Scheme of Instruction and Syllabi

of

BE V to VI SEMESTERS

of

FOUR YEAR DEGREE COURSE

in

ELECTRONICS AND COMMUNICATION ENGINEERING

(AICTE Model Curriculum with effect from AY 2020-21)

R-20 Regulation

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(Autonomous Institution under UGC, Affiliated to Osmania University)
Department of Electronics & Communication Engineering
Accredited by NBA and NAAC-UGC,
Chaitanya Bharathi (Post), Gandipet, Hyderabad–500075

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

OUR MOTTO: SWAYAM TEJASWIN BHAVA

Institute Vision	To be a centre of excellence in technical education and research.	
Institute Mission	To address the emerging needs through quality technical education and advanced research.	
Department Vision	To emerge as a vibrant model of excellence in education, research and innovation in Electronics and Communication Engineering.	
Department Mission	M1	To impart strong theoretical and practical knowledge of the state of art technologies to meet growing challenges in the industry
	M2	To carry out the advanced and need based research in consultation with the renowned research and industrial organizations.
	M3	To create entrepreneurship environment including innovation, incubation and encourage to patent the work
PEO 1		Engage successfully in professional career and/or pursue higher education in Electronics and Communication and allied areas.
PEO 2		Pursue research, design and development of state-of-the art systems applying the knowledge of Electronics and Communication engineering
PEO 3		Begin start-ups and involve in entrepreneurship activities by adopting changing professional and societal needs.
PEO 4		Exhibit professional ethics and values with lifelong learning and work effectively as individuals/team members in multidisciplinary projects.
PSO 1		Ability to apply the acquired knowledge of core subjects in design and development of Communications/Signal processing/ VLSI/ Embedded systems.
PSO 2		Analyze and solve the complex Electronics and Communication engineering problems using state-of-art hardware and software tools
PSO 3		Develop innovative technologies for Entrepreneurship based on the research outcomes of Electronics and Communication engineering.

Program Outcomes of B.E (ECE) Program

1. Engineering Knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems
2. Problem Analysis	Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/Development of Solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6. The Engineer and Society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and Teamwork	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication	Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project Management and Finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long Learning	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum with effect from AY 2022-23

B.E (Electronics and Communication Engineering)

SEMESTER – V

S.no	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	20ECC15	Computer Architecture and Microprocessors	3	-	-	3	40	60	3
2	20ECC16	Digital Communication	3	-	-	3	40	60	3
3	20ECC17	Digital Signal Processing	3	-	-	3	40	60	3
4	20ECC18	Linear and Digital Integrated Circuits	3	-	-	3	40	60	3
5	20MBC01	Engineering Economics and Accountancy	3	-	-	3	40	60	3
6		Professional Elective-I	3	-	-	3	40	60	3
7		Professional Elective-II	2	-	-	3	40	60	2
PRACTICALS									
8	20ECC19	Digital Communication Lab	-	-	2	3	50	50	1
9	20ECC20	Digital Signal Processing Lab	-	-	2	3	50	50	1
10	20ECC21	Linear and Digital Integrated Circuits Lab	-	-	2	3	50	50	1
11	20ECI02	Industrial/Rural Internship	3-4 Weeks/90 Hours				50	-	2
Total			**20**	**-**	**06**	**30**	**480**	**570**	**23+2**
Clock Hours Per Week: 26									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum with effect from AY 2022-23

B.E (Electronics and Communication Engineering)

SEMESTER – V

List of Courses in Professional Elective-I		List of Courses in Professional Elective-II	
Course code	**Title of the Course**	**Course code**	**Title of the Course**
20ECE01	CAD for VLSI Verification	20ECE07	CMOS Analog IC Design
20ECE02	Optical Communication	20ECE08	Mobile Cellular Communication
20ECE03	Signal Detection Techniques	20ECE09	Biomedical Signal processing
20ECE04	Embedded C Programming	20ECE10	Sensors and Actuators
20ECE05	Software Defined Radio	20ECE11	Drones and Applications
20ECE06	Principles and Applications of AI	20ECE12	Fundamentals of Cloud Computing

20EC C15

COMPUTER ARCHITECTURE AND MICROPROCESSORS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Basic knowledge on digital system design

Course Objectives: This course aims to:

1. Study and understand the principles of computer system
2. Understand the design of computer system
3. Explore the architecture and instruction set of the microprocessors

Course Outcomes: Upon completion of this course, students will be able to:

1. Apply fixed and floating-point arithmetic algorithms.
2. Understand how the computer works.
3. Classify different organizations of CPU and I/O.
4. Compare various memories and memory access techniques.
5. Understand the architecture and instruction set of a microprocessor.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	-	-	-	-	-	-	-	-	2	2	1
CO2	2	1	3	1	-	-	-	-	-	-	-	2	3	2	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-	3	2	-
CO4	2	2	2	2	2	-	-	-	-	-	-	1	3	2	-
CO5	3	1	2	2	2	-	-	-	-	-	-	1	3	3	-

UNIT-I

Data representation and Computer Arithmetic: Basic structure of computers, Functional units, Fixed point representation of numbers, Digital arithmetic algorithms for Addition, Subtraction, Multiplication using Booth's algorithm and Division using restoring and non-restoring algorithms, Floating-point representation with IEEE standards.

UNIT-II

Basic Computer Organization and Design: Instruction codes, Stored program organization, Computer registers and computer instructions, Timing and control, hardwired and microprogrammed control unit, Instruction cycle, Program interrupt, Interrupt cycle, Micro programmed Control organization, Address sequencing, Micro instruction format.

UNIT-III

Central Processing Unit: General register organization, Stack organization, Instruction formats, Addressing modes, Data transfer and manipulation, Program control, CISC and RISC: features and comparison, Instruction Pipeline.

Input-Output Organization: Peripheral devices, I/O interface: I/O Bus and interface modules, isolated versus memory-mapped I/O. Modes of Transfer: Programmed I/O, DMA and Interrupt initiated I/O. Priority interrupt: Daisy chaining, Parallel Priority interrupt

UNIT-IV

Memory Organization: Memory hierarchy, Primary memory, Auxiliary memory, Associative memory, Cache memory, mapping functions: direct, associate and set associate, Virtual memory: address mapping using pages, Memory management.

UNIT-V

8086 Microprocessor: Evolution of microprocessors, 8086 Microprocessor**:** Internal architecture, flag register, Signal description under minimum and maximum mode of operation, register organization, Addressing modes. Overview of Instruction set. Introduction to the advanced microprocessors (x86): Salient features, real and protected modes. Evolution of Pentium Processors.

Text Books:

1. Moris Mano M., "Computer System Architecture", 3/e, Pearson Education, 2005.
2. Hayes J.P, "Computer Architecture and Organization", 3/e, Mcgraw Hill, 2012.
3. Barry B. Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro, Pentium II, III, IV", 8/e Pearson Education, 2006.

Suggested Reading:

1. Carl Hamacher, ZvonkoVranesic, SafwatZaky, "Computer Organization" 5/e McGraw Hill, 2011.
2. Ray A.K. and Bhurchandi, K.M., "Advanced Microprocessor and peripherals", 2/e TMH 2007.
3. Douglas V Hall, SSSP Rao, "Microprocessors and Its Interfacing" (SIE), 3/e, Tata McGraw-Hill Education Pvt. Ltd, 2012.

20EC C16

DIGITAL COMMUNICATION

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Fundamentals of probability theory and analog communication systems are required.

Course Objectives: This course aims to:

1. Make the student learn the different techniques involved in the digital transmission of analog signals.
2. Give the student an understanding of the various concepts of information theory, source coding, and channel coding schemes.
3. Enable the student to interpret the performance of digital modulation schemes and various Spread spectrum modulation schemes.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the concept of pulse digital modulation schemes and compare their performance.
2. Interpret the concept of information theory and apply source coding schemes.
3. Demonstrate various error control schemes and develop the encoding and decoding techniques to detect and correct the errors.
4. Analyze different digital modulation schemes and can compute the bit error performance.
5. Identify and apply spread spectrum modulation techniques.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	1	-	-	2	-	3	3	2	-
CO2	3	3	1	1	-	-	1	-	-	2	-	3	3	2	-
CO3	3	3	3	2	-	2	1	-	-	2	-	3	3	2	2
CO4	3	3	1	1	-	1	1	-	-	2	-	3	3	2	1
CO5	3	3	1	2	-	2	2	-	-	2	-	3	3	2	1

UNIT-I

Digital Transmission of Analog Signals: Elements of a digital communication system, Uniform quantization, PCM system, Bandwidth requirement of PCM system, Noise in PCM Systems, Non- uniform quantization, TDM-PCM system. Differential quantization, Differential PCM system, Delta Modulation, Noise in DM system, ADM. Comparison of PCM, DPCM, DM and DM schemes.

UNIT-II

Information Theory: Uncertainty, Information and Entropy, Source coding: Source coding theorem, Shannon – Fano algorithm and Huffman coding. Discrete memory-less channels, Types of channels, cascaded channels, mutual information, Channel capacity, Information rate and Information capacity.

UNIT-III

Error Control Coding: Need for error control coding, Types of transmission errors. Linear Block Codes (LBC): description of LBC, generation, Syndrome and error detection, minimum distance of a block code, error detecting capabilities and error correcting, Hamming codes, Standard array and syndrome decoding. Binary cyclic codes (BCC): description of cyclic codes, encoding, decoding and error correction of cyclic codes using shift registers, Convolution codes: description, encoding, decoding: Exhaustive search method and sequential decoding.

UNIT-IV

Digital Carrier Modulation Schemes: Optimum receiver for Binary Digital Modulation Schemes, Binary ASK, PSK, DPSK, FSK signaling schemes and their error probabilities. Introduction to MSK, Comparison of Digital Modulation Schemes. Introduction to M-ary Signaling Schemes: QPSK, Synchronization methods.

UNIT–V

Spread-Spectrum Modulation: Need for spreading a code, generation and properties of PN sequence. Direct Sequence Spread Spectrum, Frequency Hopping spread spectrum systems and their applications. Acquisition and Tracking in DSSS and FHSS Systems.

Text Books:

1. Sam Shanmugham K., "Digital and Analog Communication Systems", Wiley, 2012.
2. Simon Haykin, "Communication Systems", 4/e, Wiley India, 2011.
3. Herbert Taub, Donald L. Shilling & Goutam Saha, "Principles of Communication Systems", 4/e, Tata McGraw-Hill Education 2013.

Suggested Reading:

1. John Proakis, Massoud Salehi, "Digital Communications", 5/e, McGraw Hill Higher Education, 2007.
2. R.P. Singh, S.D. Sapre, "Communication Systems", 2/e, Tata McGraw Hill Education, 2008.

20EC C17

DIGITAL SIGNAL PROCESSING

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Concepts of Signals, Systems and analog filter design.

Course Objectives: This course aims to:

1. Know Discrete-time signals in the frequency domain using DFT and FFT.
2. Design digital IIR and FIR filters for the given specifications.
3. Introduce the basics of Multi-rate digital signal processing, Digital signal processor and its applications

Course Outcomes: Upon completion of this course, students will be able to:

1. Apply the concept of DFT and FFT for signal processing applications.
2. Implementation of IIR filters for the given specifications.
3. Design FIR filters for the given specifications.
4. Interpret the concepts of Multi-rate digital signal processing and its applications.
5. Understand the architecture features of TMS320C67XX processor.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	3	3	3	2	3	2	-	-	3	2	-	3	3	3	3
CO2	3	3	3	2	3	2	-	-	3	2	-	3	3	3	3
CO3	3	3	3	2	3	2	-	-	3	2	-	3	3	3	3
CO4	3	3	3	2	3	2	-	-	3	2	-	3	3	3	3
CO5	3	3	3	2	3	2	-	-	3	2	-	3	3	3	3

UNIT-I

Discrete Fourier Transform: Introduction, Discrete Fourier Transform (DFT), Properties of DFT, Efficient computation of DFT-Fast Fourier Transform (FFT) algorithms: Radix-2 FFT algorithms – Decimation in Time, Decimation in Frequency algorithms, Inplace computation, Bit reversal algorithm, Linear filtering using FFT algorithm.

UNIT-II

IIR Filter Design: Butterworth and Chebyshev approximation, IIR digital filter design techniques- Impulse Invariant transformation, Bilinear transform techniques, Digital Butterworth and Chebyshev filters, Spectral transformation techniques. Comparison between FIR and IIR filters.

UNIT-III

FIR Filter Design: Linear phase FIR filters –Introduction, types, magnitude and phase responses of linear phase FIR filters, Windowing technique for design of FIR filters – Rectangular, Bartlet, Hamming, Blackman, and Kaiser Windows. Realization of IIR filters-Direct form-I and II, Realization of FIR filters-Direct form, linear phase, Finite word length effects.

UNIT- IV

Multirate Digital Signal Processing: Introduction -Decimation by a Factor -D, Interpolation by a Factor -I, Sampling Rate Conversion by a Rational Factor -I/D, Nobel identities, design of multistage decimator, Applications of Multirate Signal Processing: Narrowband filters, subband coding of speech signal.

UNIT-V

DSP Processors: Introduction, Difference between DSP and General Purpose Processor architectures, need for DSP processors. TMS320C67XX DSP processor: architecture, functional units, pipelining, registers, linear and circular addressing modes, instruction set.

Text Books:

1. John G. Proakis & Dimtris G. Manolakis, "Digital Signal Processing Principles, Algorithms and Application", PHI, 4/e, 2012.
2. Sanjit K Mitra, "Digital Signal Processing, A computer based approach", TMH, 3/e, 2011.
3. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", John wiley & sons, 2005.

Suggested Reading:

1. K. Deergha Rao & MNS swamy, "Digital Signal Processing: Theory and Practice", Springer, 2018
2. Avtar Singh & S. Srinivasan, "Digital Signal Processing Implementation using DSP microprocessors", Thomson Brooks, 2/e, 2004.

20EC C18

LINEAR AND DIGITAL INTEGRATED CIRCUITS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge about Analog electronic circuits.

