SIDDHARTHA ACADEMY OF HIGHER EDUCATION

(Deemed to be University)

M.Tech (Signal Processing and Communication)

SCHEME OF INSTRUCTION AND SYLLABUS M.Tech (2025)

(w.e.f 2025– 2026)

Department of Electronics and Communication Engineering

VELAGAPUDI RAMAKRISHNA SIDDHARTHA SCHOOL OF ENGINEERING

Kanuru, Vijayawada -520 007, Andhra Pradesh www.vrsiddhartha.ac.in

VISION

To be a Centre of Excellence in Education, Innovation and Research with Global presence in Arts, Science, Technology, Medicine, Management, Legal and Social Studies in enriching the frontier areas of National and International Importance.

MISSION

To create a transformative educational experience for students focused on problem solving skills, communication abilities, and interpersonal relations and leadership.

To cultivate a vibrant university community for attracting and retaining diverse, world-class talent creating a collaborative environment open to the free exchange of ideas where research, creativity, innovation and entrepreneurship can flourish and ensuring individuals to achieve their full potential.

To impact society in a pragmatic manner— regionally, nationally, and globally — by engaging with industry, outstanding national and international universities and research organizations.

To be a global University that nurtures excellence in education and innovation for creating a knowledgeable society.

DEPARTMENT VISION

To produce globally competitive and socially sensitized engineering graduates and to bring out quality research in the frontier areas of Electronics & Communication Engineering.

DEPARTMENT MISSION

To provide quality and contemporary education in the domain of Electronics & Communication Engineering through periodically updated curriculum, best of breed laboratory facilities, collaborative ventures with the industries and effective teaching learning process.

To pursue research and new technologies in Electronics & Communication Engineering and related disciplines in order to serve the needs of society, industry, government and scientific community.

PROGRAM OUTCOMES

PO1 Independently carry out research /investigation and development work to solve practical problems.

PO2 Write and present a substantial technical report/document.

PO3 Demonstrate a degree of mastery over the area as per the Signal Processing and Communication program.

PO4 Devise and apply appropriate techniques and modern engineering tools to complex engineering activities with an understanding of the limitations

PO5 Recognize the need for and an ability to engage in lifelong learning to keep oneself abreast of the knowledge to be competent.

SIDDHARTHA ACADEMY OF HIGHER EDUCATION

(an Institution Deemed to be University),

Velagapudi Ramakrishna Siddhartha School of Engineering

SCHEME OF INSTRUCTION FOR TWO YEAR PG PROGRAMME[M.Tech25]

M.Tech in Signal Processing and Communication

SEMESTER I

CONTACT HOURS: 26

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Programme Core – I	25ECSC501	FPGA based System Design (Integrated)	2	0	2	3
2	Programme Core - II	25ECSC502	ARM Controllers & Embedded C Programming	3	0	0	3
3	Programme Core - III	25ECSC503	Advanced Digital Communications	3	0	0	3
4	Programme Elective – I	25ECSC504A	Detection and Estimation Theory	3	0	0	3
		25ECSC504B	VLSI signal processing				
5	Programme Elective - II	25ECSC505A	RF Engineering	3	0	0	3
		25ECSC505B	Internet of Things for Real time systems				
6	Mandatory Learning Course	25ECUC501	Research Methodology and IPR	2	0	0	-
7	Audit Course	25ECUC502	Mathematical Foundations for Communication Engineers	2	0	0	-
8	Laboratory – I	25ECSC581	Digital Communication Lab	0	0	3	1.5
9	Laboratory - II	25ECSC582	Embedded Systems Design (ARM) Lab	0	0	3	1.5
Total				18	0	8	18

SEMESTER II

CONTACT HOURS: 28

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Programme Core - IV	25ECSC506	RTOS, Linux Shell Scripting and Embedded Linux Device Drivers(Integrated)	2	0	2	3
2	Programme Core - V	25ECSC507	Advanced Wireless and 5G Communication	3	0	0	3
3	Programme Core - VI	25ECSC508	Advanced DSP, Image and Video Processing	3	0	0	3
4	Programme Core - VI I	25ECSC509	Software Defined Radios	3	0	0	3
5	Programme Elective – III	25ECSC510A	Information theory and coding	3	0	0	3
		25ECSC510B	RF IC Design				
6	Programme Elective - IV	25ECSC511A	Radar Systems	2	0	0	2
		25ECSC511B	Communication buses and Interfaces				
7	Laboratory – I	25ECSC583	Real Time Operating Systems Lab	0	0	3	1.5
8	Laboratory - II	25ECSC584	Wireless Communication Lab	0	0	3	1.5
9	Term Paper	25ECSC591	Term Paper	0	0	2	1
10	Audit Course	24MTUC502	Technical Report Writing	2	0	0	-
Total				18	0	10	21

SEMESTER III

CONTACT HOURS: 27

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Programme Elective - V	25ECSC601	Mobile Networks (self learning)	3	0	0	**3**
2	Internship	25ECSC691	Internship/Summer Training at Avantel Limited (After II Sem)	0	0	4	**2**
3	Project (Part-A)	25ECSC692	Dissertation/ Industrial Project - Part A	0	0	20	**10**
Total				**3**	**0**	**24**	**15**

*To be continued in the IV Semester
Program Elective V may be completed in semester I or II by satisfying the pre-requisites

SEMESTER IV

CONTACT HOURS: 32

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Project (Part-B)	25ECSC693	Dissertation/ Industrial Project	0	0	32	**16**
Total				**0**	**0**	**32**	**16**

L – Lecture, T: Tutorial, P – Practical, C – Credits Total Credits:70

Semester	Credits
1	18
2	21
3	15
4	16
Total	70

Note:

1. Student has to carry out a project applying the knowledge and hands on technical skills they have gained through course work and lab sessions in Semester-I under Capstone Project 1

2. Student should carry out literature survey of the selected problem and present it in a Seminar for the yearlong Project Work under Term Paper.

3. Student has to carry out a project applying the knowledge and hands on technical skills they have gained through course work and lab sessions in Semester-II under Capstone Project 2

4. At least one theory course in the I & II semesters can be made as integrated course (Theory coupled with Laboratory).

5. Maximum of three theory courses (40% of courses) can be offered as self-learning courses in each of the First and Second semesters.

25ECSC501: FPGA Based System Design (Integrated)

Course Category:	Program Core-I	Credits:	3
Course Type:	Integrated course	Lecture - Tutorial -Practice:	2-0-2
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Use sequential and combinational design techniques to implement digital systems				
	CO2	Implement a digital design in Verilog HDL, behavioural and dataflow modelling.				
	CO3	Compare different implementations in terms of timing and hardware resources				
	CO4	Discuss the FPGA architecture and process flow.				
	CO5	Design and implement system on FPGA using IP Blocks.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3		2	2	1
	CO2	2		3	1	1
	CO3	2		3	3	1
	CO4	3		2	2	1
	CO5	3		3	1	1

Course Content

UNIT - I:

System Design using Verilog HDL: HDLs, Verilog description of combinational circuits, Modules, Assignments, Procedural Assignments, always block, Delays, Compilation, simulations and synthesis, Variables, datatypes, operators and language constructs, Behavioural and structural Verilog, Constants arrays and loops, Verification and testbenches, Functions and tasks, File I/O, Multivalued Logic and signal resolution

UNIT - II:

Digital System Design: Top-down Approach to Design, Data Path, Control Path, Controller behaviour and Design, Design Examples - BCD Adder, Traffic Light Controller, Binary Multiplier & Divider.

UNIT – III:

Programmable Devices: Overview of Programmable Devices, CPLDs, FPGAs – Implementing functions using FPGAs, Architectures of Commercial FPGAs Xilinx, Intel - Altera and Atmel, Carry Chains and Cascade chains, Logic Blocks, Dedicated memories and ALUs, Cost of programmability, Maximum gates vs usable gates, Synthesis, mapping, placement and routing, Timing analysis and timing constraints. I/O constraints.

UNIT – IV:

Embedded System Design Using FPGAs: Embedded cores in FPGAs, hard vs soft core processors, C-to-RTL High Level Synthesis, Hardware Software codesign, Case Study: System Design using Microblaze softcore processor and Xilinx Embedded Design Kit (EDK), peripherals, developing software applications on microblaze.

UNIT – V:

Case Study: Xilinx Zynq SOCs, Programmable Logic and Processor Systems, High Level Synthesis using Xilinx Vivado HLS, Creating a complete system using built-in ARM Cortex processor and an IP blocks in PL.

