systems.
2. Apply concepts of frequency reuse, cell splitting, and sectoring to improve system capacity.
3. Analyze MAC techniques and compare the spectral efficiencies of FDMA, TDMA, and CDMA.
4. Evaluate the advancements and limitations of 3G and 4G technologies including smart antennas.
5. Demonstrate understanding of 5G principles, technical specifications, and error correction.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Describe analog & digital cellular mobile systems	M	–	M	H	L	M
CO2: Apply frequency reuse, cell splitting & sectoring	H	–	H	H	M	M
CO3: Analyze MAC techniques & spectral efficiencies	H	–	H	H	H	H
CO4: Evaluate advancements & limitations of 3G/4G with smart antennas	H	M	H	H	H	H
CO5: Demonstrate understanding of 5G specs & error correction	H	M	H	H	H	H



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I Semester

L	T	P	C
3	1	0	4

RADAR SYSTEMS
(ELECTIVE-II)

COURSE OBJECTIVES:

1. To introduce the fundamental principles and operational concepts of radar systems.
2. To understand various radar types and tracking techniques used in modern radar systems.
3. To explore radar signal detection, information extraction, and estimation methods.
4. To study radar signal processing techniques including Doppler and MTI processing.
5. To examine advanced radar applications in navigation, warfare, and high-resolution imaging.

UNIT -I:

Radar fundamentals and operation: Introduction, principles, types of radar, transmitter functions, wave form spectra, receiver functions, signal processing, Radar equation, Radar cross section.

UNIT -II:

Radar Systems: Pulse, CW, FM-CW, MTI, Doppler and multimode techniques, Tracking Radar: Tracking system parameters, Conical Scan, amplitude comparison DTOA and phase interferometry. Range and velocity tracking, tracking accuracy, types of antennas using in radar systems.

UNIT -III:

Detection of Radar Signals and information extraction and estimation: Detection introduction, threshold detection, Signal integration, Binary integrators, CFAR, Theoretical accuracy of radar measurements, ambiguity function and radar waveform design, correlation detection and matched filter receiver.

UNIT – IV:

Radar signal processing: Signal integration, spectrum analysis, windows and resolution, MTI principles and methods, De staggering and processing, Moving Radars and moving clutter, Doppler processing.

UNIT – V:

Radar Applications: Direction finders, instrument landing systems, Radar beacons, Electronic Warfare, ECM and ECCM, high resolution radar, range and Doppler resolution, Pulse compression (analog and digital), Synthetic aperture radar, millimeter wave radars for radio fuse applications.

TEXT BOOKS:

1. Skolnik M.M., "Introduction to Radar systems & quot;, McGraw Hill, (Second Edition) 1981.
2. Byron Edde. 'Radar: principles, technology and applications Pearson Education Inc., 1995.

REFERENCE BOOKS:

1. D.Curtis Scheleher, "Introduction to Electronic Warfare Artech House Inc., 1986
2. Wheeler G.J., "Radar Fundamentals & quot;, Prentice Hall Inc. NJ 1967.



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3. LavanonNadav, "Radar Principles & quot; john Wiley & Sons, 1988.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the basic principles, types, and components of radar systems including transmitter and receiver functions.
2. Analyse different radar techniques such as pulse, CW, FM-CW, MTI, and Doppler, and evaluate tracking methods.
3. Apply detection and estimation techniques including CFAR, matched filtering, and ambiguity function analysis.
4. Demonstrate understanding of radar signal processing methods including spectrum analysis and Doppler processing.
5. Evaluate radar applications in direction finding, electronic warfare, pulse compression, and synthetic aperture radar.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Explain radar principles, types & components	M	–	M	H	L	M
CO2: Analyse radar techniques & tracking methods	H	–	H	H	H	M
CO3: Apply detection & estimation techniques (CFAR, matched filter)	H	–	H	H	H	H
CO4: Demonstrate radar signal processing (spectrum & Doppler)	H	–	H	H	H	H
CO5: Evaluate radar applications (EW, SAR, pulse compression)	H	M	H	H	H	H



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I Semester

L	T	P	C
3	1	0	4

BIOMEDICAL SIGNAL PROCESSING

Course Outcomes (COs)

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

CO1: Analyze the characteristics of random processes, ergodicity, autocorrelation, and power spectral density, and apply them to noise analysis in communication and biomedical systems.

CO2: Apply and compare lossy and lossless data compression techniques for biomedical signals, with emphasis on ECG compression and DICOM standards.

CO3: Design and implement cardiological signal processing techniques for QRS detection, arrhythmia analysis, ECG pattern recognition, and adaptive noise cancelling including fetal ECG monitoring.

CO4: Apply signal averaging and modelling techniques such as Prony's method, linear prediction, and Yule-Walker equations for analysis of evoked potentials.

CO5: Model and analyze neurological signals (EEG) for detection of brain wave patterns, seizure identification, and sleep stage analysis using advanced filtering and regression-based methods.

UNIT	CONTENTS
UNIT – 1	Random Processes: Stationary random process, Ergodicity, Power spectral density and autocorrelation function of random processes. Noise power spectral density analysis, Noise bandwidth and noise figure of systems.
UNIT– 2	Data Compression Techniques: Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, CORTES, Huffman coding, vector quantization DICOM Standards
UNIT – 3	Cardiological Signal Processing: Pre-processing, QRS Detection Methods, Rhythm analysis Arrhythmia Detection Algorithms, Automated ECG Analysis, ECG Pattern Recognition Adaptive Noise Cancelling Principles of Adaptive Noise Cancelling, Adaptive Noise Cancelling with the LMS Adaptation Algorithm Noise Cancelling Method to Enhance ECG Monitoring, Fetal ECG Monitoring
UNIT – 4	Signal Averaging, Polishing: Mean and trend removal, Prony's method, Prony's Method based on the Least Squares Estimate, Linear prediction, Yule – Walker (Y –W) equations, Analysis of Evoked Potentials
UNIT – 5	Neurological Signal Processing: Modelling of EEG Signals, Detection of spikes and spindles Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modelling of seizure EEG. Sleep Stage analysis Inverse Filtering, Least squares and polynomial modelling.

TEXT BOOKS:

1. Probability, Random Variables & Random Signal Principles – Peyton Z. Peebles, 4th Ed., 2009, TMH.
2. Biomedical Signal Processing- Principles and Techniques - D. C. Reddy, 2005, TMH.