Course Objectives: This course aims to:

1. Impart the concepts of Op-Amp, 555 Timers, IC regulator, data converter and its characteristics.
2. Illustrate the linear and nonlinear applications of operational amplifier.
3. Design combinational and sequential circuits with IC, memories and PLD.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the basic construction, characteristics and parameters of Op-Amp.
2. Analyze the linear and nonlinear applications of Op-Amp.
3. Explain the concepts of IC555 timer, IC723 regulator, memories and PLD.
4. Classify and describe the characteristics of different logic families
5. Design logic functions of Combinational and Sequential circuits with ICs.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1	-	-	-	-	-	-	2	2	1	-
CO2	2	3	3	3	2	2	-	1	-	-	-	3	3	3	2
CO3	2	2	2	2	2	-	-	1	-	-	-	2	2	1	1
CO4	1	1	2	2	2	-	-	-	-	-	-	2	2	1	1
CO5	2	2	3	3	2	2	-	1	-	-	-	3	3	3	1

UNIT – I

Operational Amplifier: Op-Amp block diagram, ideal Op-Amp Characteristics, Inverting and Non-inverting amplifiers with ideal and non-ideal Op-amps, Voltage Follower, Op-Amp parameters: Input offset voltage, Output offset voltage, input offset and bias currents, Slew rate, CMRR and PSRR.

UNIT – II

Op-Amp Applications: Summing Amplifier, Difference Amplifier, ideal and practical Integrator and differentiator. Sample and hold circuit, Comparator, Schmitt Trigger with and without reference voltage, Triangular waveform generator.

UNIT – III

555 Timer: Functional diagram. Modes of operation: Monostable, Astable multivibrators.

Voltage Regulator: IC7805, Analysis and design of regulators using IC 723.

Data Converters: Specifications, DAC- Weighted Resistor, R-2R Ladder, ADC-Parallel Comparator, Successive Approximation and Dual Slope.

UNIT – IV

Logic Families: Digital IC characteristics. TTL logic family, TTL series and TTL output configurations: open collector, Totem pole, Tri state logic. MOS logic family, CMOS logic family and its series characteristics, CMOS transmission gate, CMOS open drain and high impedance outputs. Comparison of TTL and CMOS logic families.

UNIT – V

Combinational and Sequential Circuits: Design of logic functions/circuits with: Decoder, Multiplexer, Adder: Serial adder, parallel adder and BCD adder, counters: asynchronous counter (7493/74293) and synchronous counter (74163/74193)

Semiconductor Memories: Memory Terminology, ROM, RAM types, Architectures, operation, Expanding word size and capacity, Introduction to PLD's: PAL and PLA, Programming with PLDs, Introduction to CPLD&FPGA and it's architectures.

Text Books:

1. Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", 4/e, PHI, 2015.
2. Ronald J. Tocci, Neal S. Widmer & Gregory L. Moss, "Digital Systems: Principles and Applications", PHI, 12/e, 2016..

Suggested Reading:

1. K.R. Botkar, "Integrated Circuits", 10/e, Khanna Publishers, 2010.
2. Roy Chowdhury D, Jain S.B, "Linear Integrated Circuits",4/e, New Age International Publishers, 2018.
3. Jain R.P., "Modern Digital Electronics", 4/e, TMH, 2011.
4. Charles H Roth and Larry L Kinney, "Fundamentals of Logic Design" 7th edition, Cengage Publication, 2014.
5. David A. Bell, 'Operational Amplifier and Linear ICs', third edition, Oxford university press, 2013.

20MB C01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Concepts related to business, economics and accountancy are required.

Course Objectives: This course aims to:

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

Course Outcomes: Upon completion of this course, students will be able to:

1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	3	1	1	1	1	1	1	1	-	-	-	-	-
CO2	2	2	2	2	-	1	1	1	-	1	-	1	-	-	-
CO3	1	2	1	2	2	-	2	1	-	1	-	-	-	-	-
CO4	2	2	1	2	2	1	1	3	-	1	-	-	-	-	-
CO5	1	3	1	2	1	1	2	-	-	1	2	1	-	-	-

Unit-I

Introduction to Managerial Economics: Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance; Relationship with other Subjects. Its usefulness to Engineers; Basic concepts of Managerial economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equimarginal Principle, Contribution, Negotiation Principle.

Unit-II

Demand and Supply Analysis: Demand Analysis - Concept of Demand, Determinants, Law of demand - Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems; Concept of Supply - Determinants of Supply, Law of Supply; Demand Forecasting - Methods.

Unit-III

Production and Cost Analysis: Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations; Laws of returns; Internal and External Economies of Scale. Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run; Market structures – Types of Competition, Features, Price Output Determination under Perfect Competition, Monopoly and Monopolistic Competition; Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

Unit-IV

Accountancy: Book-keeping, Principles and Significance of Double Entry Book Keeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments. Ratio Analysis.

Unit-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods - Numerical problems.

Text Books:

1. Mehta P.L., "Managerial Economics: Analysis, Problems and Cases", Sultan Chand & Son's Educational publishers, 2016.
2. Maheswari S.N. "Introduction to Accountancy", Vikas Publishing House, 11th Edition, 2013.

Suggested Reading:

1. Panday I.M. "Financial Management", 11th edition, Vikas Publishing House, 2015.
2. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
4. A. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2013.

20EC E01

CAD for VLSI verification

(Professional Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Knowledge of VLSI Design and basics of Digital system design.

Course objectives: This course aims to:

1. Different CAD tools available for various aspects of VLSI Design and their flows
2. Working of different simulators
3. Design Flow of popular commercially used CAD tools.

Course Outcomes: After completion of this course, students will be able to:

1. Justify the importance and use of CAD tools.
2. Differentiate design flow for different types of ASIC.
3. Understand the design flows of CADENCE Virtuoso, CADENCE NCLaunch and XILINX ISE
4. Understand the importance of design for testability
5. Differentiate various type of simulators.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	1	1	3	-	-	2	-	-	-	2	1	3	1
CO2	2	2	2	-	3	-	-	2	-	-	-	2	1	3	1
CO3	1	2	2	1	3	-	-	2	-	-	-	2	1	3	1
CO4	2	1	-	-	-	-	-	2	-	-	-	2	3	-	-
CO5	1	2	-	-	3	-	-	2	-	-	-	2	1	3	1

UNIT 1: Evolution and classification of CAD tools

Evolution from SSI to VLSI, Hardware description language (HDL), Register Transfer Level (RTL), Importance of Design Automation, Role of CAD Tools, Role of the Designer Types of CAD tools: Editor, Simulator, Analyzer, Synthesis. Types of editors.

UNIT 2: Digital Design Flow

Custom ASIC Design Flow, Cadence Digital Design Flow, nclaunch.
FPGA Design Flow, Xilinx design flow, ISE simulator, RTL synthesis. Bit file generation, uploading an FPGA

UNIT 3: Analog Design Flow

Cadence Analog Design Flow, Schematic editor, Spectre simulator, Layout editor, DRC, LVS, RC extraction

UNIT 4: Simulation tools for VLSI

Introduction, Circuit Level Simulation, Liner Model of MOS, Switch Model of MOS, Gate level simulation, VLSI circuit Analysis, Timing Verification, Circuit Optimization.

UNIT 5: Design for Testability

Introduction to VLSI testing: Importance of testing, Challenges in VLSI testing, Levels of abstractions in VLSI testing, Functional vs. Structural approach to testing, Complexity of the testing problem, Controllability and Observability.

Text books:

1. Wolfgang Fichtner Martin Morf, "CAD for VLSI Design and Application" 2003

Suggested Reading:

1. Parag K. Lala, An Introduction to Logic Circuit Testing, Morgan & Claypool Publishers

20EC E02

OPTICAL COMMUNICATION

(Professional Elective-I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Fundamentals of Electromagnetics and Communication are required.

Course Objectives: This course aims to:

1. Understand the properties of optical fiber that affect the performance of a communication link and types of fiber materials with their properties and the losses occur in fibers and the principles of single and multi-mode optical fibers and their characteristics.
2. Know the working of semiconductor lasers, and differentiate between direct modulation and external electro-optic modulation.
3. Analyze the operation of LEDs, Laser diodes, and PIN photo detectors (spectral properties, bandwidth, and circuits) and apply in optical systems.

Course Outcomes: Upon completion of this course, students will be able to:

1. Select necessary components required in modern optical communications systems.
2. Analyze various distortions in optical fibers.
3. Distinguish the various Optical sources and Optical detectors.
4. Examine the Power Launching and Coupling and fiber optical receiver.
5. Determine the performance of Optical Communication link.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	2	3	2	2	2	1	1	1	3	3	2
CO2	3	3	3	3	2	3	2	2	1	1	1	1	3	3	2
CO3	2	3	3	3	2	3	3	2	1	1	1	1	3	3	2
CO4	3	2	3	2	2	3	3	2	1	1	1	1	3	3	2
CO5	2	2	3	3	2	3	3	2	1	1	1	1	3	3	2

UNIT–I

Overview of Optical Fiber Communication: The general system, advantages of optical fiber communications. Optical fiber wave guides- Acceptance angle, Numerical Aperture, Skew rays, Cylindrical fibers: Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers: Cut off wavelength, Mode Field Diameter, Effective Refractive Index.

UNIT–II

Signal Distortion in Optical Fibers: Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay, Types of Dispersion: Material dispersion, Wave-guide dispersion, Polarization, Mode dispersion, Intermodal dispersion, Pulse broadening in Graded index fiber.

Optical Fiber Connectors: Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing: Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss: Multimode fiber joints, single mode fiber joints.

UNIT–III

Optical Sources: LEDs, Structures, Materials, Quantum efficiency, Power Modulation. Injection Laser Diodes: Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Optical detectors: Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors.

UNIT–IV

Source to Fiber Power Launching: Power coupling, Power launching, Fundamental receiver operation, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit.

UNIT–V

Optical System Design: Point-to- point links, Component choice and considerations, Link power budget, Rise time budget with examples, WDM **and its applications**.

Text Books:

1. Gerd Keiser, "Optical Fiber Communications", McGraw-Hill International edition, 5th Edition, 2017.
2. John M. Senior, "Optical Fiber Communications", PHI, 3rd Edition, 2009.
3. D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, "Fiber Optic Communications", Pearson Education,2005.

Suggested Reading:

1. S.C. Gupta, "Text Book on Optical Fiber Communication and its Applications", PHI, 2005.
2. Govind P. Agarwal, "Fiber Optic Communication Systems", John Wiley, 3rd Edition, 2004.
3. Joseph C. Palais, "Fiber Optic Communications", 4th Edition, Pearson Education, 2004.

20EC E03

SIGNAL DETECTION TECHNIQUES

(Professional Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Concepts of random variables and random processes.

Course Objectives: This course aims to:

1. Study the importance of discrete random processes in the communications.
2. Understand random signal modelling and statistical decisions.
3. Acquire the knowledge about various detection techniques.

Course Outcomes: Upon completion of this course, students will be able to:

1. Apply and analyse discrete random process concepts in communications.
2. Understand binary hypothesis techniques
3. Analyse the various statistical decision techniques.
4. Demonstrate the various binary detection techniques and M-ary detection.
5. Evaluate various CFAR detectors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	3	-	-	2	2	1	3	3	1	2
CO2	3	3	2	-	-	3	-	-	2	2	1	3	3	1	2
CO3	3	3	2	-	-	3	-	-	2	2	1	3	3	1	2
CO4	3	3	2	-	-	3	-	-	2	2	1	3	3	1	2
CO5	3	3	2	-	-	3	-	-	2	2	1	3	3	1	2

UNIT-I

Discrete-Time Random Processes: Introduction, Definitions, Auto Regressive (AR) Processes, Moving Average (MA) Processes, Auto Regressive Moving Average (ARMA) Processes.

UNIT-II

Statistical Decision Theory: Introduction, Bayes' Criterion - Binary Hypothesis Testing and M-ary Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion.

UNIT-III

The General Gaussian Problem: Introduction, Binary Detection, Same Covariance - Diagonal Covariance Matrix and Non-Diagonal Covariance Matrix, Same Mean - Uncorrelated Signal Components and Equal Variances, Uncorrelated Signal Components and Unequal Variances.

UNIT-IV

Detection: Introduction, Binary Detection, Simple Binary Detection, General Binary Detection, M-ary Detection, Correlation Receiver, Matched Filter Receiver.

UNIT-V

Adaptive Thresholding CFAR Detection: Introduction, Principles of Adaptive CFAR Detection, Target Models, Review of Some CFAR Detectors.

Text Books:

1. Mourad Barkat, "Signal Detection and Estimation", Artech House, 2nd Edition, 2005.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.

Suggested Reading:

1. Papoulis and S.U. Pillai, "Probability, Random Variables and Stochastic Processes", 4th Edition, McGraw Hill, 2002.
2. Payton. Z. Peebles Jr., "Probability Random Variables and Random Signal Principles", TMH, 4th Edition, 2003.
3. Fundamentals of Statistical Signal Processing", Volume II: Detection Theory: 2, by Steven M. Kay, Prentice Hall Signal Processing Series 1998 for the course "Signal Detection Techniques.

20EC E04

EMBEDDED C PROGRAMMING

(Professional Elective-I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Programming in 'C' Language

Course Objectives: This course aims to:

1. Describe the developments of embedded C programming
2. Interfacing of various sensors along with displays using Embedded 'C'
3. Develop the various applications using embedded development board

Course Outcomes: Upon completion of this course, students will be able to:

1. Analyze the various functions used in embedded C programming
2. Understand the evaluation of Arduino family and its development board details
3. Interface the sensors and various i/o devices to embedded development board
4. Apply the concepts of IoT to embedded development board
5. Demonstrate and design embedded C based applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	2	2	-
CO2	2	2	2	1	2	-	-	-	-	-	-	1	-	3	2
CO3	2	2	3	2	2	-	-	-	-	-	-	-	3	2	2
CO4	2	1	2	2	3	-	-	-	-	-	-	2	3	2	3
CO5	2	2	3	3	2	-	-	-	-	-	-	2	3	2	2

UNIT-I

Introduction to Embedded C: Overview, Data types: variables and constants, Operators, Control Statements, Arrays and Functions. i/o Functions: Pins Configured as input, Pins Configured as output, pinMode function, digitalWrite function, analog Read function, time delay functions. Simple programming in 'C'

UNIT-II

Introduction to Arduino: Origin of Arduino, familiarizing with Arduino family Introduction to Arduino UNO: Pin configuration and architecture, power connections, concept of digital and analog ports, Arduino clones and variants , installation of Arduino IDE, uploading of the program.

UNIT-III

Interfacing with Displays and Sensors: Working with Serial Monitor, Line graph via serial monitor, LED interfacing, 8 bit LCD interfacing to Arduino, Fixed one line static message display, Running message display,. Interfacing-humidity sensor, temperature sensor, gas detection sensor, PIR Sensor, Ultrasonic Sensor.