Experiments using FPGA

	(Artix-7 FPGA Development Board or Equivalent) 1. Design and implement a 4/8-bit counter on a Xilinx FPGA using Vivado . 2. Creating a system (hardware and software) that can output a simple message via the UART and blink LEDs on the board. 3. Write a C program and run it on a single processor system, based on a MicroBlaze soft core, using the available Xilinx FPGA platform. 4. Create a simple ARM Cortex based processor system through Vivado and IP integrator on available Xilinx FPGA platform. 5. Create an ARM Cortex based processor system through Vivado and IP integrator with two GPIO IPs in Programmable logic (PL). 6. Create a custom IP and adding it in the PL of the previously created processor system. Write a basic software application using SDK and verify its functionality on the developed processor system in the Xilinx FPGA platform.
Text books and Reference books	1. Charles H. Roth Jr. Lizy Kurian John, Beyeong Kil Lee, "Digital Systems Design Using Verilog", CL Engineering, 1st edition, 2015. 2. Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd edition, 2004 3. Charles H. Roth Jr, "Fundamentals of Logic Design", CL Engineering, 7th edition, 2013. 4. John F. Wakerly, "Digital Design - Principles and Practices", Pearson, 4th edition, 2008. 5. W. Wolf, "FPGA- based System Design", Pearson, 1st edition, 2004. 6. D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design: Modeling, Synthesis, Verification, Springer, 2009. 7. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization", Wiley-IEEE Press, 1st edition, 2007 . 8. J. Bhasker, "A Verilog HDL Primer", Star Galaxy Publishing, 3rd edition, 2005. 9. Xilinx FPGA user guides and University Program Course materials
E-resources and other digital material	

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC502: ARM Controllers for Embedded C Programming

Course Category:	Programme Core - II	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand and analyze the design aspects, Architecture, and instruction set associated with ARM processors.
	CO2	Analyze the C programming optimization methods for ARM processor.
	CO3	Apply the concepts of UART, ADC, and DAC to Peripherals
	CO4	Analyze the Memory Protection Units, Memory Management Units around ARM, and GPIO Pins, Interrupt handling, and Timers concepts
	CO5	Design and implementation of embedded case study with serial protocols

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5
CO1	2		2		1
CO2	3		2	2	1
CO3	2		2		1
CO4	3		3	2	1
CO5	3		3		1

Course Content

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**.**

UNIT - II:

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 - III:

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 – IV:** **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 **UNIT-V:** **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 **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 **Inter-Integrated Circuit (1^2C):** I^2C operating modes, Configuration of I^2C, Interface a sensor using I^2C 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 I^2C Module to measure the room temperature.
Text books and Reference books	**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.
E-resources and other digital material	1. https://nptel.ac.in/courses/106105193/ 2. https://www.arm.com/resources/education/education-kits/efficient-embedded-systems 3. https://www.keil.com/dd/docs/datashts/philips/lpc17xx_um.pdf 4. https://www.nxp.com/docs/en/datasheet/LPC1769_68_67_66_65_64_63.pdf 5. https://www.nxp.com/downloads/en/schematics/LPCXpresso-LPC1769-CMSIS-DAP.pdf

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC503: Advanced Digital Communications

Course Category:	Programme Elective - I	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Design optimum receivers for digital modulation techniques
	CO2	Compare the various modulation schemes from the point of view of bandwidth, circuit complexity and noise performance
	CO3	Determine the probability of error for a given scheme
	CO4	Analyze the probability of error in detection of PAM, Modulation codes for spectrum shaping
	CO5	Design an equalizer in the context of band-limited linear filter channels

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5
CO1	3		2	1	1
CO2	2		1	1	1
CO3	3		2	2	2
CO4	3		2	1	2
CO5	2		2	2	2

Course Content

UNIT - I:

Elements of a Digital Communication System, mathematical models for communication channels, Communication channels and their characteristics.

Representation of bandpass signals and system, Signal space representations. Representation of digitally modulated signals, Memoryless modulation methods-Pulse Amplitude Modulation, Phase Modulation schemes, Quadrature Amplitude Modulation, Multi-dimensional signalling - Spectral characteristics of Digitally modulated signals.

UNIT - II:

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 - III:

Signal parameter estimation, Carrier phase estimation, Symbol timing estimation, Joint estimation of carrier phase and symbol timing, Performance characteristics of ML estimators.

UNIT - IV:

Characterization of band-limited channels, Signal design for band-limited channels, Probability of error in detection of PAM, Modulation codes for spectrum shaping.

Optimum Receiver for channels with ISI and AWGN, Linear equalization, Decision feedback equalization, Reduced complexity ML detectors, Iterative equalization and decoding-Turbo

	equalization. **UNIT - V:** **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
Text books and Reference books	**Text Books:** 1. J.G. Proakis, ' Digital communications' , MGH, 4th edition, 2001 2. Upamanyu Madhow, 'Fundamentals of Digital Communication', Cambridge University Press 3. Michael Rice, Digital Communications: A Discrete-Time Approach, Prentice Hall,
E-resources and other digital material	

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC504A: Detection and Estimation Theory

Course Category:	Programme Core - III	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Apply discrete-time and continuous-time signal theory to estimate the signal parameters.				
	CO2	Extract useful information from random observations in communications.				
	CO3	Design and analyze optimum detection schemes.				
	CO4	Understand different estimation schemes such as ML, LSE and MMSE estimators.				
	CO5	Design the filters for signal detection and estimations				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2		2		1
	CO2	2		1		1
	CO3	3		2		2
	CO4	2		2		2
	CO5	2		3		1
Course Content	**UNIT - I:** **Detection theory** **Introduction:** Detection Theory in Signal Processing; the Detection Problem; the mathematical Detection Problem; Hierarchy of Detection Problems; Role of Asymptotics; Summary of Important PDFs (Fundamental Probability Density Functions); Monte Carlo Performance Evaluation, Number of required Monte Carlo trials. **Statistical Decision Theory:** Neyman-Pearson Theorem; Receiver Operating Characteristics; Minimum Probability of Error (ML, MAP, Baye's); Multiple Hypothesis Testing. **UNIT - II:** Deterministic Signals: Matched Filters – Development of Detector, Performance of Matched Filter; Multiple Signals – Binary case, Performance of Binary Case, M-ary case. **Random Signals:** Estimator-Correlator – Energy Detector; Linear Model – Rayleigh Fading Sinusoid, Incoherent FSK for a Multipath Channel; Signal Processing Example – Tapped Delay Line Channel Model **UNIT - III:** **ESTIMATION THEORY** **Introduction:** Estimation in Signal Processing; Mathematical Estimation Problem; Assessing Estimator Performance. **Minimum Variance Unbiased Estimation:** Unbiased Estimators; Minimum Variance Criterion; Existence of the Minimum Variance Unbiased Estimator; Finding the Minimum Variance Unbiased Estimator. **Cramer-Rao Lower Bound:** Estimator Accuracy Considerations; Cramer-Rao Lower Bound; General CRLB for Signals in WGN; Extension to a Vector Parameter; Signal Processing Examples –					

	Range Estimation, Sinusoidal Parameter Estimation). **Linear Models:** Definition and Properties; Linear Model Examples – Curve Fitting, Fourier Analysis, System Identification. **UNIT - IV:** **General Minimum Variance Unbiased Estimation**: Sufficient Statistics; Finding Sufficient Statistics; Using Sufficiency to Find the MUV Estimator. **Best Linear Unbiased Estimators:** Definition of the BLUE; Finding the BLUE. **Maximum Likelihood Estimation:** Example – DC Level in WGN; Finding the MLE; Properties of the MLE; MLE for Transformed Parameters. **Least Squares Estimation:** The Least Squares Approach; Linear Least Squares; Order Recursive Least Squares. **UNIT - V:** **The Bayesian Philosophy:** Prior Knowledge and Estimation, Nuisance parameters **General Bayesian Estimators:** Risk Function; Minimum Mean Square Error Estimators; Maximum A Posteriori Estimators. **Kalman Filters and Wiener Filters:** Introduction, Summary, Dynamic signal models, Scalar Kalman filter, Kalman versus Wiener filter.
Text books and Reference books	**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. 3. **Harry L. Van Trees**, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, Inc. 2011. 4. **A. Papoulis and S. Unnikrishna Pillai**, "Probability, Random Variables and stochastic processes, 4e". The McGraw-Hill 2010.
E-resources and other digital material	

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC504B: VLSI Signal Processing

Course Category:	Program Elective -I	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:	DSP,VLSI	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Apply pipelining and parallel processing techniques to the design of FIR digital filters and low-power systems. [K3]				
	CO2	Solve systems of inequalities related to retiming and apply retiming techniques to optimize digital systems [K3].				
	CO3	Apply folding transformations and register minimization techniques in digital system design, particularly in multirate systems [K3].				
	CO4	Develop and design systolic architectures for FIR filters and matrix multiplication, effectively selecting scheduling vectors and handling space representations with delays [K6].				
	CO5	Implement and design fast convolution algorithms, understand the principles behind Cook-Toom, Winograd, and other iterative cyclic convolution methods to create efficient convolution systems [K3].				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2	2	2		
	CO2	2	2	2		
	CO3	3	2	3	2	
	CO4	3	2	2	2	
	CO5	3	2	2	2	
Course Content	**Unit 1: Pipelining and Parallel Processing (9 Hrs)** Introduction, Pipelining of FIR, Digital Filters, Parallel processing, Pipelining and Parallel Processing for low power **Unit 2: Retiming (9 Hrs)** Introduction, Definition and Properties, Solving System of Inequalities, Retiming Techniques **Unit 3: Unfolding & Folding (9 Hrs)** Introduction to Algorithms for Unfolding, Properties of Unfolding, Critical Path, Unfolding and Retiming Application of Unfolding, Introduction to Folding Transformation, Register Minimization Techniques, Register Minimization Technique in Folded Architectures, Folding in Multirate Systems **Unit 4: Systolic Architecture Design (9 Hrs)** Introduction, Systolic Array design Methodology, FIR Systolic Arrays, Selection of scheduling Vector, Matrix Multiplication, 2D Systolic Array Design, Systolic Design for Space Representations containing delays **Unit 5: Fast Convolution (9 Hrs)** Introduction, Cook-Toom Algorithm, Winogard Algorithm, Iterated Convolution, Cyclic Convolution, Design of fast convolution					
Text books and Reference books	**Textbooks:** 1. Keshab K. Parhi,"VLSI Digital Signal Processing Systems", Wiley-InterSciences, 1999 **References:** 1. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern singalprocessing, Prentice Hall, 1985					