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REFERENCE BOOKS:

1. Digital Bio Signal Processing - Weitkunat R, 1991, Elsevier.
2. Biomedical Signal Processing - Akay M, IEEE Press.
3. Biomedical Signal Processing - Vol. I Time & Frequency Analysis - Cohen. A, 1986, CRC Press

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Analyze random processes, ergodicity, PSD, autocorrelation, and noise figure of systems	H	M	M	H	M	L
CO2: Apply and compare lossy and lossless ECG data compression techniques and DICOM standards	M	H	M	M	H	L
CO3: Design cardiological signal processing methods for QRS detection, arrhythmia, adaptive noise cancelling, and fetal ECG monitoring	H	M	H	H	M	M
CO4: Apply signal averaging and modelling (Prony's, Yule-Walker, linear prediction) for evoked potential analysis	M	M	H	H	M	L
CO5: Model and analyze EEG signals for brain wave detection, seizure identification, and sleep stage analysis	H	M	H	M	M	M



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I Semester	L	T	P	C
	0	1	2	2

ADVANCED DIGITAL COMMUNICATIONS LAB

COURSE OBJECTIVES

1. Introduce simulation techniques for digital modulation and signal reconstruction.
2. Explore bit error rate (BER) performance of modulation schemes in noisy channels.
3. Analyse signal constellations and pulse shaping for efficient data transmission.
4. Design equalizers for mitigating channel effects in baseband communication.
5. Simulate OFDM systems for high-speed data transmission and spectral efficiency

SIMULATION BASED EXPERIMENTS: (MATLAB SIMULATION)

1. Sampling & reconstruction of low pass signals
2. BPSK Modulation & detection
3. BER of BPSK in AWGN channel
4. QPSK generation & detection
5. BER of QPSK in AWGN channel
6. QAM generation & detection
7. 16 QAM constellation diagram
8. Generation of Nyquist-I pulse
9. Designing an equalizer in the context of baseband binary data transmission
10. OFDM generation and detection

Lab Course Outcomes (COs)

After completion of the lab, students will be able to:

1. **CO1:** Demonstrate sampling, reconstruction, and baseband signal transmission.
2. **CO2:** Implement and analyze digital modulation techniques such as BPSK, QPSK, and QAM.
3. **CO3:** Evaluate bit error rate (BER) performance of digital modulation schemes in AWGN channels.
4. **CO4:** Design and simulate equalization and Nyquist pulse shaping for baseband transmission.
5. **CO5:** Simulate and analyze OFDM systems and constellation diagrams for multicarrier transmission.



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Experiment-CO Mapping

Experiment	Mapped CO
1. Sampling & reconstruction of low pass signals	CO1
2. BPSK Modulation & detection	CO2
3. BER of BPSK in AWGN channel	CO3
4. QPSK generation & detection	CO2
5. BER of QPSK in AWGN channel	CO3
6. QAM generation & detection	CO2
7. 16 QAM constellation diagram	CO5
8. Generation of Nyquist-I pulse	CO4
9. Designing an equalizer in baseband binary data transmission	CO4
10. OFDM generation and detection	CO5

CO-PO Mapping (H/M/L)

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Demonstrate sampling & reconstruction	M	–	M	H	L	M
CO2: Implement & analyze modulation techniques (BPSK, QPSK, QAM)	H	–	H	H	H	H
CO3: Evaluate BER performance in AWGN	H	–	H	H	H	H
CO4: Design equalizers & Nyquist pulse shaping	H	–	H	H	H	H
CO5: Simulate OFDM & constellation diagrams	H	M	H	H	H	H



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I Semester

L	T	P	C
0	1	2	2

EMBEDDED SYSTEM DESIGN LAB

COURSE OBJECTIVES:

1. To provide hands-on experience with ARM Cortex-M microcontroller programming.
2. To develop embedded applications using GPIO, timers, interrupts, and serial communication.
3. To explore advanced interfacing techniques including ADC, PWM, LCD, and SD card integration.
4. To implement wireless communication using BLE and Wi-Fi for smart system applications.
5. To design and deploy embedded systems capable of real-time monitoring and control.

EXPERIMENTS USING ARM CORTEX-M MICROCONTROLLER

(NUCLEO board -F429ZI):

1. Program to configure and control General Purpose Input / Output (GPIO) port pins.
2. Program to demonstrate Serial communication. Transmission from Kit and reception from PC using Serial Port on IDE environment use debug terminal to trace the program.
3. Program to demonstrate Time delay program using built in Timer / Counter feature on IDE environment.
4. Program to demonstrate a simple interrupt handler and setting up a timer.
5. Program to Displaying a message in a 2-line x 16 Characters LCD display and verify the result in debug terminal.
6. Program to demonstrate ADC interfacing.
7. Generation of PWM Signal with the objective of introducing the practical application of timers and fundamental principles of control theory.
8. To integrate a micro-SD card with the computing system for the purpose of storing event logs conveniently on the SD card.
9. To establish a connection between the two computing systems using Bluetooth Low Energy (BLE), with the objective of monitoring pertinent information from one system and facilitating gate control through the other system.
10. To enhance the smart home system by enabling it to host a web page through Wi-Fi connectivity, thereby allowing users to access information using a smartphone or PC.



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Lab Course Outcomes (COs)

After completing the lab, students will be able to:

- CO1:** Configure and control GPIO, timers, and interrupts in ARM Cortex-M microcontrollers.
- CO2:** Implement serial communication, LCD display, and peripheral interfacing.
- CO3:** Develop programs for data acquisition using ADC and PWM signal generation.
- CO4:** Design and implement data logging and external storage using SD card.
- CO5:** Develop and integrate wireless communication modules (BLE/Wi-Fi) for IoT applications.

Experiment–CO Mapping

Experiment	Mapped CO
1. GPIO port configuration	CO1
2. Serial communication (Kit ↔ PC)	CO2
3. Timer-based time delay	CO1
4. Interrupt handler with timer	CO1
5. LCD display message	CO2
6. ADC interfacing	CO3
7. PWM signal generation	CO3
8. SD card data logging	CO4
9. BLE communication	CO5
10. Wi-Fi web server for smart home	CO5

CO–PO Mapping (Qualitative H/M/L)

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: GPIO, timers, interrupts	H	M	H	H	M	L
CO2: Serial, LCD interfacing	H	M	H	M	M	L
CO3: ADC & PWM programming	H	M	H	H	H	M
CO4: SD card data logging	H	M	H	H	H	M
CO5: BLE & Wi-Fi IoT integration	H	H	H	H	H	M



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I Semester

L	T	P	C
0	0	2	1

SEMINAR-I



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II Semester

L	T	P	C
3	1	0	4

SYSTEM DESIGN WITH RTOS & EMBEDDED LINUX

COURSE OBJECTIVES

1. To introduce the fundamentals of Real-Time Operating Systems (RTOS) and task management.
2. To understand synchronization, communication mechanisms, and I/O subsystems in RTOS.
3. To explore exception handling, interrupt management, and timer services in real-time systems.
4. To provide hands-on knowledge of Linux kernel operations and shell scripting.
5. To study embedded Linux architecture and techniques for application porting and development.

UNIT -I: Introduction to RTOS and Task Management

Introduction to Real-Time Operating Systems (RTOS): Key characteristics, scheduler, kernel objects and services, system calls, static and dynamic libraries, cross tool chains, Task management: Defining tasks, task states, scheduling, task operations, synchronization, communication, concurrency.