UNIT-IV

Internet of Things Programming: Communicating with web servers: HTTP, HTML, Arduino uno as a web server, Web controllers using Arduino, calling web services, Arduino uno and IFTTT, Introduction to NodeMCU and its web services

UNIT-V

Applications/Case Study: Testing the Arduino board, problems with IDE, debugging techniques, Case studies related on agriculture, medical domains using Ardunio, Applications on consumer electronics, automotive and security using Arduino development board

Text Books:

1. Simon Monk, "Programming Arduino: Getting Started with Sketches", McGraw-Hill Education, Second Edition, 2016
2. Massimo Banzi, "Getting Started with Arduino: The Open Source", Shroff Publishers & Distributors Pvt Ltd, 2014
3. Michael J. Pont, "Embedded C", 2nd Edition, Pearson Education, 2008

Suggested Reading:

1. Margolis, "Arduino Cookbook", Shroff/O'Reilly Publication, 2nd Edition 2012

20EC E05

SOFTWARE DEFINED RADIO

(Professional Elective-I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: The students should have knowledge of analog and digital communications.

Course Objectives: This course aims to:

1. Make the students understand the differences between Super-heterodyne Radio, Software Defined Radio, and Cognitive Radio.
2. Give the Knowledge to students about FPGA-based architectures and processors with low power consumption.
3. Understand the single node Cognitive radio techniques and basics of Co-operative Spectrum sensing and the applications of CR.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand and compare the Super-heterodyne receiver, SDR and CR.
2. Analyze the basic architecture of SDR
3. Determine the processor based on the application.
4. Evaluate and choose the various spectrum sensing methods based on application.
5. Choose the USRP and WARP boards based on the facilities required for an SDR application.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	2	3	2	-	1	1	1	1	3	3	2
CO2	2	1	1	1	1	-	-	-	-	1	-	1	3	2	3
CO3	2	1	1	1	1	-	1	1	-	1	-	1	3	2	2
CO4	2	2	1	1	1	-	-	1	-	1	-	1	3	3	3
CO5	2	1	1	1	1	-	2	1	-	-	-	1	3	3	3

UNIT-I

Introduction to SDR

What is Software-Defined Radio, The Requirement for Software-Defined Radio, Legacy Systems, The Benefits of Multistranded Terminals, Economies of Scale, Global Roaming, Service Upgrading, Adaptive Modulation and Coding, Operational Requirements, Key Requirements, Reconfiguration Mechanisms, Handset Model, New Base-Station and Network, Architectures, Separation of Digital and RF, Tower-Top Mounting, BTS Hoteling, Smart Antenna Systems, Smart Antenna System Architectures, Power Consumption Issues, Calibration Issues, Projects and Sources of Information on Software Defined Radio.

UNIT-II

RF System Design: Introduction, world frequency band plans, Noise, and channel Capacity, link budget, free space loss, practical loss models, detailed system link budget, 3G Rf performance requirements, multicarrier power amplifiers, signal processing capacity trade-off, Design flow.

UNIT-III

Basic Architecture of a Software Defined Radio Software Defined Radio Architectures, Ideal Software Defined Radio Architecture, Required Hardware Specifications, Digital Aspects of a Software Defined Radio, Digital Hardware, Alternative Digital Processing Options for BTS Applications, Alternative Digital Processing Options for Handset Applications, Current Technology Limitations, A/D Signal to-Noise Ratio and Power Consumption, Derivation of Minimum Power Consumption, Power Consumption Examples.

UNIT-IV

Signal Processing Devices and Architectures General Purpose Processors, Digital Signal Processors, Field Programmable Gate Arrays, Specialized Processing Units, Tilera Tile Processor, Application-Specific Integrated Circuits, Hybrid Solutions, Choosing a DSP Solution, Comparison of all processors.

UNIT-V

Introduction to Cognitive Radio: Techniques and Signal Processing History and background, Communication policy and Spectrum Management, Cognitive radio cycle, Cognitive radio architecture SDR architecture for cognitive radio, Spectrum sensing Single node sensing: energy detection. Introduction and challenges of Co-operative spectrum sensing.

Textbooks:

1. Eugene Grayver, "Implementing Software Defined Radio", Springer, New York Heidelberg Dordrecht London, ISBN 978-1-4419-9332-8 (eBook) 2013.
2. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, ISBN 10: 0-7506-7952-2, 2/e, 2006.
3. Paul Burns, "Software-Defined radio for 3G", Artech house Publishers, Inc, © 2003.

Suggested Reading:

1. Peter B. Kenington, "RF and Baseband Techniques for Software Defined Radio", Artech House Publishers, Inc © 2005.
2. HüseyinArslan, "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Springer, ISBN 978- 1-4020-5541-6 HB, 2007.

20EC E06

PRINCIPLES AND APPLICATIONS OF AI

(Professional Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of probability, Linear Algebra, Data Structure and programming.

Course Objectives: This course aims to:

1. Exposure to the foundation of Artificial Intelligence.
2. Familiarize the applications of Artificial Intelligence in Industry
3. Inculcate the concepts of Neural Networks and Pattern Recognition

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the basics of AI and intelligent agents.
2. Apply Expert Systems to solve real time problems
3. Understand knowledge representation methods.
4. Build algorithms using neural network techniques for various applications
5. Solve the various classification problems like object recognition

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	1	1	-	-	-	-	1	3	-	-
CO2	3	3	3	2	2	3	2	1	2	-	1	2	3	1	-
CO3	3	3	-	3	1	1	1	-	-	-	-	1	3	-	-
CO4	3	3	3	2	2	1	1	-	1	-	-	1	3	1	-
CO5	3	3	3	3	1	3	2	1	2	-	-	1	3	2	-

UNIT-I

Introduction to AI and Intelligent Agents: Concept of AI, current status of AI, Agents, Good Behavior: Environment, problem formulation. The structure of agents. Basic concepts of Search Algorithms: Uninformed depth first search, breadth first search, uniform cost search, depth limited search, iterative deepening search and informed search techniques like greedy best first search and A* algorithm, concepts of admissibility.

UNIT-II

Knowledge representation: Bayesian network representation, Construction and inference. Hidden Markov Model.Approaches to knowledge representation, knowledge representation using the semantic network, extended semantic networks for Knowledge representation, knowledge representation using frames.

UNIT-III

Expert system and applications: Introduction phases in building expert systems, expert system versus traditional systems, Rule-based expert systems, blackboard systems truth maintenance systems and application of expert systems.

UNIT-IV

Neural Networks: What is a neural network, the human brain, models of a neuron, neural networks as a directed graph, feedback and network architectures. Learning processes and learning tasks.

UNIT-V

Applications and tools of Artificial Intelligence: Pre-processing, feature extraction and time series prediction. Principle Component Analysis.

Statistical Pattern Recognition: Object recognition, Classification and regression. Application of AI in speech, Image processing and IoT, AI applications in biometric and face recognition. Introduction AI & Deep Learning with TensorFlow, Case Studies – AI in Finance and Agriculture.

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence—A Modern Approach", 3rd Edition, Prentice-Hall Series, 2010.
2. Christopher M. Bishop, Clareddon, "Neural networks for pattern Recognition", Oxford, 1995.
3. Simon Haykin, "Neural networks and learning Machines", 3rd Edition, Pearson- Prentice Hall, 2009.
4. M. Narsimhamurty and V. Susheela Devi, "Pattern Recognition- An Algorithmic Approach", Springer Universities Press, 2011
5. B. Yegnanarayana, "Artificial Neural Networks", PHI, 2005.

Suggested Books:

1. Elaine Rich, Kevin Knight and Shivashankar B Nair, "Artificial Intelligence", Tata McGraw Hill Education Pvt. Ltd., 2010.
2. Flasiński, Marius, "Introduction to Artificial Intelligence", Springer International Publisher, 2016.

20EC E07

CMOS Analog IC Design

(Professional Elective-II)

Instruction	2L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Pre-requisites: Knowledge of basic circuit theory and Electronic Devices and circuits.

Course objectives: This course aims to:

1. The MOS characteristics, second order effects in MOSFET and MOS modelling.
2. The design and analysis of single stage and differential MOS Amplifiers.
3. The frequency response and noise analysis of the Amplifiers.

Course Outcomes: After completion of this course, students will be able to:

1. Recall the elementary concepts of MOS device, MOS amplifiers, Current Mirrors, frequency response and noise.
2. Classify different types of MOS devices, MOS amplifiers and current mirrors.
3. Analyze (analytically) a given amplifier circuit for extracting parameters like gain, impedance, bandwidth, noise, etc.
4. Design an amplifier or it's subcomponent as per the given specification.
5. Justify with sufficient trade-off the use of an appropriate amplifier or subcomponent for a given specification.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	1	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
CO3	3	3	1	3	-	-	-	-	-	-	-	-	3	3	-
CO4	3	2	3	1	-	-	-	-	-	-	-	-	3	3	3
CO5	3	3	2	3	-	-	-	-	-	-	-	3	3	3	3

UNIT I

MOS and it's Characteristics: Introduction to analog design, Basics of MOS device Physics: MOS as a Switch, MOS structure, MOS symbols, threshold voltage, derivation of MOS VI Characteristics, Second order effects, MOS parasitic capacitances overview, MOS small signal model, long channel vs short channel MOSFET.

UNIT II

Single stage MOS amplifiers: Basic concept of Amplifier, common source stage with resistive load, common source stage with diode load, common source stage with current source load, common source stage with source degeneration, Source follower, common gate stage, cascode stage, folded cascode.

UNIT III

Current mirrors: Basic Current Mirrors, Cascode Current Mirror (Gain , Output Resistance), Bipolar Current Mirrors, High out Impedance Current Mirrors - Cascode Gain Stage, Wilson current mirror, Source degenerated current mirrors, MOS amplifiers using Current Mirror as load.

UNIT IV

Differential Amplifier: Single ended vs differential operation, basic differential pair, basic differential pair - quantitative analysis, Common mode response, Differential amplifier with MOS loads, Differential pairs with current mirror loads (i.e. active load), large signal analysis, small signal analysis, common mode properties. Basic two stage MOS Operational amplifier– Characteristic parameters.

UNIT V

Frequency Response of Amplifiers and Noise: Miller effect, association of poles with nodes, Frequency Response: common source stage, source follower, common gate stage, differential pair.

Noise, Statistical characteristics of noise, noise spectrum, types of noise: thermal noise, flicker noise, representation of noise in circuit, Noise in common source amplifier.

Text books:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Tata McGrah Hill. 2002
2. Jacob Baker. R.et.al., CMOS Circuit Design, IEEE Press, Prentice Hall, India, 2000.

Suggested Reading:

1. David Johns, Ken Martin, Analog Integrated Circuit Design, John Wiley & sons. 2004
2. Paul. R. Gray & Robert G. Major, Analysis and Design of Analog Integrated Circuits, John Wiley & sons. 2004.

20EC E08

Mobile Cellular Communication

(Professional Elective-II)

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: A course on digital communications is required.

Course Objectives: This course aims to:

1. To familiarize the concepts related to cellular communication and its capacity.
2. To teach students the fundamentals of propagation models and multipath fading.
3. To describe diversity schemes as applied in mobile communication and understand latest Mobile technologies

Course Outcomes: Upon completion of this course, students will be able to:

1. Relate the cellular concepts like frequency reuse, hand off, coverage and capacity.
2. Analyse the mobile radio propagation with large scale and small scale fading.
3. Select the suitable diversity technique to combat the multipath fading effects.
4. Compare the mobile radio standards.
5. Examine the advance wireless standards.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	2	-	-	-	-	1	3	2	2
CO2	3	2	3	3	2	-	1	-	-	-	-	1	3	2	2
CO3	2	2	2	2	3	-	2	-	-	-	-	1	3	2	2
CO4	2	2	2	3	2	2	1	-	-	2	-	2	3	2	2
CO5	1	1	2	3	2	2	1	-	-	1	-	1	3	2	2

UNIT – I

Cellular concepts: Frequency reuse, Channel Assignment strategies, Hand off strategies. Interference and System capacity, improving coverage and capacity in cellular systems.

UNIT – II

MOBILE RADIO PROPAGATION : Large Scale Fading - Free space propagation model, Three basic propagation mechanisms, Reflection, Ground Reflection(Two-Ray)Model, Diffraction, Scattering, Practical link budget using path loss models. Small Scale Fading : Multipath Propagation, Types of small scale fading, Parameters of Mobile Multipath channels, Fading effects due to multipath time delay Spread and Doppler spread.

UNIT – III

Diversity Techniques: Diversity – Types of diversity – Diversity combining techniques: Selection, Feedback, Maximal Ratio Combining and Equal Gain Combining – Rake receiver

FDMA, TDMA, CDMA, OFDM, SDMA, Comparison of Multiple Access Techniques.

UNIT - IV

Mobile Radio standards: AMPS,2G Architecture such as GSM and CDMA, GSM system overview: GSM system architecture, GSM radio subsystem, GSM channel types, Frame structure for GSM, Signal processing in GSM, 2.5G – GPRS and EDGE- features. Concept of UWB

UNIT - V

Advance Wireless standards: Need for 3G and 4G technologies, 3G standard: UMTS - Introduction to LTE, IS-95/CDMA one, CDMA-2000.4G-features and architecture, 4G-LTE, 4.5 G and 5G.

Text books:

1. Theodore S. Rappaport - Wireless Communications Principles and Practice, 2nd Edition, Pearson Education, 2003.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, First Edition, 2005.
3. Andreas F.MOlisch - Wireless Communications John Wiley, 2nd Edition, 2006.

Suggested Reading:

1. W.C.Y. Lee - Mobile Cellular Communications, 2nd Edition, MC Graw Hill, 1995.
2. Modern Wireless Communications-Simon Haykin, Michael Moher, Pearson Education, 2005.
3. Wireless Communications and Networking, Vijay Garg, Elsevier Publications, 2007.

20EC E09

BIOMEDICAL SIGNAL PROCESSING

(Professional Elective-II)

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Course on Digital Signal Processing**.**

Course Objectives: This course aims to:

1. Understand the physiological systems, present in the human body.
2. Understand the signal processing techniques used for ECG and EEG.
3. Understand the concept of BCI

Course Outcomes: Upon completion of this course, students will be able to:

1. Describe the physiological, physical, and chemical background of the most common bioelectrical phenomena.
2. Implement signal processing techniques on biomedical signals.
3. Adapt various detection techniques to identify ECG parameters
4. Assess various Signal Processing techniques for analysis of EEG
5. Understand the signal processing steps involved in Brain-Computer Interface.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	2	2	2	2	1	2	-	-	-	-	-	2	3	2	2
CO2	2	3	3	3	1	2	-	-	-	-	-	2	3	2	2
CO3	2	3	3	3	2	2	-	-	-	-	-	2	3	3	2
CO4	2	3	3	3	3	2	-	-	-	-	-	2	3	3	2
CO5	2	3	3	3	3	2	-	-	-	-	-	2	3	3	2

UNIT-I: **Biomedical Signals and Acquisition**

Introduction to bio-signals: Cell structure. Origin of bioelectric potentials. Biomedical signals. The Brain and its potentials. Electrophysiological origin of brain waves.