	2. Jose E. France, Yannis Tsividls, Design of Analog Digital VLSI Circuitsfor Telecommunications and Signal Processing' Prentice Hall, 1994.Ramesh, S. (2013). *Engineering chemistry* (2nd ed.). Wiley India.
E-resources and other digital material	1. https://www.win.tue.nl/~wsinmak/Education/2IN35/Parhi/chap3.pdf 2. http://twins.ee.nctu.edu.tw/courses/vsp_12/lecture/VSP-lec01-pipelining%20&%20retiming.pdf 3. https://www.oreilly.com/library/view/vlsi-digital-signal/9780471241867/sec-4.4.html#:~:text=Cutset%20retiming%20only%20affects%20the,4.4(a). 4. http://www.ece.umn.edu/users/parhi/SLIDES/chap4.pdf 5. https://www.eecs.harvard.edu/htk/static/files/1978-cmu-cs-report-kung-leiserson.pdf 6. https://dsp-book.narod.ru/DSPMW/08.PDF

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC505A: RF Engineering

Course Category:	Programme Elective - II	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Simulate passive circuits in microstrip line technology				
	CO2	Design microstrip lowpass, high pass, bandpass and band stop filters.				
	CO3	Design microstrip based couplers and power dividers				
	CO4	Ability to use and measure S-parameters using microwave instruments				
	CO5	Design and analysis of Power Dividers and Directional Couplers				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2		2		1
	CO2	2		1		1
	CO3	3		2		1
	CO4	2		2		2
	CO5	2		3		1

Course Content

UNIT - I:

Scattering Parameters: Scattering and chain scattering matrices, generalized scattering matrix, Analysis of two port Networks, scattering matrix, representation of microwave components (directional coupler, circulators, hybrids, and isolators).

UNIT - II:

Planar Transmission Line : Microstrip lines: Geometry of microstrip, quasi-TEM mode of propagation, Static-TEM parameters, Characteristic impedance, effective permittivity, synthesis formulae, analysis formulae, dispersion in microstrip.

UNIT - III:

High Frequency Filter Design : Filter design using Insertion loss method, characterization by power loss ratio, maximally flat low pass filter, Equal-ripple low pass filter,

UNIT - IV:

Filter transformations: impedance and frequency scaling, bandpass and band stop transformations, Filter implementation: Richard's transformation, Kuroda's identities.

UNIT - V:

Power Dividers and Directional Couplers: Basic properties of dividers and Couplers. Even mode and odd mode analysis, Wilkinson power divider, quadrature hybrid, and coupled line directional coupler.

Text books and Reference books	**Text Books:** 1. D. M. Pozar, Microwave Engineering, 3nd Edition, John Wiley & Sons. 2. R. Sorrentino and G. Bianchi, Microwave and RF Engineering, John Wiley & Sons. 3. Reinhold Ludwig and Gene Bogdanvov, ―RF Circuit Design – Theory and Application, 2nd Edition, Pearson, 2012. 4. E.da Silva, ―High Frequency and Microwave Engineering, Butterworth Heinmann publications, Oxford, 2001. 5. T. C. Edwards, Foundations of Interconnects and Microstrip lines, John Wiley & Sons.
E-resources and other digital material	

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC505B: Internet of Things for Real Time Systems

Course Category:	Program Elective -II	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:	UG Embedded Systems	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Identify and explain IoT protocols, enabling technologies, and communication models. [K2].				
	CO2	Design and implement IoT systems using a structured methodology [K3].				
	CO3	Develop programming skills in Python. [K3]				
	CO4	Develop IoT applications and projects using Raspberry Pi. [K3]				
	CO5	Analyze real-world case studies representing diverse IoT applications [K4].				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1			2		
	CO2			2		
	CO3			2	2	
	CO4			2	3	
	CO5				3	3

Course Content

UNIT - I: Introduction to IoT **(9 Hrs)**

Introduction: Definition & Characteristics of IoT, Physical Design of loT, Things in loT, loT Protocols, Logical Design of IoT, loT Functional Blocks, loT Communication Models, loT Communication API's, loT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems

Domain Specific IoTs: Introduction, Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Lifestyle.

UNIT - II: IoT and M2M **(9 Hrs)**

IoT and M2M- Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization.

LoT Platforms Design Methodology- Introduction, loT Design Methodology, Case Study on loT System for Weather Monitoring

UNIT - III: IoT Systems – Logic Design using Python. **(9 Hrs)**

Introduction to Python, Python Data types & Data Structures, Control flow, functions, Modules, Packages, File Input/output, Date/Time Operations, Classes.

UNIT - IV: loT Physical Devices & Endpoints **(9 Hrs)**

loT Physical Devices & Endpoints - Basic building blocks of a loT Device, Exemplary Device: Raspberry PI, Raspberry PI Interfaces, serial, SPI, I2C, Programming Raspberry Pi with Python, Controlling LED with Raspberry Pi, Interfacing an LED and Switch with Raspberry Pi, Interfacing LDR with Raspberry Pi.

UNIT - V: Case Studies illustrating IoT Design **(9 Hrs)**

Introduction, Home Automation, Smart lighting, home intrusion detection, Cities, smart parking, Environment, weather monitoring system, weather reporting bot, air pollution monitoring, forest fire detection, Agriculture, smart irrigation.

Text books and Reference books

Textbooks:

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things A Hands-on Approach, Universities press (India) Pvt. Ltd, 2023.

References:

1. Rajkumar Buyya, Amir Vahid Dastjerdi, and Syed Shahrestani, "Internet of Things: Principles and Paradigms", Morgan Kaufmann Publishers, 2016.

	2. Maciej Kranz, "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry", Jhon Wiley & Sons publishers, 2016. 3. Brian Russell and Drew Van Duren, "Practical Internet of Things Security", PACKT publishers, 2016.
E-resources and other digital material	a. https://www.i-scoop.eu/internet-of-things-guide/ b. https://www.postscapes.com/internet-of-things-protocols/ c. https://www.ibm.com/cloud/learn/internet-of-things d. https://www.link-labs.com/blog/iot-vs-m2m e. https://www.sdxcentral.com/sdn/definitions/what-the-definition-of-software-defined-networking-sdn/ f. https://www.networkworld.com/article/3238446/what-is-nfv-network-functions-virtualization-explained.html g. https://www.learnpython.org/en/Control_Flow h. https://realpython.com/python3-object-oriented-programming/ i. https://www.raspberrypi.org/documentation/usage/python/ j. https://www.smarthome.com.au/smarthome-case-studies k. https://www.smartcitiesworld.net/news/news/smart-city-case-studies-4449 l. https://www.hackster.io/projects/environmental-monitoring m. https://www.iotforall.com/smart-agriculture-iot

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECUC501: Research Methodology and IPR

Course Category:	Mandatory Learning Course	Credits:	0
Course Type:	Theory	Lecture - Tutorial -Practice:	2-0-0
Prerequisites:	-	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Demonstrate proficiency in formulating research problems, applying scientific methods, and understanding the significance of research methodology in academic and professional settings. [K2]
	CO2	Achieve proficiency in critically reviewing literature, enhancing research methodologies, and designing effective research studies that contribute to knowledge broadening and contextual understanding. [K2]
	CO3	Gain proficiency in designing reliable sampling strategies, applying measurement scales, and executing data collection methods to minimize errors and enhance research validity.[K2]
	CO4	Conduct hypothesis tests, interpret test statistics, and utilize data analysis methods to enhance research validity. [K2]
	CO5	Interpret research results, write impactful reports, and apply knowledge of intellectual property rights to research practices. [K2]

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5
CO1	2	2			
CO2		2			2
CO3		2		2	
CO4		1	2		
CO5		2	2		

Course Content

Unit 1: Research Methodology: and **Research Problem (5 Hrs)**

- Introduction to Research Methodology: Meaning, Objectives, Motivation, Approaches, Significance, and Scientific Methods.
- Research Process: Steps, Criteria of Good Research, and Common Problems Encountered by Researchers in India.
- Defining the Research Problem: Selecting and Defining the Problem, Techniques, and Illustration.

Unit 2: Literature Review and Research Design (5 Hrs)

- Reviewing the Literature: Importance, Methodology Improvement, Knowledge Broadening, and Contextual Findings.
- Research Design: Meaning, Need, Features of a Good Design, Concepts, Basic Principles, and Experimental Designs.