UNIT -II: Synchronization, Communication, and I/O Systems

Semaphores: Operations, use cases, Message Queues: Types, operations, use cases (including pipes, event registers, signals, condition variables), I/O Subsystems: I/O concepts, subsystems, Synchronization and Communication: Resource synchronization methods, critical section, design patterns, priority inversion, common design problems (deadlocks, priority inversion).

UNIT- III: Exceptions, Interrupts, and Timer Services

Exceptions and Interrupts: Definitions, applications, spurious interrupts, Timer Services: Real-time clocks, system clocks, programmable interval timers, timer interrupt service routines.

UNIT- IV: Linux Kernel and Shell Scripting

Introduction to Linux Kernels: Linux basics, GNU utilities, distributions, access methods (CLI, graphical terminal emulators), Bash Shell Commands: Navigation, file handling, system monitoring, environment variables, user-defined variables, Shell Scripting: Script creation, control structures (if-else, loops, case commands), output redirection, practical examples, handling signals, background scripts, basic script functions, alternative shells (dash, zsh).

UNIT -V: Embedded Linux Architecture and Application Porting

Embedded Linux Architecture: Kernel architecture, memory manager, scheduler, file system, I/O and networking subsystems, IPC, user space, startup sequence, Board Support Package: Embedded storage (MTD), embedded file system, embedded device drivers (communication between user space and kernel, character/block drivers, interrupt handling, kernel modules), Porting Applications: Real-time Linux, hard real-time programming, building and debugging (bootloaders, kernel, root file system, device tree).



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TEXT BOOKS:

1. Qing Li, Caroline Yao (2020), “Real-Time Concepts for Embedded Systems”, CMP Books.
2. Chris Simmonds, “Mastering Embedded Linux Programming” - Second Edition, PACKT Publications Limited.

REFERENCE BOOKS:

1. Karim Yaghmour, “Building Embedded Linux Systems”, O'Reilly & Associates.

COURSE OUTCOMES :

After completion of the course, students will be able to:

1. Explain the key features of RTOS and manage tasks using scheduling, synchronization, and communication techniques.
2. Apply semaphores, message queues, and I/O subsystem concepts to design robust real-time applications.
3. Handle exceptions, interrupts, and implement timer services for real-time responsiveness.
4. Utilize Linux commands and scripting techniques to automate system tasks and manage embedded environments.
5. Demonstrate understanding of embedded Linux architecture and port applications using kernel modules and device drivers.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1 – RTOS basics, task mgmt	H	M	H	H	–	M
CO2 – Sync, comm, I/O subsystems	H	H	H	H	M	H
CO3 – Exceptions, interrupts, timers	M	H	H	H	–	H
CO4 – Linux shell, scripting	M	M	H	M	H	H
CO5 – Embedded Linux architecture, drivers, porting	H	H	H	H	H	H



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II Semester

L	T	P	C
3	1	0	4

ADVANCED SIGNAL AND IMAGE PROCESSING**COURSE OBJECTIVES:**

1. To introduce the fundamentals of digital signal processing and ARM Cortex processor architecture.
2. To understand digital image and video formats, sampling, filtering, and transform techniques.
3. To explore image and video enhancement, restoration, and color processing methods.
4. To study segmentation techniques for image and video analysis including motion and semantic segmentation.
5. To examine compression techniques for efficient image and video storage and transmission.

UNIT- I:

Introduction to Digital Signal Processing, Signals in Time and Frequency Domains, Signals and Filtering, Architecture of ARM Cortex M3/M4 Processor, ADC/ DAC Interfacing to ARM Cortex M3/M4 Processor, Digital Signal Processing Algorithms: Filter Design, FIR Digital filter design, Frequency Domain, Fourier Transform: DFT, FFT, Spectral Analysis

Unit -II

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

Unit -III

Image and Video Enhancement and Restoration: Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, video resolution enhancement, Image and Video restoration (recovery). Colour image Processing: Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour image processing, Full colour processing

Unit -IV

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

Unit- V

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

TEXT BOOKS:

1. Digital Signal Processing Implementation Using the TMS320C6000 DSP Platform, 1 st Edition; by:



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Naim Dahnoun

2. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010
3. DSP Applications using 'C' and the TMS320C6X DSK, 1 st Edition; by: Chassaing
4. Digital Signal Processing: A System Design Approach, 1 st Edition; by: David J Defatta J, Lucas Joseph G & Hodkiss William S; John Wiley
5. Digital Signal Processing with Field Programmable Gate Arrays: 2nd Edition, by: U. Meyer – Base, Springer.

REFERENCE BOOKS:

1. Real - Time Digital Signal Processing: Implementations, Applications, and Experiments with the TMS320C55X, Kuo, Sen M, Lee, Bob H, John Wiley & Sons Ltd.
2. Digital Signal Processing – A Practical Guide for Engineers and Scientists, Steven W Smith, Elsevier
3. Digital Signal Processing - A Student Guide, 1 st Edition; by: T.J. Terrel and LikKwan Shark; Macmillan Press; Ltd.
4. Sanjit K. Mitra, "Digital Signal Processing Laboratory Using MATLAB", McGrawHill College, ISBN-13: 978-0073108582

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Apply DSP concepts and algorithms using ARM Cortex M3/M4 processors for signal analysis.
2. Analyse image and video formats and perform basic processing using various transform techniques.
3. Implement enhancement and restoration algorithms for image and video quality improvement.
4. Perform segmentation using edge detection, thresholding, and motion estimation techniques.
5. Demonstrate understanding of image and video compression methods including lossless and lossy.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1 – DSP concepts on ARM	H	M	H	H	M	H
CO2 – Image/Video formats & transforms	H	H	H	H	M	H
CO3 – Enhancement & restoration	H	H	H	H	H	H
CO4 – Segmentation & motion estimation	H	H	H	H	H	H
CO5 – Compression & standards	M	H	H	H	M	H



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II Semester

L	T	P	C
3	1	0	4

INFORMATION THEORY AND CODING**COURSE OBJECTIVES:**

1. To introduce the foundational concepts of information theory including entropy, mutual information, and their applications.
2. To study various source coding techniques and understand their efficiency and implementation.
3. To explore communication channel models and analyze their capacity and performance.
4. To understand video and speech coding techniques for compression and multimedia transmission.
5. To examine error control coding methods for reliable data communication and storage.

Unit -I: Introduction

Information Source, Symbols, and Entropy, Mutual information, information Measures for Continuous Random Variable, Joint and Conditional Entropy, Relative Entropy, Applications Based on information Theoretic Approach.

Unit -II: Source coding

Source Coding Theorem, Kraft inequality, Shannon-Fano Codes, Huffman Codes, Run Length Code, Arithmetic Codes, Lempel-Ziv-Welch Algorithm, Universal Source Codes, Prefix Codes, Variable Length Codes, Uniquely Decodable Codes, instantaneous Codes, Shannon's Theorem, Shannon Fano Encoding Algorithm, Shannon's Noiseless Coding Theorem, Shannon's Noisy Coding Theorem.