EEG signal and its characteristics. ECG signal origin and characteristics. Normal and abnormal ECG.

Speech Signals and characteristics. Other biomedical signals: EMG, EOG, respiration.

Sources of Noise. Noise characteristics

UNIT-II: Biomedical Signal Processing Techniques

Transform analysis of LTI system: DFT, STFT – Introduction to wavelets – CWT and DWT with Haar wavelet.

Adaptive interference / Noise cancellation: Types of noise in biosignals; Digital filters – IIR and FIR – Notch filters – Optimal and adaptive filters. Weiner filters, the cancellation of 50 Hz signal in ECG.

UNIT-III: Cardiological Signal Processing

ECG Filtering and Frequency Analysis. Filter design for noise removal. ECG parameters and their estimation. Normal and Abnormal ECG. Arrhythmia analysis monitoring. ECG data compression techniques: AZTEC, CORTES, TPA

UNIT-IV: Neurological and allied signal processing

Detection and analysis of EEG rhythms. Parametric modeling, Detection of Spindles and spikes. Sleep stage identification. Linear prediction theory; Autoregressive (AR) method; Recursive estimation of AR parameters. EMG, EOG, respiration. Signal and feature extraction

UNIT-V: Brain-Computer Interface (BCI)

Signal modalities in BCIs, Generic setup for a BCI, Feature extraction, and Feature translation involved in BCIs. Different types of BCI techniques. EEG/ECG Based BCI, Spikes Based BCI. Systems Engineering in BCI. Invasive Interfaces. Spikes-Based Controllers. Prosthetics; Neurostimulation. Recent Developments. Typical medical applications.

Text Books:

1. John G. Webster, "Medical Instrumentation: Application and Design" Wiley, 4/e, 2015.
2. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice-Hall of India Pvt. Ltd., 2012.
3. Wai Yie Leong, "EEG Signal Processing: Feature Extraction, Selection, and Classification Methods", Institution of Engineering & Technology, 2019.

Suggested Reading:

1. D.C. Reddy, "Biomedical Signal Processing: Principles and Techniques" McGraw Hill, 2005.
2. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley-India, 2009.
3. Jonathan Wolpaw and Elizabeth Winter Wolpaw, "Brain-Computer Interfaces: Principles and Practice", Oxford University Press, 2012.

20EC E10

SENSORS AND ACTUATORS

(Professional Elective-II)

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Basic electronics, Measurements and Instruments

Course Objectives: This course aims to:

1. To expose the students to many varieties of transducers, measuring instruments, their Operating principles and construction.
2. Understand the concept sensor and actuator systems for practical applications
3. To provide an idea of strengths and weaknesses of the various types of sensors and actuators.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the fundamental and applications of several different types of sensors and actuators.
2. Evaluate and perform accurate measurements for any engineering system with clear idea of the potential errors.
3. Understand the working principles of various transducers.
4. Select an appropriate transducer for given application.
5. How to develop a sensor and actuator systems for practical applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	2	2	-	1	1	-	2	3	1	1
CO2	3	3	2	1	-	-	1	1	1	1	-	2	3	2	1
CO3	3	3	2	1	-	2	2	-	1	1	-	2	3	1	1
CO4	3	3	2	1	-	-	2	-	1	1	-	2	3	1	1
CO5	3	3	2	1	-	2	1	-	1	1	-	2	3	2	2

UNIT-I

SENSORS: Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Strain Gauges, Resistance thermometer, Thermistor, Resistance Hygrometer, Photo-resistive sensor.

Electronic measurement: Moving coil and moving iron meters.

UNIT-II

INDUCTIVE & CAPACITIVE TRANSDUCER: Transducer principles, active and passive transducers

Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer.

Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: - capacitor microphone, capacitive pressure sensor, proximity sensor**.**

UNIT-III

ACTUATORS: Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria.

UNIT-IV

MICRO SENSORS AND MICRO ACTUATORS:

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors.

Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators-Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.

UNIT-V

SENSOR MATERIALS AND PROCESSING TECHNIQUES: Materials for sensors: Silicon, Plastics, Metals, Ceramics, Glasses, Nano Materials. Processing Techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining and LIGA process.

Text Books:

1. D. Patranabis, “Sensors and Transducers”, Prentice Hall India Pvt., 2nd Ed, 2021.
2. Clarence W. De Silva, “Sensors and Actuators Engineering System Instrumentation”, Taylor & Francis Ltd, 2nd Ed, 2015.

Suggested Readings:

1. Jacob Fraden, “Hand Book of Modern Sensors: Physics, Designs and Application” 4Ed, Springer, 2010.
2. Jonathan Wolpaw and Elizabeth Winter Wolpaw, “Brain-Computer Interfaces: Principles and Practice”, Oxford University Press, 2012.
3. D. V. S. Murty, “Transducers and Instrumentation”, Prentice Hall India Pvt., Limited, 2008.

20EC E11

DRONES AND APPLICATIONS

(Professional Elective-II)

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Knowledge of basic concepts of signals, control systems and microprocessors is required.

Course Objectives: This course aims to:

1. To understand Flight dynamics and construction of Drones
2. To assemble and Control the operations of Drones
3. To design Quadcopter and Implement them for real world applications

Course Outcomes: Upon completion of this course, students will be able to:

1. Apply the concept of Flight dynamics for building Drone
2. Assemble and Program the Drone
3. Perform Testing and Control operations on the Drone
4. Apply control mechanism to track and control Parallax ELEV-8 Quadcopter Build.
5. Use of Drone for real-world applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	3	2	2	2	-	-	-	-	-	-	3	3	1
CO2	3	-	1	1	2	2	-	-	-	-	-	-	3	2	3
CO3	2	-	3	2	3	3	-	-	-	-	-	-	3	3	2
CO4	2	-	2	3	2	3	-	-	-	-	-	-	2	3	2
CO5	1	-	1		2	2	-	-	-	-	-	-	3	3	1

UNIT I

FLIGHT DYNAMICS OF AERIAL VEHICLES:

Types of current generation of drones based on their method of propulsion, Drone design and fabrication: Classifications of the UAV, Overview of the main drone parts, assembling a drone the energy sources, Level of autonomy. UAV, RPA, Quad copters, Basic Components and Categories, Principles of Flight, Flight Maneuvers Airframes, creating a Frame: Materials, Different Frame Shapes, Building Airframes, Flight dynamics

UNIT II

HARDWARE ANATOMY OF DRONES

Power Train, Propellers, Motors, Total Lift, Electronic Speed Controllers, Flight Battery, Radio transmitter and receiver, Flight Controller, GPS, Compass, Camera Assembling for Quad copter, Connectors, Mounting of Propellers and Powering up. Flight modes Wi-Fi connection, Concept of operation for drone Flight modes Operate a small drone in a controlled environment Drone controls Flight operations management tool.

UNIT III

TESTING AND MAINTENANCE OF DRONES

Key Flight Safety Rules, Preflight Checklist and Flight Log Information, Flight Instructions, Repair and Maintenance: Crash analysis, Common issues, Voltage testing. The safety risks Guidelines to fly safely Specific aviation regulation in the European Union European system of standardization.

UNIT IV

PARALLAX ELEV-8 QUADCOPTER:

Parallax Open Source Project,- Building the Elev-8 Quadcopter, Programming the Parallax Propeller Chip, Propulsors, Radio Controlled Systems and Telemetry, Servo Control Systems, Tracking and Performance Checks.

UNIT V

REAL WORLD APPLICATIONS AND CASE STUDIES:

Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Search and Rescue, Infrastructure Inspection, Conservation. Case Studies: Agriculture Weed Classification, Microdrone surveillances.

Text Books:

1. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones ",Maker Media, Inc, 2016
2. Vasilis Tzivaras, "Building a Quadcopter with Arduino", Packt Publishing, 2016.
3. Donald Norris, "Build Your Own Quadcopter -Power Up Your Designs with the Parallax Elev-8" , McGraw-Hill Education, 2014

Suggested Reading:

1. Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016.
2. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010.
3. Sebbane, Smart Autonomous Aircraft: Flight Control and Planning for UAV. CRC Press, 2015.
4. Zavrsnik, Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance. Springer, 2015

20EC E12

FUNDAMENTALS OF CLOUD COMPUTING

(Professional Elective-II)

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Fundamental concepts of computer networking.

Course Objectives: This course aims to:

1. To impart the fundamentals and essentials of Cloud Computing.
2. Describes the cloud architecture, layers and models.
3. Introduce the concepts of resource management and security in cloud.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the basic concepts of cloud computing.
2. Describe the characteristics, advantages, risks and challenges associated with cloud computing.
3. Explain and characterize various cloud service models, cloud deployment models.
4. Investigate/Interpret the security and privacy issues related to cloud computing environments.
5. Apply the concepts of cloud computing in real world scenario.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	1	-	-	-	-	-	-	-	2	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	1	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	1	-	-
CO4	3	3	1	2	-	-	-	-	-	-	-	1	-	-	-
CO5	2	3	-	1	-	-	-	-	-	-	-	2	-	-	-

UNIT-I

Cloud Computing Overview: Origins of Cloud computing – Cloud components - Essential characteristics – On-demand self-service, Broad network access, Location independent resource pooling, Rapid elasticity, Measured service, Comparing cloud providers with traditional IT service providers, Roots of cloud computing.

UNIT-II

Cloud Insights: Architectural influences – High-performance computing, Utility and Enterprise grid computing, Cloud scenarios – Benefits: scalability, simplicity, vendors, security, Limitations – Sensitive information - Application development-security level of third party - security benefits, Regularity issues: Government policies.

UNIT-III

Cloud Architecture- Layers and Models

Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption. Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing.

UNIT-IV

Resource Management and Security in Cloud: Inter Cloud Resource Management – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Data Security –Application Security – Virtual Machine Security.

UNIT-V

Case Studies: Google App Engine(GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services(AWS), Google Cloud Platform (GCP) and Azure. GAE Applications – Cloud Software Environments – Eucalyptus – Open Nebula – Open Stack.

Text Books:

1. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", 1st Edition, John Wiley and Sons, 2011.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
3. Rittinghouse, John W, and James F. Ransome, Cloud Computing: Implementation, Management, And Security, CRC Press, 2017.
4. Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, Tata McGraw- Hill , New Delhi – 2010
5. Michael Miller – Que, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", 2008

Suggested Reading:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach", Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", OReilly, 2009.
4. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, "Cloud computing for dummies", Wiley Publishing, Inc, 2010.

20EC C19

DIGITAL COMMUNICATION LAB

Instruction	2 P Hours per Week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Knowledge about analog communication is required.

Course Objectives: This course aims to:

1. Carry out experiments on various pulse digital modulation techniques.
2. Conduct the experiment to identify errors in cyclic codes
3. Work on convolutional encoder and decoder for controlling the errors.

Course outcomes: Upon completion of this course, students will be able to:

1. Demonstrate various pulse digital modulation techniques.
2. Assess different line coding techniques.
3. Detect and correct errors in cyclic codes.
4. Examine the errors in convolutional encoder and decoder.
5. Evaluate various digital carrier modulation techniques experimentally.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	1	1	2	1	2	3	3	1
CO2	3	3	3	3	2	3	2	1	1	2	1	2	3	3	2
CO3	3	3	3	3	2	3	3	2	1	2	1	3	3	3	2
CO4	3	3	3	3	1	3	3	2	1	2	1	3	3	3	2
CO5	3	3	3	3	1	3	3	2	1	2	1	3	3	3	2

List of Experiments:

1. PCM generation and detection.
2. Data formats / Line coding techniques.
3. Linear Delta Modulation and demodulation.
4. Adaptive Delta Modulation and demodulation.
5. Error detection and correction in cyclic codes.
6. Convolutional encoder and decoder.
7. ASK generation and detection.
8. FSK generation and detection.
9. BPSK generation and detection.
10. QPSK generation and detection.
11. MSK generation and detection.
12. Structured Enquiry:
    - Design N-bit PCM encoder based on the given specifications.

13. Open ended Enquiry:
    - Develop a code for different digital modulation schemes and verify through simulation.
    - Design different Line coding schemes using logic Gates.

Suggested Reading:

1. A.M. Zungeru, J.M. Chuma, M. Mangwala , L.K. Ketshabetswe, “Handbook of Laboratory Experiments in Electronics and Communication Engineering”, Vol. 2, 1st Edition, Notion press, 2017.

20EC C20

DIGITAL SIGNAL PROCESSING LAB

Instruction	2 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: The knowledge of basics of signals, systems, linear algebra and calculus is required.

Course Objectives: This course aims to:

1. Simulation of DFT, FFT, Digital filters and multirate concepts using MATLAB.
2. Understand spectral analysis of noisy signals using MATLAB.
3. Implementation of digital filters on DSP Processor.

Course Outcomes: Upon completion of this course, students will be able to:

1. Illustrate linear convolution and correlation using MATLAB.
2. Design the digital filters using MATLAB.
3. Examine the performance of multirate techniques using MATLAB.
4. Experiment with decimator and interpolator on DSP processor.
5. Implement the digital filters on DSP processor.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	2	2	1	2	2	-	-	-	-	2	-	1	3	1	1
CO2	2	3	2	2	2	-	-	-	-	2	-	1	3	2	2
CO3	2	2	1	2	2	-	-	-	-	2	-	1	3	2	1
CO4	2	2	1	2	2	-	-	-	-	2	-	1	3	2	1
CO5	2	3	2	2	2	-	-	-	-	2	-	1	3	3	2

List of Experiments

(A) Experiments on signal processing using MATLAB.

1. To Perform basic matrix operations and Generation of test signals.
2. Compute the Linear Convolution, circular convolution and Correlation of two sequences.
3. Determine the Discrete Fourier Transform(DFT) and Fast Fourier Transform(FFT) of the given sequence.
4. Design of FIR filter using different windows
5. Design of IIR filter: Butter worth, Chebyshev type 1 and 2: LPF, HPF, BPF & BSF filter.
6. Spectral Analysis of noisy signal using Welch's method
7. Implementation of Interpolation and Decimation
8. Design of Multistage filter

(B) Experiments on DSK and CCS

1. Study of procedure to work in real- time
2. Solutions of difference equations
3. Linear Convolution
4. Implementation of FIR filter
5. Implementation of second order IIR filters
6. Decimation and Interpolation
7. Dual Tone Multi Frequency(DTMF)

Structured enquiry: Design the best IIR band pass filter to meet the given specifications:

Pass band cut off frequencies: [500 600] Hz
Stop band cut off frequencies: [525 675] Hz
Pass band ripple: ≤ 2dB
Stop band attenuation: ≥ 60dB

Open-ended enquiry: Design a three stage multirate filter to meet the given specifications:

Pass band cut off frequency: 450 Hz
Stop band cut off frequency: 500 Hz
Pass band ripple: ≤ 3dB
Stop band attenuation: ≥ 40dB
Sampling frequency: 40 KHz
Compare with single stage filter.