Unit 3: Sampling Design , Data Collection, ICT Tools and Techniques in Research: (5 Hrs)

- Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample vs. Census Survey.
- Measurement and Scaling: Qualitative and Quantitative Data, Measurement Scales, Goodness, and Sources of Error.
- Data Collection: Experimental and Surveys, Primary and Secondary Data Collection, Case Study Method.
- Software for Reference Management (Zotero/ Mendeley), detecting Plagiarism, Research search Engines

Unit 4: Hypothesis Testing and Data Analysis(5 Hrs)

	• Testing of Hypotheses: Concepts, Hypothesis Testing, Test Statistics, Critical Region, Value and Decision Rule, Procedure. • Data Analysis: Techniques and Tools for Analyzing Collected Data. **Unit 5: Interpretation, Report Writing, and Intellectual Property (5 Hrs)** • Interpretation and Report Writing: Meaning, techniques, precautions, and significance of report writing. • Intellectual Property: Concept, system in India, development of TRIPS complied regime, Patents Act, Trade Mark Act, Designs Act, Geographical Indications, Copyright Act, Trade Secrets, Utility Models, WTO, Paris Convention, National Treatment, Right of Priority, Common Rules, PCT, and TRIPS Agreement.
Text books and Reference books	**Textbooks:** 1. Research methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018. 2. Research Methodology a step-by-step guide for beginners. Ranjit Kumar, SAGE Publications Ltd.,3rd Edition, 2011 3. Study Material, Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body under an Act of Parliament, September 2013. **References:** 1. An introduction to Research Methodology, Garg B.L et al ,RBSA Publishers 2002 2. An Introduction to Multivariate Statistical Analysis Anderson T.W, Wiley 3rd Edition, 3. Research Methodology, Sinha, S.C, Dhiman, EssEss Publications2002 4. Research Methods: the concise knowledge base ,Trochim ,Atomic Dog Publishing ,2005 5. How to Write and Publish a Scientific Paper, Day R.A, Cambridge University Press 1992 6. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009 7. Proposal Writing, Coley S.M. Scheinberg, C.A, Sage Publications, 1990 8. Intellectual Property Rights in the Global Economy, Keith Eugene Maskus, Institute for International Economics
E-resources and other digital material	1. https://www.techtarget.com/whatis/definition/scientific-method 2. https://www.geophysik.uni-muenchen.de/~valerian/Scientific_Working/SRMTunit2.pdf 3. https://hmhub.in/3rd-4th-sem-research-methodology-notes/criteria-of-good-research/ 4. https://researcher.life/blog/article/what-is-a-research-problem-types-and-examples/ 5. https://www.questionpro.com/blog/data-collection-methods/ 6. https://southcampus.uok.edu.in/Files/Link/DownloadLink/RM%20U2%20P2.pdf 7. https://www.studysmarter.co.uk/explanations/psychology/cognition/formulation-of-hypothesis 8. https://www.aimlaywriting.com/significance-of-research-report-writing/ 9. https://www.lexology.com/library/detail.aspx?g=7045cf52-4a2c-465f-980b-b5af034e2064 10. https://www.trade.gov/country-commercial-guides/india-protecting-intellectual-property

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECUC502: Mathematical Foundations for Communication Engineers

Course Category:	Program Elective-V	**Credits:**	2
Course Type	Theory	**Lecture-Tutorial-Practice:**	2-0-0
Prerequisites:	---	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	- 100 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the mathematical concepts related to probability theory and random processes				
	CO2	Formulate and solve communication problems involving random processes				
	CO3	Understand the fundamental concepts in vector spaces, linear operators, matrices				
	CO4	Apply the concepts of inner product spaces to orthogonality and approximation problems				
	CO5	Design and analyze the matrices and vectors for linear operations				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2		2		2
	CO2	2		2		2
	CO3	1		2		2
	CO4	3		2		2
	CO5	3		2		2
Course Content	**UNIT I:** **PROBABILITY AND RANDOM VARIABLES:** Meaning of probability, Axioms of Probability, Conditional Probability, Concept of a Random Variable, expected values for discrete and continuous random variables, Function of one Random Variable, Two Random variables, conditional probability density functions. **UNIT II:** **RANDOM PROCESSES:** Classification, Auto Correlation, Cross Correlation, Stationary and wide sense stationary random process, Gaussian random process, Poisson random process. **UNIT III:** **LINEAR ALGEBRA:** Vector spaces, Linear combination of vectors, Linear dependence, Basis and dimensions, finite dimensional vector spaces, Linear Transformations. Norms and normed vector spaces, Inner products and inner product spaces. **UNIT – IV:** **LINEAR OPERATORS AND MATRIX INVERSES:** Matrix factorizations, LU factorization, unitary matrices and QR factorization. Singular value decomposition, pseudo inverses and the SVD. **UNIT – V:** **EIGEN VALUES AND EIGEN VECTORS:** Introduction to Eigen values and Eigen vectors, Linear dependence of Eigen vectors, diagonalization of matrix.					

Text books	[1]. A. Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill. (Indian Edition is available). [2]. Gibert Strang," Linear Algebra and its applications", Thomson Learning Inc, 4th Edition.
Reference books	. H.Stark and J. Woods, 'Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education. (Indian Edition is available). . Steven M. Kay, " Intuitive Probability and Random Process using Matlab", Springer Publications. . Todd K Moon, Wynn C. Stirling" Mathematical Methods and Algorithms for Signal Processing, Prentice Hall.

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC581: Digital Communication Lab

Course Category:	Laboratory-I	Credits:	1.5
Course Type:	Laboratory	Lecture - Tutorial -Practice:	0-0-3
Prerequisites:	Digital Logic Design	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Identify the different line codes and infer the quality of the received signal using eye diagram				
	CO2	Appreciate the principle of generation and detection of BPSK, DPSK, DEPSK, MSK, GFSK, GMSK signals.				
	CO3	Appreciate the principle of generation and detection of QPSK, DQPSK signals.				
	CO4	Generate and detect rate ½ convolutional code				
	CO5	Use a software tool to generate time domain and frequency domain descriptions of various binary digital modulation schemes.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1		**1**		**3**	
	CO2		**1**		**3**	
	CO3		**1**		**3**	
	CO4		1		2	
	CO5		1		2	
Course Content	**Hardware related experiments:** 1. Sampling and reconstruction of low pass signals 2. Time Division Multiplexing 3. BPSK/DPSK generation & detection 4. QPSK/OQPSK generation &detection 5. 8-QAM generation & detection 6.FSK generation and detection **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					

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Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

25ECSC582: Embedded System Design Lab (ARM)

Course Category:	Laboratory-II	Credits:	1.5
Course Type:	Laboratory	Lecture - Tutorial -Practice:	0-0-3
Prerequisites:	Computer Architecture	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Design and execute the different concepts for embedded system using ARM processor.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1				2	
Course Content	**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. 11. Project					

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D. VENKATA RAO	

SEMESTER II

C506: RTOS, LINUX SHELL SCRIPTING AND EMBEDDED LINUX DEVICE DRIVERS

Course Category:	Programme Core - IV	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:	Embedded Systems	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Demonstrate the Real-Time Operating System's core components and explain how tasks are managed and synchronized in real-time environments.
	CO2	Apply the key synchronization concepts including semaphores, message queues, pipes, event registers, signals, and condition variables in applications based on real-time operating systems.
	CO3	Analyze the key components related to exceptions, interrupts, timers, and related services for the implementation in embedded hardware based on real time operating system.
	CO4	Build the I/O subsystems and applications for real-time operating system based IoT device.
	CO5	Understand the Linux kernel and Graphical Environment .

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	3	1	2
CO4	3	3	3	1	2
CO5	2	2	2	1	2

Course Content

UNIT - I: (9Hrs)

Introduction to Real-Time Operating Systems - Defining an RTOS, The scheduler, Kernel Objects and services, Key characteristics of an RTOS, Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, System calls, Static and dynamic libraries, Cross tool chains

Task- Defining a Task, Task States and Scheduling, Typical Task Operations, Typical Task Structure, Synchronization, Communication and Concurrency.

Semaphores - Defining Semaphores, Typical Semaphore Operations, Typical Semaphore Use.

Message Queues - Defining Message Queues, Message Queue States, Message Queue Content, Message Queue Storage, Typical Message Queue Operations, Typical Message Queue Use, Pipes, Event Registers, Signals and condition Variables.

UNIT - II: (9Hrs)

Exceptions and Interrupts - Exceptions and Interrupts, Applications of Exceptions and Interrupts, Closer look at exceptions and interrupts, Nature of Spurious Interrupts

Timer and Timer Services - Real-Time clocks and System Clocks, Programmable Interval Timers, Timer Interrupt Service Routines.