Unit -III: Communication channel

Channel and its Capacity, Continuous and Gaussian Channels, Discrete Memory-Less Channels, Symmetric Channel, Binary Erasure Channel, Estimation of Channel Capacity, Noiseless Channel, Channel Efficiency, Shannon's Theorem on Channel Capacity, MIMO Channels, Channel Capacity with Feedback.

Unit -IV: Video and speech coding

Video Coding Basics, Quantization, Symbol Encoding, Intraframe Coding, Predictive Coding, Transform Coding, Subband Coding, Vector Quantization, Interframe Coding, Motion Compensated Coding, Image Compression, Jpeg, LZ78 Compression, Dictionary Based Compression, Statistical Modelling, Speech Coding, Psycho-Acoustic Modelling, Time Frequency Mapping Quantization, Variable Length Coding, Multichannel Correlation and Irrelevancy, Long Term Correlation, Pre-Echo Control, Bit Allocation.



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Unit -V: Error control coding

Overview of Field, Group, Galois Field, Types of Codes, Hamming Weight, Minimum Distance Based Codes, Error Detection and Error Correction Theorems, Maximum Likelihood Decoder, Map Decoder, Linear Block Codes and Their Properties, Equivalent Codes, Generator Matrix and Parity Check Matrix, Systematic Codes, Cyclic Codes, Convolution Codes and Viterbi Decoding

Algorithm, Iterative Decoding, Turbo Codes and Low Density-Parity-Check Codes, Asymptotic Equipartition Property, Bch Codes, Generator Polynomials, Decoding of Bch Codes, Reed Solomon Codes, Trellis Codes, Space Time Coding.

TEXT BOOKS:

1. T.M. Cover and J.A. Thomas, Elements of Information Theory, John Wiley & Sons.
2. Todd K. Moon, Error Correction coding, John Wiley, 2005

REFERENCE BOOKS:

1. Shu lin/ Daniel J. Costello Jr., Error Control Coding, Prentice Hall series in computer applications in electrical engineering series (2/e) 2005
2. Ranjan Bose, Information Theory, coding and cryptography (2/e), McGraw Hill

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Apply information theoretic measures to analyze data sources and communication systems.
2. Design and evaluate source coding schemes such as Huffman, Shannon-Fano, and Lempel-Ziv-Welch.
3. Analyze different types of communication channels and estimate their capacities using Shannon's theorems.
4. Implement video and speech coding algorithms including transform coding, motion compensation, and psycho-acoustic modeling.
5. Demonstrate understanding of error control coding techniques including block, convolutional, turbo, and LDPC codes for robust communication.

COs	PO1	PO2	PO3	PO4	PO5	PO6
C01 – Information measures	H	M	H	H	M	M
C02 – Source coding	H	H	H	H	M	H
C03 – Channel analysis & capacity	H	M	H	H	H	M
C04 – Video & speech coding	H	H	H	H	H	H
C05 – Error control coding	H	H	H	H	H	H



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II Semester

L	T	P	C
3	0	0	3

Advanced C++ Programming
(ELECTIVE-III)

COURSE OBJECTIVES

1. To introduce object-oriented programming principles and contrast them with procedural paradigms.
2. To develop proficiency in C++ syntax, data structures, and memory management.
3. To understand class design, data abstraction, and object lifecycle management.
4. To explore inheritance, polymorphism, and virtual functions for dynamic behavior.
5. To study advanced C++ features including file I/O, exception handling, templates, and concurrency

UNIT – I: Object-Oriented Thinking: Different paradigms for problem solving, need for OOP paradigm, differences between OOP and Procedure oriented programming, Overview of OOP concepts Abstraction, Encapsulation, Inheritance and Polymorphism. C++ Basics: Structure of a C++ program, Data types, Declaration of variables, Expressions, Operators, Operator Precedence, Evaluation of expressions, Type conversions, Pointers, Arrays, Pointers and Arrays, Strings, Structures, References. Flow control statement- if, switch, while, for, do, break, continue, goto statements. Functions - Scope of variables, Parameter passing, Default

arguments, inline functions, Recursive functions, Pointers to functions. Dynamic memory allocation and de-allocation operators-new and delete, Preprocessor directives.

UNIT – II: C++ Classes and Data Abstraction: Class definition, Class structure, Class objects, Class scope, this pointer, Friends to a class, Static class members, Constant member functions, Constructors and Destructors, Dynamic creation and destruction of objects, Data abstraction, ADT and information hiding.

UNIT – III: Inheritance: Defining a class hierarchy, Different forms of inheritance, Defining the Base and Derived classes, Access to the base class members, Base and Derived class construction, Destructors, Virtual base class. Virtual Functions and Polymorphism: Static and Dynamic binding, virtual functions, Dynamic binding through virtual functions, Virtual function call mechanism, Pure virtual functions, Abstract classes, Implications of polymorphic use of classes, Virtual destructors.

UNIT – IV: C++ I/O: I/O using C functions, Stream classes hierarchy, Stream I/O, File streams and String streams, Overloading operators, Error handling during file operations, Formatted I/O. Exception Handling: Benefits of exception handling, Throwing an exception, The try block, Catching an exception, Exception objects, Exception specifications, Stack unwinding, Rethrowing an exception, Catching all exceptions.

Unit – V: Advanced Topics: Standard Template Libraries. Introduction to Smart Pointers, RValue references, Lambda expressions, Concurrency API



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TEXT BOOKS:

1. “The C++ Programming Language” – Bjarne Stroustrup
2. Programming: Principles and Practice Using C++” – Bjarne Structure

REFERENCE BOOKS:

Advanced C++ by Gaian AL ankus, Olena Liina, Rakesh Mane, Vivek Nagarajan,
 Effective C++: 55 Specific Ways to Improve Your Programs and Designs 3rd Edition
 by Scott Meyers (Author)
 Object Oriented Programming in C++, 4e Paperback – 1 January 2008
 by Lafora (Author)

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Apply object-oriented principles such as abstraction, encapsulation, inheritance, and polymorphism to solve real-world problems.
2. Develop robust C++ programs using appropriate control structures, functions, and dynamic memory management.
3. Design and implement classes with constructors, destructors, and member functions to achieve data abstraction and modularity.
4. Utilize inheritance and polymorphism to create flexible and maintainable code with runtime binding and virtual functions.
5. Handle file I/O operations and exceptions effectively, and leverage advanced C++ features like STL, lambda expressions, and concurrency for efficient programming.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	M	M	L
CO2	H	H	H	M	M	M
CO3	H	H	H	M	M	M
CO4	H	M	H	M	H	M
CO5	H	H	H	M	H	H



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II Semester

L	T	P	C
3	0	0	3

IOT & ITS COMMUNICATION PROTOCOLS
(ELECTIVE-III)

COURSE OBJECTIVES:

1. To introduce the architecture, standards, and fundamental technologies of IoT systems.
2. To explore the IoT reference architecture and understand various design and deployment views.
3. To study data link and network layer protocols relevant to IoT communication.
4. To understand transport and session layer protocols used in IoT applications.
5. To examine service layer protocols and security mechanisms essential for reliable and secure IoT.