Note:

1. Minimum of 6 from Part A and 4 from Part B is mandatory.
2. For Part "A", MATLAB with different toolboxes like Signal Processing, Signal Processing block set, and SIMULINK/ MATHEMATICA/ any popular software can be used.

Suggested Reading:

1. Vinay K. Ingle and John G. Proakis, "Digital Signal Processing using MATLAB", 4/e, Cengage learning, 2011.
2. B. Venkataramani and M. Bhaskar, "Digital Signal Processor architecture, programming and application", 6/e, TMH, 2006.

20EC C21

LINEAR AND DIGITAL INTEGRATED CIRCUITS LAB

Instruction	2 P Hours per Week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Knowledge of Analog electronic circuits.

Course Objectives: This course aims to:

1. Know and verify the concepts of 741 Op-Amp, IC555 timer, IC723 and data converters.
2. Know the various characteristics of TTL and CMOS gates and implement the circuits with Digital ICs.
3. Contrast the differences between linear and digital ICs.

Course Outcomes: Upon completion of this course, students will be able to:

1. Analyze the configurations, parameters of Op-Amp (IC741).
2. Demonstrate the circuits of Op-Amp for various applications.
3. Design the circuits using IC555 timer, IC723 and data converters.
4. Determine the characteristics of TTL and CMOS gates
5. Develop various combinational circuits and sequential circuits using digital ICs.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	-	-	1	2	2	-	2	2	2	1
CO2	2	3	3	3	1	-	-	1	2	2	-	2	3	3	1
CO3	2	3	3	3	1	-	-	1	2	2	-	2	3	3	1
CO4	2	2	2	1	1	-	-	1	2	2	-	2	2	2	1
CO5	2	3	3	3	1	-	-	1	2	2	-	2	3	3	1

Lab Experiments

Part-A: Linear IC Experiments

1. Implement Voltage Follower, Inverting and Non-Inverting Amplifiers using Op-Amp.
2. Measurement of Op-Amp parameters
3. Implement Arithmetic Circuits using Op-Amp
4. Implement Waveform generation using Op-Amp.
5. Implement Astable and Monostable multi vibrators using IC555Timer.
6. Implement Low and High Voltage Regulators using IC723.
7. Implement D to A Converter using R-2R ladder.
8. Implement A to D Converter

Part-B: Digital IC Experiments

1. Measurement of various characteristic parameters of TTL and CMOS gates.
2. Implement Logic function Implementations using Decoders.
3. Implement Logic function Implementations using Multiplexers
4. Implement Binary adder and subtractor, BCD adders using ICs.
5. Design of Synchronous, Asynchronous up/down counters.
6. Implement Shift registers and ring counter using ICs.
7. Implement the Interfacing counters with 7-segment LED display units.

Structured enquiry: Implement a Security Monitoring System (Use only nonprogrammable ICs.)

Open ended enquiry: Design a Digital Clock structure to display minutes and seconds. (Use only non-programmable ICs.)

Suggested Reading:

1. National Semiconductor Corporation, “Linear applications”, Data book, 1986.
2. National Semiconductor Corporation, “Logic data book-Vol-II”, 1984.

20EC I02

INDUSTRIAL INTERNSHIP/ RURAL INTERNSHIP

Instruction/Demonstration/Training	3-4 Weeks/90 Hours
Duration of SEE	--
SEE	--
CIE	50 Marks
Credits	2

Prerequisite: Knowledge of Basic Sciences and Engineering Sciences/Knowledge about rural environment

Course Objectives: This course aims to:

1. Exposing the students to the industrial environment/ rural environment
2. Create awareness with the current industrial technological developments relevant to program domain
3. Provide opportunity to understand the social, economic and administrative considerations in organizations/rural areas

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand Engineer's responsibilities and ethics
2. Use various materials, processes, products and quality control
3. Provide innovative solutions to solve real world problems
4. Acquire knowledge in technical reports writing and presentation
5. Apply technical knowledge to real world industrial/rural situations

.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	3	-	3	-	3	3	-	-	3
CO2	1	1	1	3	3	-	2	1	-	-	-	-	3	3	-
CO3	2	3	3	3	3	2	3	1	1	-	-	-	3	3	-
CO4	-	-	-	-	-	3	-	1	3	3	-	1	-	-	3
CO5	1	3	3	3	3	2	3	-	1	-	-	1	3	3	3

For implementation procedures and letter formats, annexures I and III of Internship document may be referred.
Evaluation of Internship: The industrial training/internship of the students will be evaluated in three stages:

a) Evaluation by the Industry (in the scale of 1 to 10 where 1-Unsatisfactory; 10-Excellent)

b) Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks)

c) Evaluation through seminar presentation/Viva-Voce at the Institute by the constituted committee (25 marks)

Evaluation through Seminar presentation/Viva-Voce at the institute: Students shall give a seminar before an E*xpert Committee* constituted by college (Director, HoD/Senior faculty, mentor and faculty expert from the same department) based on his/her training/internship carried out

The evaluation will be based on the following criteria:

- Quality of content presented
- Proper planning for presentation
- Effectiveness of presentation
- Depth of knowledge and skills

- Attendance record, daily diary, departmental reports shall be analyzed along with the internship Report

Monitoring/ Surprise Visits: During the internship program, the faculty mentor makes a surprise visit to the internship site, to check the student's presence physically. If the student is found to be absent without prior intimation to the concerned industry, entire training/internship may be canceled. Students should inform through email to the faculty mentor as well as the industry supervisor at least one day prior to avail leave.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum with effect from AY 2022-23

B.E (Electronics and Communication Engineering)

SEMESTER – VI

S.no	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	20ECC22	Microcontrollers	3	-	-	3	40	60	3
2	20ECC23	VLSI Design	3	-	-	3	40	60	3
3		Professional Elective-III	3	-	-	3	40	60	3
4		Professional Elective-IV	3	-	-	3	40	60	3
5		Professional Elective-V	3	-	-	3	40	60	3
6		Open Elective-I	3	-	-	3	40	60	3
PRACTICALS									
7	20ECC24	Electronic Design and Automation Lab	-	-	2	3	50	50	1
8	20ECC25	Microcontrollers Lab	-	-	2	3	50	50	1
9	20ECC26	Mini Project	-	-	2	-	50	-	1
10	20EGC03	Employability Skills	-	-	2	3	50	50	1
Total			**18**	**-**	**8**	**27**	**440**	**510**	**22**
Clock Hours Per Week: 26									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum with effect from AY 2022-23

B.E (Electronics and Communication Engineering)

SEMESTER – VI

List of Courses in Professional Elective-III		List of Courses in Professional Elective-IV	
Course code	**Title of the Course**	**Course code**	**Title of the Course**
20ECE13	CPLD and FPGA Architectures	20ECE19	Design for Testability
20ECE14	Coding Theory and Techniques	20ECE20	Satellite Communication
20ECE15	Multirate and Wavelet Signal Processing	20ECE21	Image and Video Processing
20ECE16	Real Time Operating Systems	20ECE22	Embedded Systems
20ECE17	Green Communication	20ECE23	Smart Antennas
20ECE18	Cryptography and Block Chain Technology	20ECE24	Data Analytics for Signal Processing

List of Courses in Professional Elective-V		List of Courses in Open Elective-I	
Course code	**Title of the Course**	**Course code**	**Title of the Course**
20ECE25	CMOS Data Converters	20BTO01	Biology for Engineers
20ECE26	5G Communications	20CSO08	Basics of Machine Learning
20ECE27	DSP Processors and Architectures	20MEO07	Intellectual Property Rights
20ECE28	Advanced Microprocessors and Applications	20ITO01	Object Oriented Programming Using JAVA
20ECE29	Principles of GNSS	20MTO03	Quantum Computing
20ECE30	Pattern Recognition using Machine Learning	20CSO09	Fundamentals of DBMS

20EC C22

MICROCONTROLLERS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of Computer Architecture and Microprocessors.

Course Objectives: This course aims to:

1. Understand architecture features of the microcontrollers
2. Learn the programming of the microcontrollers
3. Understand interfacing of various modules with microcontrollers.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the architectures of different microcontrollers to enable to design of applications using them.
2. Develop code both in assembly and in high level language for various applications of microcontrollers.
3. Analyze and develop applications by using on-chip peripherals of different microcontrollers.
4. Interface various I/O Modules with 8051 microcontrollers.
5. Apply theoretical learning to practical real time problems for automation.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	3	3	-	-	-	-	-	-	3	3	2
CO2	3	3	3	2	3	3	-	-	-	-	-	-	3	3	2
CO3	3	3	3	2	3	3	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	3	2	-	-	-	-	-	-	3	3	2
CO5	3	3	3	2	3	3	-	-	-	-	-	3	3	2	2

UNIT-I

8051Microcontroller: Introduction to Microcontroller, Overview of 8051 family, Internal Architecture of 8051, PSW, Pin description, I/O Ports, Memory organization and expansion. Addressing modes and Bit addressable features, 8051 Instruction set: Data transfer, Arithmetic, Logical, Program branching and bit manipulation instructions.

UNIT-II

8051 Programming: Introduction to 8051 programming development tools, basic programming using instruction set, Introduction to 8051 C Programming, SFRs, 8051 Timer Programming in Assembly and C, 8051 Serial port Programming in Assembly and C, 8051 Interrupt Programming in Assembly and C.

UNIT-III

8051 Interfacing: 8051 interfacing to external memory (RAM, ROM), 8255 PPI interfacing, LCD and Keyboard interfacing, Digital to Analog converter, Analog to Digital converter and Sensor interfacing, Relay and PWM, DC Motor interfacing, Stepper Motor interfacing

UNIT-IV

ARM: Introduction to RISC Processors, ARM Design Philosophy, ARM Processor families, Architecture- Revisions, Registers, Program status register, Pipeline, Introduction to Exceptions,

ARM Instruction set: Data processing instructions, Branch instructions, Load-Store instructions, Software interrupt instruction, Program Status Register instructions, Loading constants, and Conditional executions. Introduction to THUMB instructions: Differences between Thumb and ARM modes, Register usage.

UNIT-V

ARM 7 Microcontroller (LPC2148)**:** Salient features of LPC 2148, Pin description of 2148, Architectural Overview.

ARM 7(LPC2148) **Peripherals:** Description of General-purpose input/output (GPIO) ports, Pin control Block. Features, Pin description, Register description and operation of PLL, Timers, PWM, ADC, DAC. Brief overview on I2C, SPI and Embedded application using communication protocols.

Text Books:

1. Mazidi M.A, Mazidi JG & Rolin D. Mckinlay, "The 8051 Microcontroller & Embedded Systems using Assembly and C", 2/e, Pearson Education, 2007.
2. Andrew N. Sloss, Domonic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimizing system software", 1/e, Elsever, 2004.

Suggested Reading:

1. Ayala K.J, "The 8051 Microcontroller Architecture, Programming and Applications", Penram International, 2007.
2. Steve Furber, "ARM System on Chip Architecture", 2/e, Pearson education, 2000.
3. Philips semiconductors, "ARM 7 (LPC 214x)user manual", 2005.
4. Lyla B. Das, "Architecture, Programming and Interfacing of Low-power Processors-ARM 7, Cortex-M", CENGAGE, 2017.

20EC C23

VLSI DESIGN

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Aprior knowledge of Verilog HDL and MOS Transistor Theory.

Course Objectives: This course aims to:

1. Study the concepts of Verilog HDL, simulation and synthesis process/concepts.
2. Learn the various characteristics of MOS transistor, process steps in IC fabrication.
3. Learn the various concepts required to obtain the digital logic layout diagrams. To know various subsystem design concepts.

Course Outcomes: Upon completion of this course, students will be able to:

1. Model a digital design using Advanced Verilog HDL constructs.
2. Analyse the characteristic behavior of MOSFET and discuss CMOS circuit Design Process
3. Explain various process steps involved in IC fabrication.
4. Design various NMOS and CMOS based logic circuits.
5. Discuss the concepts of subsystem designs and Testing.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	1	2	-	-	-	-	-	2	-	-	-	2	3	1	1
CO2	2	3	-	3	-	-	-	2	-	-	-	2	3	2	1
CO3	-	-	-		-	-	-	2	-	-	-	2	3	1	1
CO4	1	3	-	2	-	-	-	2	-	-	-	2	3	3	1
CO5	-	1	-	1	-	-	-	2	-	-	-	2	3	1	1

UNIT-I

Advanced Verilog HDL: Review of behavioural modelling**.** Functions and tasks Switch level Modelling, UDP, Design of Mealy and Moore state models using Verilog, Logic Synthesis, Synthesis Design flow, Gate level Netlist.

UNIT–II

Introduction to MOS Technology, Basic MOS Transistor action: Enhancement and Depletion Modes. Basic electrical properties of MOS, Threshold voltage and Body Effect.

Scaling of Technology, MOS Layers, Stick diagrams, Lambda based Design rules and Layout diagrams.

UNIT–III

Process steps in IC fabrication Crystal growth and wafer preparation-Czochralski process-apparatus-silicon shaping, slicing and polishing- Diffusion, Ion implantation- Annealing process- Oxidation process- Lithography-Photolithography, electron beam and x-ray lithography-Chemical vapour deposition (CVD)-epitaxial growth-reactors-metallisation and packaging.

UNIT–IV

Design of MOS inverters with different loads. Basic Logic Gates with CMOS: INVERTER, NAND, NOR, AOI and OAI gates. Transmission gate logic circuits, BiCMOS inverter, D flip flop using Transmission gates.

UNIT–V

Memories:1T, 3T Dynamic RAM Cell, 6T Static RAM Cell. NOR and NAND based ROM Memory Design.

Testing: Introduction to Testing, Fault models (stuck-at 1 and stuck – at-0)-Path sensitization and D-Algorithm, Controllability, Observability. Introduction to SoC and ASIC design.