UNIT - III: (9Hrs)

	I/O Subsystems - I/O concepts, I/O subsystems **Synchronization and Communication -** Synchronization, Communication, Resource Synchronization Methods, Critical section, Common practical design patterns, Priority Inversion. **Common Design Problems** – Resource Classification, Dead locks, Priority inversion. **UNIT IV: (9Hrs)** **Introduction To Linux Kernals-** What Is Linux, The GNU utilities, The Linux desktop environment, Linux Distributions, Reaching the Command Line, Accessing CLI via a Linux Console Terminal, Graphical Terminal Emulation, GNOME Terminal, Console terminal and xtern Terminal Emulator. **Bash Shell Commands-** Starting the Shell, Using the Shell Prompt, interacting with the bash Manual, Navigating the File system, Listing Files and Directories, Handling Files, Managing Directories, Viewing File Contents, Monitoring Programs and Disk Space, Working with Data Files, Exploring Environment Variables, Setting User-Defined Variables, Removing Environment Variables. **Shell Scripting-** Creating a Script File, Displaying Messages, Structured Commands: Working with the if-then Statement, if-then-else, Nesting ifs, case Command, For Command, While Command, Until Command, Nested loops, Controlling the loops, Processing the Output of a Loop, Practical Examples, Presenting Data: Understanding Input and Output, Redirecting Output and Input in Scripts, Creating Your Own Redirection, Practical Example **Script Control -**Handling Signals, Running Scripts in Background Mode, Running Scripts without a Hang-Up, Controlling the Job, Running Like Clockwork, Basic Script Functions, returning a Value, Using Variables in Functions, Function Recursion, Creating a Library, Using Functions on the Command Line, Working with Alternative Shells: dash Shell, The dash Shell Features, Scripting in dash, The zsh Shell, Parts of the zsh Shell. **UNIT - V: (9Hrs)** Embedded Linux Architecture, Kernel Architecture – HAL, Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC, User space, Start-up sequence. **Board Support Package Embedded Storage:** MTD, Architecture, Drivers, Embedded File System Embedded **Device Drivers:** Communication between user space and kernel space drivers, Character and Block Device Drivers, Interrupt handling, Kernel modules **Embedded Drivers:** Serial, Ethernet, I2C, USB, Timer, Kernel Modules **Porting Applications Real-Time Linux:** Linux and Real time, Programming, Hard Real-time Linux **Building and Debugging:** Bootloaders, Kernel, Root file system, Device Tree.
Text books and Reference books	**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. 3. Karim Yaghmour, "Building Embedded Linux Systems", O'Reilly & Associates 4. P Raghvan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications **Reference Books:** 1. Albert Cheng, (2022), "Real-Time Systems: Scheduling, Analysis and Verification", Interscience.

	2. Hermann Kopetz, (2017), "Real-Time Systems: Design Principles for Distr Embedded Applications", Kluwer. 3. Insup Lee, Joseph Leung, and Sang Son, (2018) "Handbook of Real-Time Sys Chapman and Hall. 4. Krishna and Kang G Shin, (2021), "Real-Time Systems", McGraw Hill 5. Christopher Hallinan, "Embedded Linux Primer: A Practical Real-World Approach", Prentice Hall, 2nd Edition, 2010. 6. Derek Molloy, "Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux", Wiley, 1st Edition, 2014
E-resources and other digital material	1. https://nptel.ac.in/courses/106105036/ 2. https://nptel.ac.in/noc/individual_course.php?id=noc18-cs12 3. https://training.linuxfoundation.org/training/developing-embedded-linux-device-drivers/ 4. https://nptel.ac.in/courses/117106113

Designation	**Name in Capitals**	**Signature with Date**
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC507: ADVANCED WIRELESS AND 5G COMMUNICATION

Course Category:	Program Core - V	Credits:	3
Course Type	Theory	Lecture-Tutorial-Practice	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Model the wireless channel to estimate the path loss				
	CO2	Evaluate the performance of digital modulation techniques over wireless channels using software and hardware techniques				
	CO3	Suggest the possible techniques to improve the performance of wireless systems using modern tools				
	CO4	Identify the advantages of multicarrier modulation				
	CO5	Learn 5G Technology advances and their benefits				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	2	1	1
	CO2	3	3	2	1	2
	CO3	3	3	3	1	2
	CO4	3	3	3	1	2
	CO5	2	2	2	1	2

Course Content

UNIT - I: (9 Hrs)

Wireless Channels: Radio wave propagation, Physical modelling for wireless channels, Path loss and Shadowing, outage probability under path loss and shadowing, time and frequency coherence, Statistical multipath channel models, narrowband fading models, wideband fading models, Discrete-time model, Space-time channel models.

Capacity of Wireless Channels:AWGN channel capacity, capacity of flat fading channels, channel distribution Information known at transmitter or receiver and both capacity comparisons, Capacity of frequency selective fading channels-time invariant-time variant.

UNIT II: (9 Hrs)

Performance of Digital Modulation Over Wireless Channels: SNR and bit/symbol energy, error probability for BPSK, QPSK, MPSK, MPAM, MQAM, Index Modulation over fading channels. Error probability for FSK and CPFSK, error probability approximation for coherent modulations and differential modulations, Q-function representation, outage probability, average probability of error, inter symbol interference

UNIT III: (9 Hrs)

Diversity: Receiver diversity: selection combining (SC), threshold combining, maximal ratio combining (MRC), equal gain combining (EGC), transmitter diversity: channel known at the transmitter, channel unknown at the transmitter, Alamouti scheme, moment generating functions (MGF) in diversity analysis ,diversity analysis using MGF for SC-EGC-MRC, diversity analysis for non-coherent and differentially coherent modulation.

UNIT – IV: (9 Hrs)

Equalization: equalizer noise enhancement, equalizer types, zero forcing equalizer, MMSE equalizer, maximum likelihood sequence estimation, decision feedback

	equalization, adaptive equalizers. **UNIT – V: (9 Hrs)** **Overview of 5G Broadband Wireless Communications**: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G,Spectrum Analysis and Sharing for 5G. **Transmission and Design Techniques for 5G**: Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).
Text books and Reference books	**Text Books:** 1. Andrea goldsmith, `Wireless Communication`, South Asia Edition 2015, Cambridge University Press 2. Theodore S. Rappaport, 'Wireless Communications Principles and Practice," Third Edition, Pearson Education. (Indian Edition is available). 3. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell. 4. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks" , Cambridge University Press **Reference Books:** 1. David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2. Todd K Moon, Wynn C. Stirling" Mathematical Methods and Algorithms for Signal Processing, Prentice Hall 3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press. 4. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons. 5. Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press 6. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications
E-resources and other digital material	1.

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC508: ADVANCED DSP, IMAGE AND VIDEO PROCESSING

Course Category	Program Core-VI	Credits	3
Course Type	Theory	Lecture-Tutorial-Practice	3-0-0
Prerequisite		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	DSP System Design
	CO2	Filters Design with DSP
	CO3	DSP Design with FPGA
	CO4	Filter Design with FPGA
	CO5	Understand the properties, functioning of DCT, KLT and wavelet transforms for 1- D and 2-D signals.
	CO6	Implement adaptive filter algorithms for applications in noise cancellation, deconvolution, enhancement and channel equalization
	CO7	Apply higher order spectra for solving non-Gaussian, non-linear stochastic problems
	CO8	Design a decimator or interpolator for the given specifications

Contribution of Course Outcomes towards achievement of Program Outcomes (1–Low, 2-Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	3	1	2
CO4	3	3	3	1	2
CO5	2	2	2	1	2

Course Content

UNIT-I: (9Hrs)

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, Introduction to MATLAB and SIMULINK 9

Digital Signal Processing Algorithms: Filter Design, FIR Digital filter design, Frequency Domain, Fourier Transform: DFT, FFT, Spectral Analysis

UNIT-II: (9Hrs)

Digital Signal Processing Application: Real-time Implementation: Real-time Implementation of FIR Digital filter using ARM Cortex M3/M4 Processor & DSP. Real-time Implementation of Fast Fourier Transform applications using ARM Cortex M3/M4 Processor & DSP.

Current trends in Digital Signal Processor: FPGA Technology DSP Technology Requirements, Design implementation, Multiply Accumulator (MAC) and Sum of Product (SOP), Implementation of Serial/Parallel Convolution using FPGAs, FPGA Based DSP System Design, FIR filters, FIR Theory, Designing FIR filters, Direct Window Design method, Constant Coefficient FIR Design, Direct FIR Design, Cooley-Tukey FFT Algorithm implementation using FPGA Total Hours

UNIT-III: (9Hrs)

Introduction: Review of Discrete time Signals and Systems, Discrete Time Fourier Transform, Z-Transform