UNIT-I:

INTRODUCTION: IoT architecture outline, standards - IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(Xia's), M2M and IoT Analytics

UNIT-II:

IOT REFERENCE ARCHITECTURE: Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints

UNIT-III:

IoT DATA LINK LAYER & NETWORK LAYER PROTOCOLS: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

UNIT-IV:

IoT TRANSPORT & SESSION LAYER PROTOCOLS: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

UNIT-V:

IoT SERVICE LAYER PROTOCOLS & SECURITY PROTOCOLS: Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC802.15.4 , 6LoWPAN, RPL, Application Layer

TEXT BOOKS:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Wiley Publications ,2016
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence", 1st Edition Academic Press 2015



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REFERENCE BOOKS:

1. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

COURSE OUTCOMES :

After completion of the course, students will be able to:

1. Describe the components of IoT architecture and explain the role of devices, gateways, and networking in IoT ecosystems.
2. analyse the IoT reference architecture and apply design principles considering real-world constraints.
3. Evaluate and compare various data link and network layer protocols used in IoT communication.
4. Implement and utilize transport and session layer protocols for efficient data exchange in IoT systems.
5. Apply service layer protocols and security techniques to ensure safe and scalable IoT deployments.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	M	H	L	M
CO2	H	M	H	M	H	M
CO3	H	M	H	M	H	M
CO4	H	H	H	M	H	H
CO5	H	H	H	M	H	H



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II Semester

L	T	P	C
3	0	0	3

AI IN SIGNAL PROCESSING AND WIRELESS COMMUNICATION
(ELECTIVE-III)

COURSE OBJECTIVES:

1. To introduce the fundamentals of AI, ML, and DL with applications in text and image processing.
2. To explore AI-driven solutions for smart agriculture using IoT and sensor technologies.
3. To study the role of AI in wireless communication systems and antenna design.
4. To apply AI techniques in biomedical and industrial signal processing for predictive and classification tasks.
5. To investigate energy-efficient systems and advanced optimization methods using AI and metaheuristics.

UNIT 1: Fundamentals of AI and Applications in Text and Image Processing

Introduction to Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL), Long Short-Term Memory (LSTM) Deep Neural Networks for Sentiment Classification, Natural Language Processing (NLP) Techniques and Tools, Computer Vision Techniques for Plant Pest and Disease Detection, Image Processing and ANN-based Techniques in Agriculture

UNIT 2: AI Applications in Smart Agriculture and IoT

Plant Disease Identification using IoT and Deep Learning Algorithms, Precision Agriculture: Sensor Technologies and Wireless Sensor Networks (WSN), Smart Irrigation and Fertilization Systems, Smart Pest Control and Early Disease Detection, Integration of Biosensors and IoT for Soil Health Monitoring

UNIT 3: AI in Wireless Communication and Antenna Design

Artificial Neural Networks (ANN) in 5G Wireless Communication, Particle Swarm Optimization (PSO) in Antenna Design, Multiband and Broadband Antenna Design using AI Techniques, Hybrid Bio inspired Approaches for Fractal Antenna Design, AI in Direction of Arrival (DOA) Estimation Using LVMFO

UNIT 4: AI Techniques in Biomedical and Industrial Signal Processing

Prediction of Coronary Artery Disease using Logistic Regression, Acoustic Signal Classification in Milling Operations using ANN, Application of ML and DL in Biomedical Signal Processing, Evaluation Strategies for Signal Classification Models

UNIT 5: Energy-Efficient Systems and Advanced Optimization

Energy-Efficient WSN Deployment for Railway Track Health Monitoring, Hybrid MAC Protocols and Spatiotemporal Aggregation Techniques, Optimization Techniques in Signal Processing using Metaheuristics, Comparative Study of ANN, PSO, and Hybrid Approaches



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TEXT BOOKS:

1. Abhinav Sharma, Arpit Jain, Ashwini Kumar Arya, Mangey Ram (Eds.)
Artificial Intelligence for Signal Processing and Wireless Communication.
2. Machine Learning for Signal Processing, Authors: Max A. Little,
Publisher: Oxford University Press, 2019

REFERENCE BOOKS:

1. Wireless Sensor Networks: Technology, Protocols, and Applications, Authors:
Kazem Sohraby, Daniel Minoli, Taieb Znati, Publisher: Wiley-Interscience.
2. Deep Learning: Authors: Ian Goodfellow, Yoshua Bengio, Aaron Courville
Publisher: MIT Press, 2016

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Apply deep learning models such as LSTM and NLP tools for sentiment analysis and agricultural image processing.
2. Design smart agriculture systems using IoT, biosensors, and AI algorithms for disease detection and resource management.
3. Utilize AI techniques like ANN and PSO for efficient wireless communication and antenna design.
4. Implement ML and DL models for biomedical signal analysis and industrial acoustic signal classification.
5. Develop energy-efficient monitoring systems and optimize signal processing tasks using hybrid and metaheuristic approaches.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	M	M
CO2	H	H	M	M	H	M
CO3	H	M	H	M	H	M
CO4	H	M	H	M	H	H
CO5	H	H	H	M	H	H



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II Semester	SMART ANTENNAS AND BEAM FORMING TECHNIQUES(PE-3)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide the essential knowledge of the antenna parameters and measurements.
2. To design antenna array using synthesise techniques.
3. To design the single element microstrip antenna and array with feeder network
4. To introduce the types of high impedance surface antennas for various applications.

UNIT -I:

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

UNIT -II:

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

UNIT-III:

Microstrip Antennas Basic characteristics, feeding methods, Methods of analysis – Transmission line model and cavity model - Design of Rectangular patch, Circular patch –Microstrip antenna array and feed network. Antenna Design Techniques Antenna Design using Artificial Impedance Surface Metamaterial- Electromagnetic Band GapDefective Ground Structure - High Impedance Surface

UNIT-IV:

Antenna Applications-I: Integrated Antenna for wireless personal communication, mobile communication- Antenna design consideration for MIMO diversity systems - medical therapy

UNIT -V:

Antenna Applications- II: Antenna for Software Defined Radio – Cognitive Radio- Electronic Warfare-Ground penetrating Radar Method of moments (MoM), Finite element method (FEM), Finite difference time domain method

TEXT BOOKS:

1. C.A. Balanis, Antenna Theory: Analysis and Design, 2016, 4th edition, Wiley, India
2. C.A. Balanis, Modern Antenna Handbook, 2012, 1st Edition, Wiley, India.