Text Books:

1. Samir Palnitkar,"Verilog HDL:A guide to Digital design and synthesis", 2/e, Pearson Education, 2008.
2. Kamran Eshraghian, Douglas A. Pucknell, Sholeh Eshraghian, "Essentials of VLSI circuits and systems", PHI, 2011.
3. Neil HEWeste, David Harris, Ayan Banerjee, "CMOS VLSI Design–A circuit and System Perspective", 3/e, Pearson Education,2006.
4. Parag K Lal, " Fault Tolerant and Fault Testable Hardware Design " , BS Publications, 2020
5. S.M. Sze, VLSI Technology,McGraw-Hill, 2nd Edition, 1988.

Suggested Reading:

1. Michael D. Ciletti, "Advanced Digital Design with Verilog HDL", PHI, 2005.
2. John P. Uyemura, "Introduction to VLSI Circuits and systems", John Wiley & Sons, 2011.
3. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, McGraw-Hill, 1998.

20EC E13

CPLD AND FPGA ARCHITECTURES

(Professional Elective-III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Digital logic design and digital integrated circuits.

Course Objectives: This course aims to:

1. Study various PLD, CPLDs and FPGA Architectures and its features.
2. Understand the different programming technologies, placement and routing,.
3. Study the design tools for FPGA and ASICs.

Course Outcomes: Upon completion of this course, students will be able to:

1. Explain the concepts of PLDs, CPLDs and FPGAs.
2. Analyze and compare the various architectures of CPLD and FPGA and its programming technologies.
3. Implement various logic functions on PLDs, CPLDs and FPGAs.
4. Understand the concepts of placement and routing and classifying ASICs.
5. Demonstrate VLSI tool flow for CPLDs and FPGAs.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	-	1	1	-	-	2	-	-	-	2	3	3	1
CO2	2	3	1	3	2	-	-	2	-	-	-	2	3	3	1
CO3	-	2	-	1	-	-	-	2	-	-	-	2	3	3	1
CO4	2	3	-	3	2	-	-	2	-	-	-	2	3	3	1
CO5	-	3	-	2	2	-	-	2	-	-	-	2	3	3	1

UNIT I

Review of Logic Design: Implementation of logic functions with multiplexers.

Programmable Logic Devices: Architectures of PROM, PLA and PAL. Implementation of MSI circuits using Programmable Logic Devices.

UNIT II

Complex Programmable Logic Devices: Introduction to CPLD Architecture of CPLD. Logic Block, I/O Block, Interconnect matrix, and features of Altera max 7000 series, AMD Mach 4 and Xilinx XC-9500 CPLD.

UNIT III

Xilinx FPGAs: Introduction to FPGA, FPGA Programming Technologies. Architecture, Logic Blocks, I/O Block, Routing Architecture and features of Xilinx XC-4000, SPARTAN-II, Virtex-II and salient features of Virtex III to VII devices.

UNIT IV

Actel and Altera FPGAs: Anti-Fuse Programmed FPGAs: Introduction, Architecture of Actel's Act1, Act2, and Act3 FPGAs. Designing of logic circuits with the ACT devices. Logic Block, I/O Block, Routing Architecture and features of Altera's Flex 10000 series FPGA.

UNIT V

Digital Design Flow: Digital design tools for FPGAs. Digital design flow for CPLDs and FPGAs. Importance of Placement and Routing, Introduction to ASICs: Semi-Custom and Full-Custom ASICs.

Text books:

1. S. Trimberger, Edr, "Field Programmable Gate Array Technology", Springer Pub., 2011.
2. Ronald J . Tocci, Neal S. Widmer, Gregory L. Moss "Digital Systems", 10/e, Pearson academic press 2011.
3. P.K.Chan& S. Mourad, "Digital Design Using Field Programmable Gate Array", PHI, 1994.

Suggested Reading:

1. S. Brown, R.J.Francis, J.Rose, Z.G.Vranesic, "Field programmable gate array", BSP, 2007.
2. Altera, AMD, Actel, "Manuals Xilinx", 2015

20EC E14

CODING THEORY AND TECHNIQUES

(Professional Elective-III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of matrices and digital communication

Course Objectives: This course aims to:

1. Implementation of channel coding techniques in digital communications.
2. Know basic notions of error control coding and fundamentals of abstract algebra, finite fields and its extension.
3. Understand the mathematical structure and algorithms for RS and BCH codes.

Course Outcomes: Upon completion of this course, students will be able to:

1. Recall the theory and principles of information theory and channel Coding.
2. Design and analyze the encoding and decoding circuits for various coding techniques.
3. Apply the principles of abstract algebra, finite fields and its extension to design related codes.
4. Examine the error detection and correction capability of coding techniques for digital communication.
5. Evaluate the performance of error control codes using different decoding algorithms.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	1	3	-	-
CO2	2	3	1	1	-	-	-	-	-	-	-	1	3	3	-
CO3	2	3	1	1	-	-	-	-	-	-	-	1	3	3	-
CO4	2	3	-	1	-	-	-	-	-	-	-	1	3	1	-
CO5	2	3	-	1	-	-	-	-	-	-	-	1	3	1	-

UNIT I

Linear Block Codes: Introduction, generator and parity-check matrices, encoding, Syndrome decoding, Maximum Likelihood (ML) decoding-hard decision decoding and soft decision decoding.

Binary Cyclic Codes: Description, encoding, Syndrome computation and error detection, Encoder and Syndrome generator implementations, Meggit decoder.

UNIT II

Galois Fields: Fields, Binary arithmetic, Basic properties of Galois Fields, polynomials over GF (2), Construction of Galois Fields GF(2m) from GF (2), properties of extension fields, conjugates, Minimal polynomials, Factorization of (Xn+1) over a finite field..

UNIT III

BCH Codes: Introduction, general description of BCH codes, Encoding, Decoding – Berlekamp's algorithm, a Fast Berlekamp-Massey algorithm.

UNIT IV

RS Codes: Introduction, general description of Reed-Solomon codes, encoding, decoding of Reed- Solomon codes using Berlekamp-Massey algorithm. MDS codes, Spectral characteristics of cyclic codes.

UNIT V

Convolution Codes: Introduction, Encoding, State diagram, Code Tree, Code Trellis diagram, Decoding -Wozencraft's sequential decoding, Fann's algorithm, Maximum Likelihood (ML) Viterbi decoding - soft decision and hard decision decoding.

Text books:

1. Shulin and Daniel J. Costello, Jr. "Error Control Coding," 2/e, Pearson, 2011.
2. L.H.Charles LEE "Error control block codes for Communication Engineers", Artech, 2000.

Suggested readings:

1. Simon Haykin, "Communication Systems", 4/e, Wiley, 2000.
2. K Sam Shanmugum, "Digital and Analog Communication Systems", Wiley, 2005.
3. Man Young Ree, "Error-Correcting Coding Theory", Mc-Graw-Hill publishing company, 1 st edition,1989

20EC E15

MULTIRATE AND WAVELET SIGNAL PROCESSING

(Professional Elective-III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Course on Digital Signal Processing**.**

Course Objectives: This course aims to:

1. Know the basic of multirate digital signal processing operations.
2. Understand the design of the multirate filter Bank structure.
3. To learn the fundamentals of wavelet transform, and special wavelets.

Course Outcomes: On completion of this course, students will be able to:

1. Interpret the basics concepts of multirate digital signal processing.
2. Implement the multirate filter bank structures.
3. Explore the MRA and classes of wavelets.
4. Understand the basic concepts of the continuous and discrete wavelet transform.
5. Explain the special topics such as wavelet packets and Biorthogonal wavelets.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	2	3	1	1
CO2	3	3	2	1	1	2	-	-	-	-	-	-	2	2	-
CO3	3	3	3	2	1	1	-	-	-	-	-	-	3	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	2	2	-	-
CO5	3	3	2	1	-	1	-	-	-	-	-	2	1	2	1

UNIT I

Multi-rate System Fundamentals: Basic multi-rate operations: Decimation by an integer factor, Interpolation by an integer factor, sampling rate conversion by non-integer factor, Identities of multi-rate operations, poly-phase representation.

UNIT II

Multirate Filter Banks: Introduction, Uniform DFT filter banks, polyphase implementations of uniform filter banks, Two-channel QMF bank- structure, analysis, alias-free and perfect reconstruction (PR) QMF banks, maximally decimated filter banks, tree-structured filter banks with equal pass band.

UNIT III

Introduction to wavelets: Introduction to Discrete Fourier transform and Short-time Fourier transform, Time-frequency analysis, Bases of time-frequency: orthogonal, Filter banks, Multi-resolution formulation: Wavelets from filters, Classes of wavelets: Haar, Daubechies, bi-orthogonal.

UNIT IV

Continuous Wavelet Transform: Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Inverse continuous wavelet transform,

UNIT V

Discrete Wavelet Transform and Filter banks: Orthogonal and biorthogonal two-channel filter banks, Design of two-channel filter banks, Tree-structured filter banks, Discrete wavelet transform, Construction and Computation of the discrete wavelet transform, Parameterization of discrete wavelets, Bi-orthogonal wavelet bases, Two-dimensional wavelet transforms and Extensions to higher dimensions, wave packets

Text Books:

1. P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, Low Priced, Edition, 2006.
2. Stephen G. Mallat, "A Wavelet Tour of Signal Processing", Academic Press, Second, Edition, 2008.
3. Wavelet transforms: Introduction, Theory and applications, Raghuveerrao and Ajit, S.Bopardikar, Pearson Education Asia, 2000

References:

1. Sanjit K. Mitra, Digital Signal Processing: A Computer based Approach, 4^{th} Edition, McGraw Hill, 2013.
2. K. Deergha Rao and M N Swamy, Digital Signal Processing: Theory and Practice, springer, 2018.

20EC E16

REAL TIME OPERATING SYSTEMS

(Professional Elective-III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Prior knowledge of Computer Organization and Architecture is required.

Course Objectives: This course aims to:

1. Learn about the fundamental need of Real Time operating systems.
2. Understand the concepts of different RTOS.
3. Study the Linux based target system design process.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand Real-time operating system requirements and applications.
2. Categorize different scheduling approaches for real time scheduler.
3. Differentiate various RTOS features and POSIX standards
4. Analyze the inter task communication in RTOS.
5. Apply the Linux based embedded system design process.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	-	1	1	-	-	-	-	-	-	2	3	2
CO2	3	2	2	1	1	2	-	-	-	-	-	-	2	2	2
CO3	3	2	3	1	1	3	-	-	-	-	-	-	2	3	2
CO4	3	3	3	2	3	2	-	-	-	-	-	-	2	2	2
CO5	3	3	-	2	2	2	-	-	-	-	-	-	-	-	-

UNIT-I

Introduction to Operating Systems: Operating System objectives and functions, Evolution of operating systems, Developments leading to modern Operating Systems, Virtual machines, OS design consideration for multiprocessor and multicore, Overview on traditional and modern Unix OS, Differences between GPOS and RTOS

UNIT-II

Real Time System Basics: Basic model of a real time system, characteristics, applications, types of real time tasks, timing constraints, Uniprocessor Scheduling: Criteria for scheduling, scheduling algorithms: FCFS, SJF, Priority, Round Robin. **Real Time Task Scheduling:** Earliest Deadline First (EDF): Implementation, shortcoming. Rate Monotonic Algorithm (RMA): Implementation, issues associated with RMA

UNIT-III

Commercial Real Time Operating System: Time services, Features of RTOS, Unix as a RTOS, Non pre-emptive kernel, dynamic priority levels, POSIX: genesis of POSIX, Overview, Real Time POSIX standard, Priority inversion, priority ceiling and priority Inheritance protocols , a survey of contemporary RTOS: PSOS, VRTX, QNX, µC-OS-II and RT-Linux.

UNIT-IV

Introduction to Vx Works: Salient Features, Multitasking, Task state transition, Task Control: Task Creation and Activation, Task Stack, Task Names and IDs, Task Options, Task Information, Task Deletion and Safety, Semaphore and message queues related functions

UNIT-V

Linux Development Process: Types of Host /Target Development and debug setup, Generic Architecture of an Embedded Linux System, System start up, Types of Boot configurations, System Memory Layout, Development Tools: Project Workspace, IDE, GNCC cross platform, selecting and configuring kernel, setting up boot loader.

Text Books:

1. William Stallings, “Operating Systems Internals and Design Principles,” 7/e, Pearson Education, 2014
2. Rajib Mall, “Real Time Systems”, Pearson Education, 2/e, 2007.
3. KarimYaghmour, “Building Embedded Linux Systems” O'Reilly, 2000

Suggested Reading:

1. Silberschatz, Galvin, Gange “Operating Systems Concepts” 8/edition, Wiley Education, 2007.
2. Wind River SystemsInc., “VxWorks Programmers Guide”, 1997.
3. Andrew S.Tanenbaum, Herbert Bos, "Modern Operating Systems",4th edition, 2014.

20EC E17

Green Communication

(Professional Elective - III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: The student must prior knowledge in Communication systems, Mobile Cellular Communications.

Course Objectives: This course aims to:

1. To learn the importance of energy conservation in green wireless communication system.
2. To compare the different types of energy reduction techniques for different traffic scenarios.
3. To inculcate the different green concepts for designing the energy efficient next generation wireless networks

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the challenges in energy efficiency and spectral efficiency for digital data transmission.
2. Conceptualize significant energy efficiency trade off in green wireless networks. Apply the basics of Python programming language, which is used in many IoT devices.
3. Apply the methods to manage the dynamic loads of mobile communications for energy saving.
4. Indicate the design practices for power minimization at cellular base station.
5. Implement cell deployment strategies for efficient network management.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	3	2	2	3	-	-	-	-	-	-	3	3	1
CO2	3	-	2	1	2	3	-	-	-	-	-	-	3	3	3
CO3	3	-	3	3	3	3	-	-	-	-	-	-	3	3	2
CO4	3	-	3	3	3	3	-	-	-	-	-	-	3	3	2
CO5	1	-	1	-	2	2	-	-	-	-	-	-	3	3	2

UNIT I

Introduction to Green Wireless Communications: Introduction, Effective Capacity and Energy Per Information Bit, Variable-Rate/Variable- Power and Variable-Rate/Fixed-Power Transmissions, Fixed-Rate/Fixed-Power Transmissions - Transmissions over Imperfectly-Known Wireless Channels, Energy Efficiency in the Low- Power Regime - Energy Efficiency in the Wideband Regime.

UNIT II

Energy Efficiency-Spectral Efficiency Trade-off: Spectral Efficiency, Energy Efficiency, Energy Efficiency-Spectral Efficiency Trade-Off, Idealistic vs. Realistic Power Consumption Model, MIMO vs. SISO: An Energy Efficiency Analysis, Power Model Implications.