Adaptive Filter theory: Stochastic gradient based algorithms LMS algorithm, stability analysis, Mean-squared error behaviour. Convergence analysis, Normalized LMS algorithm, Gradient adaptive lattice algorithm. Prediction, filtering and smoothing, adaptive

	equalization, noise cancellation, blind deconvolution, adaptive IIR filters, RLS algorithms-GRLS, Gauss Newton and RML. **Multirate signal processing:** Decimation, Interpolation, polyphase filters and their structures. **UNIT-IV: (9Hrs)** **Image Processing Overview:** Image Sensing and Acquisition, Digital Image Representation, Basic Relationships between Pixels, Image Enhancement, Intensity Transformations and Spatial Filtering, Histogram Processing, Smoothing Spatial Filters, Sharpening Spatial Filters. **UNIT-V: (9Hrs)** **Video Sampling and Indexing:** Digital Video, Video Transmission, Spatiotemporal Sampling Structures, Sampling Structure Conversion, Image and Video Indexing and Retrieval **Video Compression:** Introduction, Application Requirements, Digital Video Signals and Formats, Digital Video Formats, Video Compression Techniques, Entropy and Predictive Coding, Block Transform Coding--The Discrete Cosine Transform, Motion Compensation and Estimation, Video Encoding Standards and H.261, MPEG-1 Video Coding Standard, MPEG-1 Video Coding vs. H.261 MPEG-1 Video Structure, Summary of the Major Differences between MPEG-1 Video and H.261 Coders, MPEG-4: Technical Description, Embedded Video Codec Design Requirements and Constraints, Embedded Video Codec Design Flow
Textbooks and Reference books	**Text Books:** 1. Digital Signal Processing Implementation Using the TMS320C6000 DSP Platform, 1 st Edition; by: 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, 1st Edition; by: Rulph Chassaing 4. Digital Signal Processing: A System Design Approach, 1st 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, Third Edition, Sanjit K. Mitra, Tata McGRWA Hill 3. Digital Signal Processing – A Practical Guide for Engineers and Scientists, Steven W Smith, Elsevier 4. Digital Signal Processing - A Student Guide, 1 st Edition; by: T.J. Terrel and LikKwan Shark; Macmillan Press; Ltd. 5. Sanjit K. Mitra, "Digital Signal Processing Laboratory Using MATLAB" , McgrawHill College, ISBN-13: 978-0073108582 6. Sen M.Kuo , Woon-Seng S. Gan, Digal Signal Processors: Architectures, Implementations, and Applications Prentice Hall 2004. 7. Keshab K. Parhi, VLSI Signal Processing Systems, Design and Implementation, John Wiley & Sons,1999. 8. Digital Signal Processing, 1 st Edition; by: Oppenheim A.V and Schafer R.W; PH 9. Digital Signal Processing Laboratory, B. Preetham Kumar, Taylor & Francis, CCS DSP Applications 10. Introduction to Digital Signal Processing, 1 st Edition; by: John G Proakis, Dimitris G Manolakis 34 /78 11. Digital Signal Processing Design, 1 st Edition; by: Andrew Bateman, Warren Yates

	12. A Simple approach to Digital Signal processing, 1 st Edition; by: Kreig Marven & Gillian Ewers; Wiely Interscience 13. DSP FIRST - A Multimedia Approach, 1 st Edition; by: JAMES H. McClellan, Ronald Schaffer and Mark A. Yoder; Prentice Hall 14. Signal Processing First, 1st edition; by: James H. McClellan, Ronald W. Schafer and Mark A. Yoder; Pearson Education 15. Digital Processing of Speech Signals, 1 st Edition; by: L.R. Rabiner and Schafer R.W; PH 16. Digital Signal Processing – Architecture, Programming and Applications, by: B. Venkataramani & M.Bhaskar; Tata McGraw Hill 17. A Practical Approach to Digital Signal Processing, by: K. Padmanabhan, S. Ananthi & R.Vijayarajeswaran; New Age International Publishers 18. Theory & Application of Digital Signal Processing, 1 st Edition; by: Rabiner L.R & Gold B; Prentice Hall 19. Digital Signal Processing, 1 st Edition; by: P Ramesh Babu, 20. DSP Principles, Algorithms and Applications JG Proakis, DG Manolakis, 3rd Edition, PHI Private Ltd., 2001. 21. Adaptive Filter Theory S. Haykin, 2nd Edition, PRENTICE HALL., 2001 22. Modern Digital Signal Processing-2 nd Edition, V.Udayashankara, PHI, 2012. 23. Modern spectral estimation, SM Kay, PH Int, 1997 24. Advanced digital signal processing, Proakis, C. M. Rader, Fuyun, Ling CL., Mcmillan Publishing Company, NY, 1992. 25. Modern Digital signal processing An Introduction Prabhakar S. Naidu, Narosa Publishing House,2003. 26. Adaptive Signal processing B. Widrow & D. Stearns, PH Int 1987 Optimum 27. Signal Processing; An Introduction, S.J.Orfanidis, Second Edition, McGraw Hill Book Company, 1992. 28. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, 4th Edition, - Pearson Education, 2015. 29. ALAN C BOVIK, “Hand Book of Image and Video Processing”, 2nd Edition, Elsevier Academic Press, 2005.
E-resources and other digital material	

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC509: SOFTWARE DEFINED RADIO

Course Category:	Audit Course	Credits:	0
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	

Course Outcomes	Upon successful completion of the course, the student will be able to					
	CO1	Demonstrate understanding of the need, characteristics and benefits of SDR				
	CO2	Analyze the RF Chain of SDR and components for overall performance.				
	CO3	Compare direct digital synthesis with analog signal synthesis in SDR.				
	CO4	Demonstrate understanding of polyphase filters, digital filter banks, timing recovery in digital receivers using multi-rate digital filters				
	CO5	Demonstrate insight to evaluate the parameters of Ideal Data Converters and Practical data Converters.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	2	1	1
	CO2	3	3	2	1	2
	CO3	3	3	3	1	2
	CO4	3	3	3	1	2
	CO5	2	2	2	1	2
Course Content	**UNIT - I:(9Hrs)** **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:(9Hrs)** **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:(9Hrs)** **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 : (9Hrs)** **Multirate Signal Processing:** Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital receivers Using Multirate Digital Filters. **UNIT - V: (9Hrs)** **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	**Text Books** 1. Jeffery H. Reed, "Software Radio, (A modern approach to radio engineeri PHI PTR, 2002. 2. John J. Rouphael, "RF and Digital Signal Processing for Software D Radio" Elsevier, Newness Publications. **Reference Books** 1. C. Richard Johnson, Jr., and William A. Sethares, Telecommuni Breakdown, Prentice Hall, ISBN 0-13-143047-5, 2004.
E-resources and other digital material	1.

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC510A: INFORMATION THEORY AND CODING

Course Category:	Programme Elective-III	Credits:	3
Course Type:	Theory	Lecture - Tutorial -Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to::					
	CO1	Identify the major classes of error detecting and error correcting codes and how they are used in practice.				
	CO2	Specify specific error detecting and error correcting codes in a precise mathematical manner.				
	CO3	Develop and execute encoding and decoding algorithms associated with the major classes of error detecting and error correcting codes.				
	CO4	Construct codes capable of correcting a specified number of errors				
	CO5					
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	2	1	1
	CO2	3	3	2	1	2
	CO3	3	3	3	1	2
	CO4	3	3	3	1	2
	CO5	2	2	2	1	2

Course Content

UNIT - I: (9 Hrs)

Probability And Random Variables: Meaning of probability, Axioms of Probability, Conditional Probability, Concept of a Random Variable, expected values for discrete and continuous random variables, Function of one Random Variable, Two Random variables, conditional probability density functions. **Random Processes:** Classification, Auto Correlation, Cross Correlation, Stationary and wide sense stationary random process, Gaussian random process, Poisson random process.

UNIT - II: (9Hrs)

Linear Algebra: Vector spaces, Linear combination of vectors, Linear dependence, Basis and dimensions, finite dimensional vector spaces, Linear Transformations. Norms and normed vector spaces, Inner products and inner product spaces

Linear Operators And Matrix Inverses: Matrix factorizations, LU factorization, unitary matrices and QR factorization. Eigen values and Eigen vectors, Linear dependence of Eigen vectors, diagonalization of matrix. Singular value decomposition, pseudo inverses and the SVD.

UNIT - III: (9Hrs)

Introduction: Entropy, Relative Entropy, Mutual Information Inequalities, Entropy rate. Asymptotic Equipartition Property (AEP): Consequences of the AEP, Typical Sequences, Shannon McMillan Breiman Theorem.

Channel capacity: Discrete Memory less Channel, Joint Typicality, Channel Coding Theorem and its converse, Feedback capacity, Source Channel Separation Theorem. Differential Entropy: Definition, Properties. Gaussian Channel: Definition, Parallel Gaussian Channels, Channels with Coloured Gaussian Noise, Gaussian Channels with Feedback, Limits to Communication.

	UNIT – IV: **(9 Hrs)** Linear Block Codes: Groups, Fields and Vector Spaces, Construction of Galois Fields of Prime Order Syndrome Error Detection, Standard Array and Syndrome Decoding, Hamming Codes, LDPC Codes. Cyclic Codes: Polynomial Representation of Codewords, Generator Polynomial, Systematic Codes, Generator Matrix, Syndrome Calculation and Error Detection, Decoding of Cyclic Codes, Meggitt decoder, BCH codes, generator polynomials with minimal polynomials, BCH decoding, non BCH codes(RS codes), RS decoding. Convolutional Codes: **UNIT–V:** **(9 Hrs)** Convolutional Encoder Representation, Tree, Trellis, and State Diagrams, Distance Properties of Convolutional Codes, Punctured Convolutional Codes and Rate Compatible Schemes, Decoding of Convolutional Codes: Maximum Likelihood Detection, The Viterbi Algorithm
Textbooks and Reference books	**Textbooks:** 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 3. Shu lin/ Daniel J.Costello Jr., Error Control Coding, Prentice Hall series in computer applications in electrical engineering series (2/e) 2005. **Reference Books:** 1. Ranjan Bose, Information Theory, coding and cryptography (2/e), McGraw Hill
E-resources and other digital material	1. 2.