REFERENCE BOOKS:

1. W.L. Stutzman and G.A. Thiele, Antenna Theory and design, 2012, 3rd Edition, Wiley, India
2. J. D. Kraus, Antennas and Wave propagation, 2012, 4th Edition, McGraw Hill, India.
3. Sanjay Kumar, Saurabh Shukla, Wave Propagation and Antenna Engineering, 2016, 1st Edition PHI, India
4. www.antenna-theory.com



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COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the fundamentals of antenna radiation mechanisms and evaluate antenna parameters such as radiation pattern, gain, directivity, efficiency, and polarization using measurement techniques.
2. Apply antenna array synthesis techniques (Fourier Transform, Schelkunoff, Dolph-Chebyshev, Taylor methods) to design antenna arrays with desired radiation characteristics.
3. Design and analyze microstrip patch antennas using transmission line and cavity models, and apply modern design techniques such as metamaterials, EBG, and HIS structures.
4. Analyze antenna requirements and design considerations for wireless communication, MIMO diversity systems, and medical applications.
5. Evaluate and implement antenna applications for advanced technologies such as software-defined radio, cognitive radio, electronic warfare, and radar using numerical methods (MoM, FEM, FDTD).

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	M
CO2	H	L	H	H	M	M
CO3	H	M	H	H	H	H
CO4	H	M	H	M	H	M
CO5	H	M	H	H	H	H



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II Semester

L	T	P	C
3	0	0	3

MOBILE NETWORKS
(ELECTIVE-IV)

COURSE OBJECTIVES :

1. To introduce wireless personal, local, and metropolitan area network standards and architectures.
2. To explore wide area wireless technologies including GSM, CDMA, and WCDMA systems.
3. To understand mobility management and IP-based protocols for wireless internet access.
4. To study wideband wireless technologies such as Ultra-Wideband (UWB) and their operational
5. To examine adhoc wireless networks, 4G technologies, and emerging concepts.

UNIT I: Wireless Area Networks and Standards

Overview of WPAN: IEEE 802.15 (Bluetooth, RFID, Zigbee, WBAN), WLAN (IEEE 802.11), WiMAX (IEEE 802.16) protocols and architectures, Bluetooth network architecture, operation, applications, RFID and Zigbee specifications, WLAN physical and MAC layer mechanisms (CSMA/CA, WiFi MAC), wideband access (802.11n/ac), energy efficiency, WiMAX: Broadband Wireless Access, issues and challenges, comparison with IEEE 802.11.

UNIT II: Wireless Wide Area Networks

GSM, 3G, and Evolution, spread spectrum, CDMA (IS 95 to CDMA 2000), WCDMA, system processing gain, types of spread spectrum systems, power control in CDMA, uplink/downlink (BS to MS, MS to BS).

UNIT III: Wireless Internet and Mobility Management

IP for wireless networks, mobile IP, IPv6 advancements, mobility management functions (location management, handoffs, registration), impact of mobility on TCP, types of TCP in wireless, wireless security standards.

UNIT IV: Wideband Wireless Technologies

UWB Radio Communication, fundamentals, major issues, operation, comparisons with other technologies, advantages and disadvantages.

UNIT V: Adhoc Wireless Networks and 4G Technologies

Characteristics of Adhoc networks, MAC protocols (table-driven, on-demand), routing protocols (DSDV, AODV, DSR, Hybrid), 4G technologies, features, challenges, LTE (FDD vs TDD), smart antennas, OFDM-MIMO systems, adaptive modulation, software-defined radio, cognitive radio.

TEXT BOOKS:

1. Theodore Rappaport —Wireless Communication, Prentice Hall, 2nd Edition.
2. William Stallings —Wireless Communications and Networks, Prentice Hall.
3. Schwartz —Mobile Wireless Communications, Cambridge University Press.
4. Mark and Zhuang —Wireless Communications and Networking, Prentice Hall.
5. Vijay Garg K, “Wireless Communications and Networks”, 2nd Edition, Morgan



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REFERENCE BOOKS:

1. Clint Smith and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2007.
2. Amitabha Ghosh and Rapeepat Ratasuk, "Essentials of LTE and LTE-A," Cambridge University Press, 2011.
3. Dharma Prakash Agrawal and Qing-An Zeng, "Introduction to wireless mobile systems" Thomson India, 2007.
4. Siva Ram Murthy C and Manoj B S, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, 2004.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.

COURSE OUTCOMES :

After completion of the course, students will be able to:

1. analyse and compare WPAN, WLAN, and WiMAX standards including their architectures, protocols, and energy efficiency.
2. Explain the evolution of wireless wide area networks and apply concepts of spread spectrum and power control in CDMA systems.
3. Evaluate mobility management techniques and assess the impact of mobility on IP and TCP protocols in wireless environments.
4. Demonstrate understanding of UWB communication systems and compare them with other wideband technologies.
5. Design and assess adhoc network protocols and understand the features and challenges of 4G technologies including LTE, OFDM-MIMO, and cognitive radio.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	M	M
CO2	H	M	H	M	M	M
CO3	H	M	H	M	H	M
CO4	H	M	M	M	M	L
CO5	H	H	H	M	H	M



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II Semester	L	T	P	C
	3	0	0	3

Radar Signal Processing
(ELECTIVE-IV)

COURSE OBJECTIVES:

1. To introduce the fundamentals of radar systems, radar equations, and matched filter concepts.
2. To study radar signal detection techniques in noisy environments and understand CFAR receivers.
3. To explore waveform selection principles and design optimal radar waveforms for cluttered.
4. To understand pulse compression techniques and their implementation in radar systems.
5. To examine phase coding methods and Doppler-tolerant waveforms for advanced radar.

UNIT-I: Introduction: Radar Block Diagram, Biostatic Radar, Monostatic Radar, Radar Equation, Information Available from Radar Echo. Review of Radar Range Performance– General Radar Range Equation, Radar Detection with Noise Jamming, Beacon and Repeater Equations, MTI and Pulse Doppler Radar. Matched Filter Receiver – Impulse Response, Frequency Response Characteristic and its Derivation, Matched Filter and Correlation Function, Correlation Detection and Cross-Correlation Receiver, Efficiency of Non-Matched Filters, Matched Filter for Non-White Noise.

UNIT-II: Detection of Radar Signals in Noise: Detection Criteria – Nyman -Pearson Observer, Likelihood-Ratio Receiver, Inverse Probability Receiver, Sequential Observer, Detectors–Envelope Detector, Logarithmic Detector, I/Q Detector. Automatic Detection-CFAR Receiver, Cell Averaging CFAR Receiver, CFAR Loss, CFAR Uses in Radar. Radar Signal Management–Schematics, Component Parts, Resources and Constraints.