UNIT III

Energy Savings through Dynamic Spectrum and Traffic Load Management: Dynamic Spectrum and Traffic Load Management, Power Saving by Dynamically Powering Down Radio Network Equipment, Power Saving by Propagation Improvement, Power Saving by Channel Bandwidth Increase or Better Balancing, Performance Assessment, Power Saving by Propagation Improvement.

UNIT IV

Green Cellular Radio Base Station Designs: Explosive Traffic Growth, Cellular Scenarios, Energy Metrics, Energy Reduction Techniques for High Traffic Load Scenarios, Energy Reduction Techniques for Low Traffic Load Scenarios, Other Energy Reduction Techniques.

UNIT V

Green Wireless Access Networks: Energy Efficiency and Network Technologies, Cell Deployment Strategies, Relaying Techniques, Base Station Coordination and Cooperation, Adaptive Network Reconfiguration, Radio Resource Management, Future Architectures, Green Ad Hoc and Sensor Networks, Energy Harvesting Techniques.

Text Books:

1. Jinsong Wu, SundeepRangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press,2016.
2. F. Richard Yu, Xi Zhang, Victor C.M. Leung "Green Communications and Networking", CRC Press,2012.

Suggested Reading:

1. Ekram Hossain, Vijay Bhargava K and Gerhard Fettweis P, "Green Radio Communication Networks", Cambridge University Press, New York,2012.
2. Mazin Al Noor, "Green Radio Communication Networks Applying Radio-Over-Fiber Technology for Wireless Access", GRINVerlag,2012.
3. Mohammad Obaidat S, AlaganAnpalagan and Isaac Woungang, "Handbook of Green Information and Communication Systems", 1st Edition, Academic Press,2012.
4. Ramjee Prasad, Shingo Ohmori and Dina Simunic, "Towards Green ICT", River Publishers, 2010.

20EC E18

CRYPTOGRAPHY AND BLOCKCHAIN TECHNOLOGY

(Professional Elective-III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Data Structures and Algorithms, Introduction to Programming.

Course Objectives: This course aims to:

1. Provide conceptual understanding of basic concepts of cryptography.
2. Describes the Blockchain technology and its applications.
3. Introduce cryptocurrency transactions using Blockchain technology.

Course Outcomes: Upon completion of this course, students will be able to:

1. Comprehend the key concepts of fundamental cryptography techniques which are required for Blockchain Technology.
2. Describe the key concepts and compare various models of Blockchain Technology.
3. Understand consensus mechanism in Blockchain.
4. Acquire knowledge regarding cryptocurrency transactions and their validation.
5. Apply the concepts of Blockchain technology in real world scenario.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	2	1	-	-	-	-	-	1	2	2
CO2	3	3	2	1	-	-	-	-	-	-	-	-	2	-	1
CO3	2	2	2	1	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	2	2	1	-	-	-	-	-	-	-	-	-	2
CO5	3	2	1	1	-	2	1	-	-	-	-	-	1	2	2

UNIT-I

Overview of Cryptography: Introduction to Cryptography, History and development of cryptography; Cryptanalysis; Classical cryptosystems: shift, substitution and Vigenere ciphers; Attacks on shift, substitution and Vigenere ciphers; Designing a provably secure system, One -Time pads.

Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography: RSA Algorithm, Elliptical Curve Cryptography, A basic Cryptocurrency and example.

UNIT-II

Introduction to Blockchain Technology: Introduction to client-server architecture, distributed computing and their limitations. Evolution of Blockchain and how it is changing the landscape of digitalization, Block in a Blockchain, Working principles of blockchain technology. Types of Blockchain: Public, Private and Consortium, Permissioned Model of Block chain, Public Ledgers, Smart Contracts, Transactions, Mining Mechanism, Consensus.

UNIT-III

Introduction to digital wallet and types of wallets: Desktop, mobile and Meta mask/Browser based wallets. Introduction to Bitcoin Blockchain, Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW), HashcashPoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

UNIT-IV

Bitcoin versus Ethereum, Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verifications, using smart contracts to enforce legal contracts, Introduction to Hyperledger and Truffle..

UNIT-V

Applications: Blockchain Technologies for IoT, Supply Chain Management in Agriculture using Blockchain and IoT.

Text Books:

1. Paar Christof, Pelzl Jan, "Understanding Cryptography A Textbook for Students and Practitioners", Springer, 2010.
2. Joseph J. Bambara, Paul R. Allen, “Blockchain A Practical Guide to Developing Business, Law, and Technology Solutions”, 1st Edition, Mc. Graw Hill, 2018.
3. Daniel Drescher, “Block Chain Basics”, Apress; 1st Edition, 2017.
4. Shiho Kim, Ganesh Chandra Deka, "Advanced Applications of Blockchain Technology", Springer, 2020.

Suggested Reading:

1. Imran Bashir, “Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing, 2018.
2. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing, 2018.

20EC E19

DESIGN FOR TESTABILITY

(Professional Elective-IV)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: A prior knowledge of Digital System Design.

Course Objectives: This course aims to:

1. Provide an in-depth understanding of the testing and faults affecting VLSI circuits.
2. Provide knowledge on various testing methods.
3. Evaluate various test cases

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the concepts of testing for VLSI circuits.
2. Apply techniques to improve testability of VLSI circuits.
3. Utilize logic simulation methods such as ATPG in testing of VLSI circuits.
4. Analyze the concepts of BIST in testing of VLSI circuits.
5. Evaluate various Testing methods

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	2	-	-	-	2	3	1	1
CO2	2	2	2	-	-	-	-	2	-	-	-	2	3	`	1
CO3	1	-	-	-	-	-	-	2	-	-	-	2	3	1	1
CO4	1	2	1	-	-	-	-	2	-	-	-	2	3	1	1
CO5	1	1	1	-	-	-	-	2	-	-	-	2	3	1	1

UNIT-I

Introduction to VLSI testing: Importance of testing, Challenges in VLSI testing, Levels of abstractions in VLSI testing, Functional vs. Structural approach to testing, Complexity of the testing problem, Controllability and Observability, Generating test for a single stuck at fault in combinational logic, D-algorithm, PODEM algorithms, Test optimization and fault coverage.

UNIT–II

Design for testability (DFT): Testability analysis, Scan cell design, Scan architectures, Scan design rules, Scan design flow, Special purpose scan designs Logic and fault simulation, Fault detection, Adhoc and structured approaches to DFT, Various kinds of scan design.

UNIT–III

Test generation: Random test generation, Boolean difference, ATPG algorithms for combinational circuits, Sequential ATPG, Untestable faults, IDDQ testing The LFSRs and their use in random test generation and response compression.

UNIT–IV

Built-in self-test (BIST): Design rules, Exhaustive testing, Pseudo-random testing, Pseudo-exhaustive testing, Output response analysis, Logic BIST architectures Test compression: Test stimulus compression,

UNIT–V

Boundary scan and core -based testing: IEEE standards for digital boundary scan, Embedded core test standards Analog and mixed signal testing, Delay testing, Physical failures, Soft errors Reliability, FPGA testing.

Text Books:

1. Parag K. Lala, An Introduction to Logic Circuit Testing, Morgan & Claypool Publishers
2. Michael L. Bushnell and Vishwani D. Agrawal, Essentials of Electronic Testing, Springer India

Suggested Reading:

1. Parag K Lal, " Fault Tolerant and Fault Testable Hardware Design " , BS Publications, 2020
2. M. Abramovici, M. Breuer, and A. Friedman, Digital System Testing and Testable Design, Jaico Publishing House

20EC E20

SATELLITE COMMUNICATION

(Professional Elective-IV)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: A course on digital communications is required.

Course Objectives: This course aims to:

1. To understand the orbital aspects of satellite communication.
2. To study the satellite links and earth stations.
3. To know the working principles of DBSTV and VSAT.

Course Outcomes: Upon completion of this course, students will be able to:

1. Demonstrate the fundamental concepts of Orbital Aspects and Orbital Mechanics
2. Identify the mechanisms for placing satellites and examine the orbital effects on satellites, launch mechanisms.
3. Compare the Multiple access techniques for satellite communications and demonstrate the satellite subsystems.
4. Design an appropriate satellite communication link for the given specifications
5. Inspect the working principle and related aspects of DBSTV and VSAT.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	-	1	-	-	-	-	1	3	2	-
CO2	3	2	2	2	2	-	2	-	-	-	-	1	3	2	-
CO3	2	2	2	1	3	2	-	-	-	-	-	1	3	-	-
CO4	2	2	1	3	2	2	-	-	-	-	-	1	3	3	1
CO5	2	2	2	2	2	-	-	-	-	-	-	2	3	-	-

UNIT - I

INTRODUCTION AND ORBITAL ASPECTS OF SATELLITE COMMUNICATIONS : Introduction to Satellite Communication: Brief history of satellite communications, satellite services, frequency allocations, basic communication satellite system – earth segment and satellite segment, advantages and applications of satellite communications, salient features of Indian communication satellites. Introduction to satellite orbits – LEO, MEO, HEO, Polar orbits, sun-synchronous orbits, geo-synchronous and geo-stationary orbits. **Orbital Mechanics:** Kepler's laws, describing the orbit of a satellite, locating the satellite in the orbit and with respect to earth, Keplerian elements.

UNIT – II

Look Angle Determination: sub-satellite point, elevation and azimuth angle calculations, visibility test.

Orbital Perturbations: Longitudinal changes and inclination changes

Orbital Effects on Communication System Performance

Launches and Launch Vehicles: Launch vehicles, placing satellites into geo-stationary orbit, salient features of Indian launch vehicles – PSLV and GSLV.

UNIT – III

SATELLITE SUB SYSTEMS: Introduction, attitude and orbit control system, Telemetry, tracking, command and monitoring, Power Systems, Communication Subsystems, Satellite antennas. **MULTIPLE ACCESS TECHNIQUES:** Introduction, FDMA Systems, TDMA Systems, Beam switching and satellite switched TDMA, Spread spectrum techniques (CDMA), Comparison of multiple access techniques.

UNIT - IV

SATELLITE LINK DESIGN: **Satellite Link Design:** Basic transmission theory, system noise temperature and G/T ratio – noise temperature, calculation of system noise temperature, noise figure and noise temperature, design of down link, uplink design, design for specified C/N – combining C/N and C/I values, overall $(C/N)_0$ with uplink and downlink attenuation, attenuation in rain, uplink attenuation and $(C/N)_{up}$, downlink attenuation and $(C/N)_{dl}$, satellite communication link design procedure.

UNIT - V

DBS TV: Introduction, power rating and number of transponders, frequencies and polarization, transponder capacity, home receiver outdoor unit and indoor unit.

VSAT: Overview, network architecture, modulation, coding and interference issues, brief introduction to VSAT antennas, indoor and outdoor units.

Text Books:

1. T Pratt and W Bostiain - Satellite Communications, 2nd Edition, John Wiley, 2003.
2. Dennis Roddy, Satellite communications, McGraw Hill, 4 th Edition, 2009.
3. DC Agarwal, Satellite Communications, Khanna Publishers, 2003 Robert M Gagliard, Satellite
4. Communications.

Suggested Reading:

1. M. Richharia, “Satellite Communication Systems: Design Principles”, McGraw Hill, 2/e, 2003.
2. Gagliardi Robert M, “Satellite Communications”, 2/e, Van Nostrand Reinhold, 1991.

20EC E21

IMAGE AND VIDEO PROCESSING

(Professional Elective-IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: A prior knowledge of Signal Processing is required

Course Objectives: This course aims to:

1. To introduce the basic concepts and methodologies involved in image and video processing.
2. To understand the fundamentals of image compression
3. To provide a conceptual foundation that can be used as a basis for further study and research in this field.

Course Outcomes: Upon completion of this course, the student will be able to

1. To Learn image representation.
2. Apply Image enhancement and segmentation techniques both in spatial and frequency domain.
3. To reduce the redundancy in both lossy and lossless compression models.
4. Apply 2D-Motion estimation algorithms and develop predictive coding.
5. Creatively apply contemporary theories, processes and tools in the development and evolution of solutions to problems related to image and video processing.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	1	-	1	-	-	-	-	-	-	2	-	2	1
CO2	2	3	2	1	1	-	-	-	-	2	-	2	2	3	2
CO3	1	2	3	2	-	1	-	-	-	-	-	3	1	2	3
CO4	1	2	3	2	-	1	-	-	-	-	-	2	1	2	3
CO5	-	2	3	-	3	-	-	-	-	-	-	3	-	2	3

UNIT I

Fundamentals of Image Processing:

Basic steps of Image Processing System, Sampling and Quantization of an image, Basic relationship between pixels.

UNIT II

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

Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening.

UNIT III

Image Compression: Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy& Lossless, Arithmetic coding, Run length coding, Bit plane coding, Transform coding.

UNIT IV

Basic concepts of Video Processing

Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Sampling of Video signals, Filtering operations.

UNIT V

2-D Motion Estimation

Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding.

Text books:

1. Gonzaleze and Woods, Digital Image Processing ,4th ed., Pearson, 2018.
2. Yao Wang, Joem Ostermann and Ya–quin Zhang, Video processing and communication, 1st Ed., PH Int. 2001.

Suggested Reading:

1. M. Tekalp, Digital Video Processing, Prentice Hall International, 1995.

20EC E22

EMBEDDED SYSTEMS

(Professional Elective - IV)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Computer Architecture, Microprocessors and Microcontrollers.

Course Objectives: This course aims to:

1. Learn about fundamentals of the embedded systems.
2. Understand the hardware and software details of the embedded systems.
3. Acquire knowledge on the serial, parallel and network communication protocols.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the fundamentals of the embedded systems.
2. Analyze the hardware and software details of the embedded systems.
3. Design interfacing of the systems with other data handling / processing systems.
4. Evaluate the performance of an embedded system using various debugging tools.
5. Apply the embedded design approach for various applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	-	-	-	1	-	-	2	-	-	-	-	1	-	-	-
CO2	-	2	1	1	3	3	2	-	-	-	-	2	-	2	1
CO3	2	2	-	3	3	3	3	-	-	-	-	2	2	2	-
CO4	2	3	2	1	3	3	-	-	-	-	-	3	2	3	2
CO5	3	3	2	1	3	3	3	-	-	-	-	3	3	3	2

UNIT-I

Introduction to Embedded Systems: Embedded systems versus General Computing Systems, History of embedded systems, classifications, applications areas, characteristics and quality attributes of embedded systems, Design metrics and challenges in embedded system design.

UNIT-II

Embedded Hardware and Software: Processor embedded into a system, Processor selection for embedded system, embedded hardware units and devices in a system, embedded software in a system and an overview of programming languages, challenges and issues related to embedded software development.