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC510B: RF IC Design

Course Category:	Programme Elective-III	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial -Practice:**	3-0-0
Prerequisites:	RF& MW Theory, VLSI Design	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Analyze different characteristics of RF circuits and Systems				
	CO2	Design active and passive CMOS circuits used in RF applications				
	CO3	Design and measure performance metrics of low-noise amplifiers and power amplifiers				
	CO4	Design and analyze the functionality and performance characteristics of mixers and oscillators				
	CO5	Evaluate the performance and design principles of frequency synthesizers and loop filters				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	2	2	1	1
	CO2	3	3	3	1	1
	CO3	3	2	3	1	1
	CO4	3	3	2	1	1
	CO5	3	3	2	1	1

Course Content

UNIT I: **(9 Hrs)**

Fundamentals of RF circuits and systems: Duplexing, FDMA, dB, dBm, Voltage gain, Channel, ACR, AACR, Noise factor, NF of a cascaded system, Sensitivity, HD, Gain compression, P1 dB, Cross modulation, Inter modulation, IM3, IIP3, SFDR, Transmit mask. *Transmitter and Receiver Architectures:* Review of modulation schemes, Receiver architectures, Transmitter architectures

UNIT II: **(9 Hrs)**

Passive and active components for CMOS RFIC: Review of MOSFET, RF transistor layout, CMOS process, Capacitors, Varactors, Resistors, Inductors, Transformers, Transmission lines Resonance, Matching, S-parameters, etc. Noise in electrical circuits and NF calculations, Two port noise theory.

UNIT III: **(9 Hrs)**

Low Noise Amplifiers: Resistive terminated CS and CG LNA, Inductive degenerated LNA, Shunt feedback LNA, Noise cancelling LNAs, Linearity improvement techniques

Power Amplifiers: Class A, B, C, D, E, F and other configurations, Power combining, Linearity improvement techniques.

UNIT – IV: **(9 Hrs)**

Mixers: Specifications, NL system as a mixer, Active mixers, Passive mixers

Oscillators: Introduction, LC Oscillators, Phase noise

Introduction to PLLs, Type-I PLLs, Charge pump PLLs: Mathematical model, Design issues and Phase noise

UNIT – V: **(9 Hrs)**

Frequency synthesizers: PLL-Based Frequency Synthesizer, Dividers, VCO, Ring Oscillators.

Loop Filter: General Description, Design Approaches, A Complete Synthesizer Design Example, Implementation of a Frequency Synthesizer with a Fractional Divider.

Text books and Reference books	**Text Books** 1. B. Razavi, "RF Microelectronics", 2nd Edition, Pearson, 2012. 2. Thomas H. Lee, "The design of CMOS radio-frequency integrated circuits", 2nd Edition, Cambridge University Press, 2004. 3. Leung, Bosco, "VLSI for wireless communication", 2nd Edition, Springer Science & Business Media, 2011. **Reference Books** 1. Samar K. Saha, "Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond", Taylor & Francis, 2015. 2. H. Ruiz, R. Pérez, "Linear CMOS RF Power Amplifiers: A Complete Design Workflow", Springer, 2014 edition. 3. Manganaro, Gabriele, and Domine MW Leenaerts, "Advances in analog and RF IC design for wireless communication systems", Academic Press, 2013. 4. Noulis, Thomas, Mixed-signal circuits, CRC Press, 2018. 5. Rincon-Mora, Gabriel, "Analog IC design with low-dropout regulators (LDOs)", McGraw-Hill, 2009.
E-resources and other digital material	1. RF Integrated Circuits, IIT Delhi, Dr. Shouribrata Chatterjee https://nptel.ac.in/courses/117102012

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC511A: RADAR SYSTEMS

Course Category:	Program Elective-IV	Credits:	3
Course Type:	Theory	Lecture-Tutorial-Practice:	3-0-0
Prerequisites:		Continuous Evaluation: Semester End Evaluation: Total Marks:	40M 60M 100M

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the different types of radars and analyze different radar functions.				
	CO2	Understand the different radar systems, tracking of radar and types of antennas used in radar systems				
	CO3	Understand detection of radar signals and analysis of information extraction.				
	CO4	Understand the radar signal processing.				
	CO5	Understand the different radar applications.				
Contribution of Course Outcomes towards achievement of Program Outcomes: (1 - Low, 2 - Medium, 3 - High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	2	2	1	1
	CO2	3	2	2	1	1
	CO3	3	2	2	1	1
	CO4	3	2	2	1	1
	CO5	3	2	2	1	1

Course Content

UNIT-I **(9 Hrs)**

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 **(9 Hrs)**

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 **(9 Hrs)**

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 **(9 Hrs)**

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:(9 Hrs)

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 Book and Reference Books

Textbooks:

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

	3. D.Curtis Scheleher, "Introduction to Electronic Warfare Artech House Inc., 1986. . **References**: 1. Wheeler G.J., "Radar Fundamentals & quot;, Prentice Hall Inc. NJ 1967. 2. LavanonNadav, "Radar Principles & quot; john Wiley & Sons, 1988.
E-Resources and other digital material	1.

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC511B: COMMUNICATION BUSES AND INTERFACES

Course Category:	Programme Elective-IV	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial -Practice:**	3-0-0
Prerequisites:	Computer Networks	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the Basics of Serial Communication and Data Transmission				
	CO2	Select and apply a particular Low-Speed serial bus Interface suitable for a given application				
	CO3	Analyze and make a decision to use Medium-Speed serial bus Interface for an application.				
	CO4	Examine and decide a High-Speed serial bus Interface for an application.				
	CO5	Investigate the use of Broadband and wireless Interfaces				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	3	2	2
	CO2	3	3	3	2	2
	CO3	3	3	3	3	2
	CO4	3	3	3	3	2
	CO5	3	2	2	2	2
Course Content	**UNIT I:** **(10 Hrs)** Introduction to Serial I/O Communications, Serial I/O Primer: A Short Course in Data Communications and Networking **Low-Speed Interfaces:** Controller Area Network (CAN), standard CAN, Extended CAN, CAN message, arbitration, message types, CAN bus, Inter-Integrated Circuit (I2C) Bus, RS-232, RS-485. **UNIT II:** **(10 Hrs)** **Medium-Speed Interfaces**: Ethernet, Firewire, Joint Test Action Group (JTAG), Media oriented system transport, Serial Peripheral Interface, Universal Serial Bus, host and devices, assigning a driver on the host, transfer types, transactions **UNIT III:** **(9 Hrs)** **High-Speed Interfaces**: 100 Gigabit Ethernet attachment unit interface, Fiber channel, high-definition multimedia interface (HDMI), hyper transport, optical transport network, PCI express, Synchronous optical network and synchronous digital hierarchy, thunderbolt. **UNIT – IV:** **(9 Hrs)** **Broadband Interfaces:** Broadband Interface concepts, Data over Cable Service Interface Specifications (DOCSIS), Digital subscriber Line, HomePlug (HP) , Multimedia over cable alliance, PoweRline Intelligent Metering Evolution (PRIME), X10 Interface. **UNIT – V** **(9 Hrs)**					

	Wireless Interfaces: Wireless Interfaces, 802.15.4, Bluetooth, Digital Enhanced Cordless Telecommunications (DECT), EnOcean, Industrial Scientific Medical Wireless, Near Field Communications, Ultra-Wideband, Wi-Fi, Wireless HART, ZigBee.
Text books and Reference books	**Text Books:** 1. Louis E Frenzel Jr, "Hand book of Serial Communication Interfaces", Newness publications, 2016 2. Jan Axelson, "Serial PortComplete COM Ports, USB Virtual COM Ports, and Ports for Embedded Systems", Lakeview ResearchPublished,2nd edition Mindshare Press 3. Steve Corrigan, "Introduction to the Controller Area Network (CAN)", Texas Instruments, 2016. **Reference Books:** 1. Jan Axelson, "USB Complete", Penram Publications, 2016Serial Front Panel Draft Standard VITA 17.1 – 200x
E-resources and other digital material	www.can-cia.org www.pcisig.com www.usb.org

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC583: REAL TIME OPERATING SYSTEMS LAB

Course Category:	Laboratory-I	Credits:	1.5
Course Type:	Laboratory	Lecture - Tutorial -Practice:	0-0-3
Prerequisites:	Micro controller and Embedded systems lab	Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Design and execute the different RTOS concepts for real time embedded system design.				
	CO2	Developing the RTOS applications for Micro controller boards				
Contribution of Course Outcomes towards achievement of Program Outcomes(1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	2	1	1
	CO2	3	3	2	1	2
Course Content	**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. **11.** Project.					
Lab Requirements	Software:1.FreeRTOS 2.Open STM32 System Work bench					
Hardware:	1.The development kits of ARM Developer Kits/ STM32F4 Discovery and Nucleo board. 2. Serial Cables, Network Cables, and recommended power supply for the board.					