UNIT-III: Waveform Selection: Radar Ambiguity Function and Ambiguity Diagram – Principles and Properties; Specific Cases – Ideal Case, Single Pulse of Sine Wave, Periodic Pulse Train, Single Linear FM Pulse, Noise Like Waveforms, Waveform Design Requirements, Optimum Waveforms for Detection in Clutter, Family of Radar Waveforms.

UNIT-IV: Pulse Compression in Radar Signals: Introduction, Significance, Types, Linear FM Pulse Compression – Block Diagram, Characteristics, Reduction of Time Side lobes, Stretch Techniques, Generation and Decoding of FM Waveforms – Block Schematic and Characteristics of Passive System, Digital Compression, SAW Pulse Compression.

UNIT-V: Phase Coding Techniques: Principles, Binary Phase Coding, Barker Codes, Maximal Length Sequences (MLS/LRS/PN), Block Diagram of a Phase Coded CW Radar. Poly Phase Codes : Frank Codes, Costas Codes, Non-Linear FM Pulse Compression, Doppler Tolerant PC Waveforms – Short Pulse, Linear Period Modulation (LPM/HFM), Sidelobe Reduction for Phase Coded PC Signals.



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TEXT BOOKS:

1. Radar Handbook - M.I. Skolnik, 2ndEd., 1991, McGraw Hill.
2. Radar Design Principles: Signal Processing and The Environment - Fred E. Nathanson, 2nd Ed. 1999, PHI.
3. Introduction to Radar Systems - M.I. Skolnik, 3rdEd., 2001, TMH.

REFERENCE BOOKS:

1. Radar Principles - Peyton Z. Peebles, Jr., 2004, John Wiley.
2. Radar Signal Processing and Adaptive Systems - R. Nitzberg, 1999, Artech House

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Illustrate the operation of Radar and derive the radar range equation.
2. Know the characteristics of Matched filter for non-white noise.
3. Apply the various detection criterion and types of detectors that can be used to detect the Radar signals in noise.
4. Analyse the waveform design requirements and optimum waveforms for the detection of signals in clutter.
5. Justify the significance and types of pulse compression techniques in radar signals.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	M	M
CO2	H	M	H	M	M	L
CO3	H	M	H	M	M	M
CO4	H	H	H	M	H	M
CO5	H	H	H	M	H	M



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II Semester

L	T	P	C
3	0	0	3

DSP PROCESSORS & ARCHITECTURES
(ELECTIVE-IV)

COURSE OBJECTIVES :

1. To understand DSP processing architectures and core algorithms used in programmable DSP.
2. To explore structural and architectural features of Texas Instruments DSP families.
3. To study VLIW architectures and the use of GPUs as alternatives for DSP applications.
4. To introduce multi-core DSP systems and parallel programming techniques using OpenMP.
5. To examine FPGA-based DSP systems and their role in advanced signal processing applications.

UNIT- I:

Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed- and Floating-Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

UNIT- II:

Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family, TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

UNIT- III:

VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed C and Assembly Language programming, On-chip peripherals, Simple applications developments as an embedded environment.

UNIT- IV:

Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi- core systems, Shared Memory parallel programming –OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem)

UNIT- V:

FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor.



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TEXT BOOKS

1. M. Sasikumar, D. Shikhare, Ravi Prakash, “Introduction to Parallel Processing”, 1st Edition, PHI, 2006.
2. Fayeze Gebali, “Algorithms and Parallel Computing”, 1st Edition, John Wiley & Sons, 2011

REFERENCE BOOKS:

1. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, Dror Maydan, Jeff McDonald, “Parallel Programming in OpenMP”, 1st Edition, Morgan Kaufman, 2000.
2. Ann Melnichuk, Long Talk, “Multicore Embedded systems”, 1st Edition, CRC Press, 2010.
3. Wayne Wolf, “High Performance Embedded Computing: Architectures, Applications and Methodologies”, 1st Edition, Morgan Kaufman, 2006.
4. E.S. Gopi, “Algorithmic Collections for Digital Signal Processing Applications Using MATLAB”, 1st Edition, Springer Netherlands, 2007.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Identify and formalize architectural level characterization of P-DSP hardware.
2. Ability to design, programming (assembly and C), and testing code using Code Composer Studio environment.
3. Deployment of DSP hardware for Control, Audio and Video Signal processing applications
4. Understanding of major areas and challenges in DSP based embedded systems.

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	M	M
CO2	H	H	M	M	M	L
CO3	H	H	H	M	M	M
CO4	H	M	H	M	H	M



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II Semester

L	T	P	C
3	0	0	3

VLSI SIGNAL PROCESSING**Course Outcomes (COs)**

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

CO1: Explain typical DSP algorithms, their benefits, and apply concepts of pipelining, parallel processing, and retiming to improve performance and power efficiency.

CO2: Apply folding and unfolding transformations to DSP architectures, including register minimization and optimization in multirate systems.

CO3: Design systolic array architectures for DSP applications such as FIR filtering, matrix multiplication, and 2D data processing.

CO4: Analyze and implement fast convolution algorithms including Cook-Toom, Winograd, cyclic, and iterative methods.

CO5: Evaluate low power design strategies, power analysis/estimation techniques, and programmable DSP processors for wireless, mobile, and multimedia applications.

UNIT-I:**Introduction to DSP**

Typical DSP algorithms, DSP algorithms benefits, Representation of DSP algorithms

Pipelining and Parallel Processing

Introduction, Pipelining of FIR Digital filters, Parallel Processing, Pipelining and Parallel Processing for Low Power

Retiming

Introduction – Definitions and Properties – Solving System of Inequalities – Retiming Techniques

UNIT-II:

Folding: Introduction -Folding Transform - Register minimization Techniques – Register minimization in folded architectures – folding of multirate systems

Unfolding: Introduction – An Algorithm for Unfolding – Properties of Unfolding – critical Path, Unfolding and Retiming – Applications of Unfolding

UNIT-III:**Systolic Architecture Design**

Introduction – Systolic Array Design Methodology – FIR Systolic Arrays – Selection of Scheduling Vector – Matrix Multiplication and 2D Systolic Array Design – Systolic Design for Space Representations contain Delays

UNIT-IV:**Fast Convolution**

Introduction – Cook-Toom Algorithm – Winograd algorithm – Iterated Convolution – Cyclic Convolution – Design of Fast Convolution algorithm by Inspection

UNIT-V:**Low Power Design**

Scaling Vs Power Consumption –Power Analysis, Power Reduction techniques – Power Estimation Approaches Programmable DSP: Evaluation of Programmable Digital Signal Processors, DSP Processors for Mobile and Wireless Communications, Processors for Multimedia Signal Processing.

TEXT BOOKS:

1. VLSI Digital Signal Processing- System Design and Implementation – Keshab K. Parhi, 1998, Wiley Inter Science.
2. VLSI and Modern Signal Processing – Kung S. Y, H. J. While House, T. Kailath, 1985,



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REFERENCE BOOKS:

1. Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing – Jose E. France, YannisTsividis, 1994, Prentice Hall.
2. VLSI Digital Signal Processing – Mediseti V. K, 1995, IEEE Press (NY), USA.

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Explain DSP algorithms, pipelining, parallel processing, and retiming for performance and power efficiency	H	M	H	H	M	L
CO2: Apply folding and unfolding transformations with register minimization in DSP and multirate systems	H	M	H	H	M	L
CO3: Design systolic array architectures for FIR filters, matrix multiplication, and 2D processing	H	M	H	H	H	L
CO4: Analyze and implement fast convolution algorithms (Cook-Toom, Winograd, cyclic, iterative)	H	M	H	H	M	L
CO5: Evaluate low-power design strategies and programmable DSP processors for wireless and multimedia applications	H	M	H	M	H	M



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	L	T	P	C
II Semester	0	1	2	2

WIRELESS COMMUNICATIONS LAB

COURSE OBJECTIVES:

1. To provide hands-on experience with Software Defined Radio (SDR) platforms for signal generation and detection.
2. To understand and implement digital modulation techniques such as BPSK, QPSK, QAM, and FSK.
3. To explore virtual lab tools like LabVIEW and MATLAB for simulation and analysis of wireless communication systems.
4. To design and evaluate baseband modulation schemes under various channel conditions.
5. To implement synchronization, channel estimation, and equalization techniques for OFDM-based systems.

PART A: List of Experiments :(Minimum of Ten Experiments has to be performed)

1. Measurement of Bit Error Rate using Binary Data
2. Verification of minimum distance in Hamming code
3. Determination of output of Convolution Encoder for a given sequence
4. Determination of output of Convolution Decoder for a given sequence
5. Efficiency of DS Spread- Spectrum Technique
6. Simulation of Frequency Hopping (FH) system
7. Effect of Sampling and Quantization of Digital Image
8. Verification of Various Transforms (FT / DCT/ Walsh / Hadamard) on a given Image (Finding Transform and Inverse Transform)
9. Point, Line and Edge detection techniques using derivative operators.
10. Implementation of FIR filter using DSP Trainer Kit (C-Code/ Assembly code)
11. Implementation of IIR filter using DSP Trainer Kit (C-Code/ Assembly code)
12. Determination of Losses in Optical Fiber
13. Observing the Waveforms at various test points of a mobile phone using Mobile Phone Trainer
14. Study of Direct Sequence Spread Spectrum Modulation & Demodulation using CDMA-DSSBER Trainer
15. Study of ISDN Training System with Protocol Analyzer
16. Characteristics of LASER Diode.

PART B: Equipment required for Laboratory Software:

1. MATLAB along with Simulink Licensed simulation software tool with communication and Signal processing Toolbox.
2. Computer Systems with required specifications.



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Hardware:

1. Hardware kits for verification of BER
2. Hardware kits of Convolution encoders, Hamming encoders.
3. Frequency spectrum
4. Mobile Phone Trainer
5. DSP Trainer Kit
6. CDMA-DSS-BER Trainer
7. ISDN Training System with Protocol Analyzer
8. Optical fiber Transmitter and receiver kit along with different lengths of cables

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Perform signal sampling, reconstruction, and multiplexing using SDR hardware platforms.
2. Generate and detect various digital modulation schemes including BPSK, QPSK, QAM, and FSK.
3. Use LabVIEW and MATLAB to simulate baseband modulation and analyse performance under AWGN and multipath channels.
4. Implement synchronization techniques such as STO and CFO estimation for QAM/QPSK and OFDM systems.
5. Apply channel equalization methods and preamble-based synchronization for robust wireless communication system design.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	L
CO2	H	H	H	M	L	L
CO3	H	H	H	M	M	L
CO4	H	H	H	H	M	L
CO5	H	H	H	H	M	L



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II Semester

L	T	P	C
0	1	2	2

SYSTEM DESIGN WITH RTOS & EMBEDDED LINUX LAB

COURSE OBJECTIVES:

1. To provide practical exposure to task management and scheduling in real-time operating systems.
2. To understand synchronization mechanisms such as semaphores and mutexes in multitasking environments.
3. To explore interrupt handling, inter-process communication, and memory management techniques.
4. To develop programs that simulate real-time OS behaviour and resource management.

List of Experiments:

1. Develop a program that involves various operations related to real-time tasks, such as creation, deletion, and synchronization.
2. Implement a program to understand and simulate task scheduling algorithms in a real-time operating system.
3. Create a program to explore the concept and mechanisms of context switching in the context of real-time operating systems.
4. Develop a program to illustrate the use of semaphores for synchronization and communication between different tasks.
5. Implement a program that demonstrates the usage of mutexes for managing critical sections in a multitasking environment.
6. Write a program to handle interrupts effectively, exploring the ways an operating system manages and responds to external interrupts.
7. Develop a program to manage and manipulate queues within the real-time operating system environment.
8. Implement a program that showcases the effective management of pipes for inter-process communication.
9. Write a program to understand and implement signal handling mechanisms within the real-time operating system.
10. Develop a program that explores memory management techniques in the context of real-time operating systems.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Implement and manage real-time tasks including creation, deletion, and synchronization.
2. Simulate and analyze task scheduling algorithms and context switching mechanisms.
3. Apply synchronization tools like semaphores and mutexes to manage concurrent tasks.
4. Handle interrupts and design inter-process communication using queues, pipes, and signals.
5. Demonstrate memory management strategies suitable for real-time operating systems.



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CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	M	H	L	L
CO2	H	H	H	M	M	L
CO3	H	H	H	H	M	L
CO4	H	H	H	H	M	M
CO5	H	H	M	H	L	L



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II Semester

L	T	P	C
0	0	2	1

SEMINAR-II



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III Semester

L	T	P	C
3	0	0	3

RESEARCH METHODOLOGY AND IPR

COURSE OBJECTIVES

1. To understand the concept of a research problem and methods for its investigation.
2. To develop skills in literature review, plagiarism detection, and research ethics.
3. To learn techniques for technical writing and research proposal preparation.
4. To gain foundational knowledge of Intellectual Property Rights (IPR) and patenting processes.
5. To explore new developments in IPR, including applications in software, biology, and traditional knowledge.

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

UNIT-IV: 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.

TEXT BOOKS:

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

REFERENCES:

1. Ranjit Kumar, 2nd Editio , "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.
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COURSE OUTCOMES:

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	M	M	L	L
CO2	H	H	H	M	M	L
CO3	M	M	M	H	L	H
CO4	M	M	L	H	L	M
CO5	M	M	L	H	M	M



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III Semester

L	T	P	C
0	0	0	3

SUMMER INTERNSHIP/INDUSTRIAL TRAINING



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III Semester

L	T	P	C
0	0	0	2

Comprehensive Viva[#]



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III Semester

L	T	P	C
0	0	20	10

Dissertation Part– A^{\$}



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IV Semester

L	T	P	C
0	0	32	16

Dissertation Part– B%