E-resources and other digital material	1. https://training.ti.com/ti-rtos-workshop-series-1-10-welcome 2. https://www.udemy.com/share/101XDy3@Lh74iiF3rMDF83Kk7Od1fQ7-RimKmKiI6HvZDtQmMx77GjLqvx7GSt0-52seWg-J/

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC584: WIRELESS COMMUNICATION LAB

Course Category:	Laboratory-II	Credits:	1.5
Course Type:	Laboratory	Lecture - Tutorial -Practice:	0-0-3
Prerequisites:		Continuous Evaluation: Semester end Evaluation: Total Marks:	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Estimate the path loss				
	CO2	Calculate the uplink and downlink SNR .				
	CO3	Assess the effects of flat and frequency fading				
	CO4	Design, implement, and distribute stand-alone applications using LabVIEW				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	2	1	1
	CO2	3	3	2	1	2
	CO3	3	3	3	1	2
Course Content	**List of Experiments: (Virtual Lab)** 1. Introduction to the labview, and MATLAB. 2. Baseband QAM Modulation and Detection design 3. Performance of Baseband QAM/QPSK Under AWGN Channel 4. STO estimation-maximum energy for QAM/QPSK modulation 5. Implementation of channel estimation for multipath environment 6. Frame detection and CFO estimation using Frank sequence 7. Multitap indirect channel equalization 8. Multitap direct channel equalization 9. OFDM modulation and demodulation and single tap equalization 10. Preamble aided synchronization for OFDM system					
Textbooks and Reference books	**Text Books:**					

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	DR. D VENKATA RAO	

25ECSC591: TERM PAPER

Course Category:	Term Paper	**Credits:**	1
Course Type:	Theory	**Lecture - Tutorial -Practice:**	0-0-2
Prerequisites:	Research Methodology and IPR	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	40 60 100

Course Outcomes	Upon successful completion of the course, the student will be able to	
	CO1	Identify and analyze the real-world problems beyond the curriculum
	CO2	Get awareness on current trends in specific area of interest.
	CO3	Prepare and write technical report on the topic selected after literature survey
	CO4	Develop communication skills to explain and interact with a cross section of audiences.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)		PO1	PO2	PO3	PO4	PO5
	CO1	2		1		2
	CO2	2			1	2
	CO3		3			2
	CO4					2

Course Content

The following method is adapted by the department for conducting Term Paper.

- Term Paper and Project Work are to be carried out individually by M.Tech. students under the supervision of a faculty member.
- The faculty member allotted to supervise the Term Paper in second Semester shall continue to be the supervisor for the Project Work also.
- Each faculty member may be permitted to supervise not more than TWO students.
- If any student/batch left over without supervisor, HOD shall use his/her discretion to allot the supervisor as supervisors are to be selected by the students themselves.

Expected outcomes of Term Paper

- To carry out literature survey (Reputed international journals / Proceedings of international conferences).
- To select a technical topic related to area of specialization.
- To submit an abstract at the beginning of second semester.
- To critically review the topic selected, prepare a report on the topic reviewed under the guidance of supervisor and submit at the end of second semester.
- To present the term paper before review panel and assessment will be done based on scholarship of knowledge, report writing and presentation Skills.

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	Dr D Venkata Rao	

24MTUC502: TECHNICAL REPORT WRITING

Course Category:	Audit Course	**Credits:**	-
Course Type:	Theory	**Lecture - Tutorial -Practice:**	2-0-0
Prerequisites:	None	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	Yes Nill Nill

Course Outcomes	Upon successful completion of the course, the student will be able to	
	CO1	Develop the ability to structure and organize scientific papers and technical documents in alignment with academic and industry standards.
	CO2	Utilize visual aids such as charts, graphs, tables, and figures effectively to enhance the clarity and impact of technical reports.
	CO3	Master LaTeX for document preparation, including advanced techniques for formatting, inserting tables, figures, and equations.
	CO4	Apply effective communication strategies to articulate research findings, project designs, and technical reports clearly and concisely.
	CO5	Produce high-quality scientific and technical documents that meet rigorous academic and professional standards, enhancing employability and success in both academic and industrial settings.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)		PO1	PO2	PO3	PO4	PO5
	CO1		2			
	CO2		2			
	CO3		2			
	CO4		2			
	CO5		2			

Course Content	**Unit I: Introduction to Scientific Writing (9 Hours)** **Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusion, Reference Management:** Citation, Bibliographies, Acknowledgements,Appendices, **Hedging, Paraphrasing, Plagiarism.** **Unit II: Visual Representation in Technical Reports (9 Hours)** **Bar Chart, Line Chart, Pie Chart, Area Chart, Cylindrical Chart, Column Bars, Bubble Chart, Flow Diagram, Effective Use of Tables, Types of Technical Reports** and **Writing Guidelines.** **Unit III: Document Preparation with LaTeX (9 Hours)** Introduction to **LaTeX**, Document structure: **Title, Sections, Labels, Table of Contents, Fonts, Colors, Lists, Comments, and Spacing, Special Characters and Symbols in LaTeX.** **Unit IV: Advanced Techniques in LaTeX (9 Hours)** Inserting **Equations** and **Mathematical Symbols,** Managing **BibTeX Files** for Bibliographies, **Citing and Formatting References,Styles and Practical Applications,** LaTeX Exercises and Projects. **Unit V: Integrating Tables, Figures, and Equations (9 Hours)** Practical Applications of Tables, Figures, and Equations, Advanced LaTeX features for Technical Documents, Using LaTeX for Complex Document Structures' Enhancing Document Quality with LaTeX. Project: Applying LaTeX in Scientific and Engineering Papers.
Text Books and Reference Books	**Text Books** 1. Barun K Mitra, Effective Technical Communication: A Guide for Scientists and Engineers. Oxford University Press, ISBN: 9780195682912. 2. LaTeX for Beginners, Workbook Edition 5, Document Reference 3722-2014. **Reference Books** 1. Goldbort R, Writing for Science, Yale University Press. (Available on Google Books) 2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press.
E-Resources and Other Digital Material	1. Online course on Data Visualization 2. Online course on Technical Report Writing 3. Overleaf LaTeX Editor 4. LaTeX Project Official Website

Designation	Name in Capitals	Signature with Date
Course Coordinator		
Program Coordinator		
Head of the Department	Dr D Venkata Rao	

SEMESTER III

25ECSC601: Self Learning Course

Course Category:	Program Elective-V	**Credits:**	3
Course Type	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	- - 100

Course Content	The courses under this category shall carry three credits and must have a minimum duration of 12 weeks/36 hours. The department will recommend the self-learning courses from the available open courseware. The self- learning courses shall be taken from the list of approved MOOCs providers (SWAYAM / NPTEL/ EDX / Others). They must be approved/ratified in the respective Board of Studies.

25ECSC691: Internship/Summer Training at Avantel Limited (After II Sem)

Course Category:	Internship	**Credits:**	2
Course Type	Practical	**Lecture-Tutorial-Practice**	0-0-4
Prerequisites:		**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	60 40 100

Course Content	The students shall undergo Internship for a period of six weeks in Industry/ Research organizations/ institute of higher learning approved by the Head of the Department during any time after the second semester and shall earn two credits.

25ECSC692: PROJECT- PART A

Course Category:	Project	**Credits:**	10
Course Type	Project	**Lecture-Tutorial-Practice**	0-0-20
Prerequisites:	Research Methodology and IPR Technical Report Writing	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	60 40 100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Identify a topic in relevant areas of Communication Engineering & Signal Processing.				
	CO2	Review literature to identify gaps and define objectives & scope of the work.				
	CO3	Understand the methods and processes from literature and apply appropriate research methodologies.				
	CO4	Develop an analytical/ computational model/ experimental set-up and prepare a report and develop competence in presenting.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2		1		
	CO2	2			1	
	CO3				3	
	CO4		3			2

Course Content	**Expected outcomes of the Project Work from Part-A:** • To select a technical topic (from the literature survey carried out as a part of Term Paper) related to specialization in consultation with supervisor and submit an abstract to Project Review Committee PRC at the beginning of the third semester. • To critically evaluate the recent literature for the problem identified To carry out the project work under the guidance of supervisor on the topic selected. • To submit reports periodically and present before PRC for a review on the progress of work carried out.

	• To prepare a report on the work carried out and submit at the end of fourth semester.

SEMESTER IV

25ECSC693: PROJECT- PART B

Course Category:	Project	**Credits:**	16
Course Type	Project	**Lecture-Tutorial-Practice**	0-0-32
Prerequisites:	Research Methodology and IPR Technical Report Writing	**Continuous Evaluation:** **Semester end Evaluation:** **Total Marks:**	60 40 100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Identify methods and resources to carry out analysis and experiments				
	CO2	Reorganize the procedures with a concern for society, environment and ethics.				
	CO3	Find solutions to complex engineering activities using modern engineering tools.				
	CO4	Analyze and discuss the results to draw valid conclusions.				
	CO5	Prepare a report and defend the work and publish the work in National /International Conferences/journals.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2		1		
	CO2	2			1	
	CO3				3	
	CO4			2		2
	CO5		3			1
Course Content	**Expected outcomes of the Project Work from Part-B:** • To critically evaluate the recent literature for the problem identified • To carry out the project work under the guidance of supervisor on the topic selected. • To submit reports periodically and present before PRC for a review of the progress of work carried out. • To test the work carried out, report the results obtained and perform comparative analysis • To publish the paper in Peer reviewed journals/conferences • To prepare a report on the work carried out and submit at the end of fourth semester.					