UNIT-III

Communication Protocols: I2C, CAN, Firewire-IEEE 1394 Bus standard, advanced serial high-speed buses. Parallel Bus device protocols: ISA, PCI, PCI-X, Internet Enabled Systems-Network protocols: Ethernet.

UNIT-IV

Embedded Software Development Process: Embedded System design and co-design issues in system development process, Design cycle in the development phase for an Embedded Systems. Embedded software development tools: Host and Target Machines, Linker/Locators for embedded software, Embedded Software into the Target system. Issues in hardware and software design and co-design.

UNIT-V

Testing, Debugging Techniques and Applications: Integration and testing of embedded hardware, testing methods, debugging techniques, Laboratory tools and target hardware debugging: Logic Analyzer, simulator, emulator and In-circuit emulator, IDE **Case Study**: Embedded Systems design for automatic vending machines and digital camera.

Text Books:

1. Raj Kamal, "Embedded Systems-Architecture, Programming and Design",3/e, McGraw Hill Education,2017.
2. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2011.

Suggested Reading:

1. Shibu K V, "Introduction to Embedded systems", 1/e McGraw Hill Education,2009.
2. David Simon, "An Embedded software primer", Pearson Education,2002

20EC E23

SMART ANTENNAS

(Professional Elective-IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: The student must have undergone the courses on Antennas, Mobile Cellular Communications, and Digital Signal Processing.

Course Objectives: This course aims to:

1. To learn the fundamentals of non-uniform and planar antenna arrays and MIMO antenna system
2. To learn the different types of smart antenna configuration and their importance.
3. To compare the different types of the algorithm used for DOA estimation and beamforming

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the basic principles of Non Uniform and Planar antenna arrays.
2. Comprehend the necessity of smart antenna and smart antenna configuration.
3. Understand the DOA estimation methods and compare different algorithms for DOA estimation
4. Analyze various beamforming algorithms used in a smart antenna system
5. Describe the fundamentals of the MIMO and RDA antenna systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	2	2	2	3	1	2	3	3	1
CO2	3	2	2	1	1	2	2	2	3	3	1	2	3	3	3
CO3	3	3	3	3	3	2	2	2	3	3	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	3	3	2	2	3	3	2
CO5	3	3	2	2	1	2	2	2	3	3	1	2	3	3	2

UNIT I

Antenna Arrays

Review of antenna Arrays – Non-Uniform Arrays; Array Weighting: Beam steered and weighted arrays, Rectangular Planar Arrays. Fixed Beam Arrays: Butler matrices, Fixed Sidelobe Cancelling.

UNIT II

Smart Antennas:

Introduction, Space Division Multiple Access, Need for Smart Antenna systems, Advantages and Disadvantages of smart antennas. Smart Antenna Configurations: Switched-Beam Antennas, Adaptive Antenna Approach. Qualitative treatment of Smart Antenna Architecture.

UNIT III

DOA Estimation:

The Array Response Vector, Received Signal Model, The Subspace-Based Data Model, Signal Auto-covariance Matrices

Conventional DOA Estimation Methods: Conventional Beamforming Method and Capon's Minimum Variance Methods. Subspace Approach to DOA Estimation: The MUSIC Algorithm, The ESPRIT Algorithm, Uniqueness of DOA Estimates

UNITIV

Beam Forming Techniques and Adaptive Algorithms:

Introduction to Beam Forming, Classical Beamformer. Statistically Optimum Beamforming Weight Vectors: The Maximum SNR Beamformer, The Multiple Sidelobe Canceller and the Maximum SINR Beamformer, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI). Adaptive Algorithms for Beamforming: The Least Mean-Square (LMS) Algorithm, The Recursive Least-Squares (RLS) Algorithm.

UNIT V

MIMO and RDA :

Introduction to MIMO Antennas, Isolation, Envelope Correlation Coefficient, Total Active Reflection Coefficient. Retrodirective Array Antenna (RDA): Van Altta Array and Phase Conjugating Array, Commercial Availability of Smart Antennas.

Text Books:

1. Balanis CA, Ioannides PI, "Introduction to Smart Antennas", Morgan & Claypool Publishers; 2007.
2. Gross F, "Smart antennas for wireless communications", McGraw-Hill Professional, 2005.
3. Luo Q, Gao SS, Liu W, Gu C. "Low-cost smart antennas", John Wiley & Sons; 2019.

Suggested Reading:

1. Godara LC, "Smart antennas" CRC press; 2004.

20EC E24

DATA ANALYTICS FOR SIGNAL PROCESSING

(Professional Elective-IV)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Programming using MATLAB/Python, probability and statistics and Linear Algebra

Course Objectives: This course aims to

1. Find a meaningful pattern in data and insights from data through visual representation
2. Implementation of various machine learning algorithms and develop intelligent decision support systems
3. Handle large scale analytics projects from various domains such as image and speech signals

Course outcomes: Upon completion of this course, students will be able to:

1. Explain data science fundamentals
2. Explore the principles of probability and statistical theory
3. Understand various machine learning algorithms using applied statistics
4. Analyze supervised and unsupervised learning models with regression and classification techniques
5. Construct various applications of image and speech processing using MATLAB/Python

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	2	1	1	1	1	-	-	-	-	-	-	-	2	-	-
CO2	2	2	2	3	-	-	-	-	-	-	-	-	3	3	-
CO3	2	3	2	3	-	-	-	-	-	2	-	-	3	3	3
CO4	2	3	3	3	3	-	-	-	-	-	-	2	3	3	3
CO5	2	3	3	3	3	2	2	-	1	2	1	2	3	3	3

Unit-I:

Introduction to Data Analytics: **Descriptive statistics**: The central limit theorem, distributions of sample mean and the sample variance for a normal population, Sampling distributions - Chi square, t , F, z .

Probability distribution and inferential statistics: Inferential statistics through testing of hypothesis, Testing of attributes: mean of normal population, one tailed and two tailed test, F test, Chi squared test, permutation and randomization test

Unit II:

Regression and ANOVA: Regression ANOVA (analysis of variance): one way and two way variance

Machine learning: Introduction to concepts, differentiating algorithmic and model base frameworks, Regression: Ordinary least squares, Ridge regression, Lasso regression, Regression and classification

Unit III:

Supervised and Unsupervised learning with Regression and classification techniques: Bias variance dichotomy , model validation approaches , logistic regression , linear discriminant analysis, quadratic discriminant analysis , Support vector machines (SVM) , Ensemble methods: Random forest, clustering: partition based clustering - k means clustering, principal

component analysis (PCA) , Hierarchical clustering- agglomerative-Divisive - Distance measures . Neural networks- the perceptron algorithm, multilayer perceptron (MLP) - back propagation nonlinear regression (BPMLP) multiclass discrimination - training procedures-dimensionality reduction interpretation

Unit IV:

Data analytics speech processing

Speech recognition using python: Understanding and visualization of speech/audio data, Spectral representation of speech/audio data: Discrete Fourier transform (DFT), Fast Fourier transform (FFT),
Spectrogram
Natural language processing: Text pre-processing, parsing and exploratory data analysis, supervised or unsupervised model of the data, Evaluation and deployment using python

Unit V

Data analytics in image processing

Transformation of images/videos data using python: Segmentation and feature extraction, detection of relationship between variables, features and time, Extraction of time stamped variables, Image compression using k means clustering.

Textbooks

1. Hastie , Trevor , et al. "The elements of statistical learning " Vol.2. No 1 New York springer , 2009
2. Montgomery, Douglas C, and George C. Runger, " Applied statistics and probability for engineers " John Wiley & sons , 2010.
3. C. Bishop, "Pattern recognition and Machine learning , Springer" 2006
4. John Mueller and Luca Massaron, "Machine learning for Dummies " John Wiley & sons, 2016

Suggested Reading

1. Little , Max A Machine learning for Signal processing : Data science , Algorithms and Computational statistics , Oxford University Press , USA 2019
2. Chellappa, Rama and Sergios Theodoridis, Signal processing Theory and Machine learning. Academic press , 2014

20EC E25

CMOS Data Converters

(Professional Elective-V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: A prior knowledge of Analog IC Design

Course Objectives: This course aims to:

1. Familiarization of OP-AMP based circuits
2. To understand performance measures of Data converters.
3. To study different types of data converter circuits.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand Op-Amp based designs
2. Explain various performance measures of Data converters
3. Design and analyze mixed mode circuits such as Comparator, switched capacitor and sample & hold circuits
4. Design and analyze an A/D or D/A converter circuits.
5. Explain principles of oversampling

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	1	2	-	-	-	-	-	2	-	-	-	2	3	1	1
CO2	2	3	-	3	-	-	-	2	-	-	-	2	3	2	1
CO3	-	-	-	-	-	-	-	2	-	-	-	2	3	1	1
CO4	1	3	-	2	-	-	-	2	-	-	-	2	3	3	1
CO5	-	1	-	1	-	-	-	2	-	-	-	2	3	1	1

UNIT I

OP-Amp as comparator, Charge injection error, switched capacitor basic operation and analysis, first order filter, switched capacitor gain circuits, Sample and hold circuit-its performance

UNIT II

Introduction, Ideal data converter, Quantization, Static performance, Dynamic performance, frequency domain measures.

UNIT III

Nyquist rated DAC, Decoder based converter, binary scaled converter, thermometer coded converter, hybrid converter

UNIT IV

Successive approximation converter, algorithmic ADC, Flash converter, two-step ADC, Interpolation ADC, folding ADC, piplied ADC,Time interleaved adc

UNIT V

Oversampled converter -Oversampling with and without noise shaping, system architecture, digital decimation filter, high order modulation, band pass over sampling converter, multi bit oversampling converter, third order ADC

Text Books:

1. D.A John & Ken Martin, "Analog Integrated Circuit Design". John Wiley Publications, Reprint 2011.
2. BehzadRazavi, "Design of Analog CMOS Integrated Circuits", Tata-McGraw Hill Publications,2002.

Suggested Book:

1. Philip E. Allen & Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2002

20EC E26

5G COMMUNICATIONS

(Professional Elective-V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: The student must prior knowledge in Communication systems, Mobile Cellular Communications

Course Objectives: This course aims to:

1. Understand the requirements & concepts of 4G/5G.
2. Expose the architecture and radio access technologies of 5G.
3. Learn Massive MIMO concepts.

Course Outcomes: Upon completion of this course, students will be able to:

1. Recall the requirements and key functionalities of 4G LTEA/5G NR technology.
2. Compare various channel access technologies, modulation techniques used in 5G wireless systems.
3. Illustrate the architecture of 5G and its NextGen core network.
4. Apply the 5G concepts to D2D communications.
5. Demonstrate the concept of massive MIMO.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	3	-	3	2	2	3	-	-	-	-	-	-	3	3	1
CO2	3	-	2	1	2	3	-	-	-	-	-	-	3	3	3
CO3	3	-	3	3	3	3	-	-	-	-	-	-	3	3	2
CO4	3	-	3	3	3	3	-	-	-	-	-	-	3	3	2
CO5	1	-	1		2	2	-	-	-	-	-	-	3	3	2

UNIT I

Overview of 4G/5G Wireless Communications: Evolution of mobile technologies (1G-5G), 3GPP Releases & its key aspects,4G overview, Overview of 5G, three high level 5G usage scenarios (eMBB, URLLC, mMTC), Key capabilities & requirements, performance & efficiency indicators, 5G vs. LTE-A Comparison, 5G frequency bands, 5G Use cases.

UNIT II

5G Channel Access Techniques: Basic requirements of transmission over 5G, Modulation Techniques- generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques –non-orthogonal multiple accesses (NOMA), Sparse Code Multiple Access (SCMA) –Comparison of multiple access methods.

UNIT III

5G Architecture: Introduction: NGMN 5G Architecture framework, Layered functionality, 3GPP 5G architecture, Non-Roaming 5G system architecture, overall RAN architecture, Functional Split Between NG-RAN and 5G Core Network.

5G NextGen core network: Modern network requirements, SDN architecture, NFV benefits and requirements, – NFV Reference Architecture.

UNIT IV

Device-to-device (D2D) communications: use cases of D2D communication in Cellular networks, D2D in 5G: research challenges, Radio resource management for mobile broadband D2D.Multi-hop D2D communications for proximity and emergency services.

UNIT V

Massive Multiple-Input Multiple-Output (MIMO) Systems: Introduction to Multi-Antenna system, Theoretical background: MIMO requirement, MIMO vs. massive MIMO, Massive MIMO benefits, single user and multi-user MIMO, capacity of MIMO for unknown CSIT, massive MIMO capacity, Massive MIMO OFDM transmitter employing digital precoding, analog beamforming and hybrid of digital precoding and analog beamforming.

Text Books:

1. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies" CRC Press, 2019. (Unit1, Unit2)
2. Suvra Sekhar Das and Ramjee Prasad, "Evolution of Air Interface Towards 5G: Radio Access Technology and Performance Analysis", Gistrup, Denmark: River Publishers series in Communication, 2018.(Unit 2)
3. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, **"**5G Mobile Communications", Springer publications-2016.(Unit 1)
4. William Stallings "5G Wireless: A Comprehensive Introduction", Pearson Education, 2021.(Unit 3)
5. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology" Cambridge University Press-2016.(Unit 4 & 5)

Suggested Reading:

1. R. S. Kshetrimayum, "Fundamentals of MIMO Wireless Communications", Cambridge University Press, UK, 2017.(Unit 5)
2. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks" first edition, John Wiley & Sons, 2015.

20EC E27

DSP PROCESSORS AND ARCHITECTURES

(Professional Elective-V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of Digital Signal Processing**.**

Course Objectives: This course aims to:

1. Learn the architectural differences between DSP and General-purpose processor.
2. Study the fixed and floating point DSP processor architectures.
3. Study the various applications of DSP Processors.

Course Outcomes: Upon completion of this course, students will be able to:

1. Classify the differences between DSP Processor and General-Purpose processor.
2. Understand the basic architectural needs of Programmable DSPs
3. Explain the architecture features of TMS320C55XX processor.
4. Develop on interface with TMS320C55XX processor to external peripherals.
5. Design and implement of various signal processing algorithms using 55xx processor.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	1	1	1	1
CO2	2	2	2	1	2	1	-	-	-	-	-	**2**	2	2	2
CO3	2	2	2	1	2	1	-	-	-	-	-	**2**	2	2	2
CO4	2	1	2	1	1	1	-	-	-	-	-	2	1	1	1
CO5	2	2	3	2	1	1	-	-	-	-	-	2	2	2	2

UNIT- I

Introduction to DSP Processors: Differences between DSP and other microprocessor architectures. Number formats- Fixed point, Floating point and block Floating point formats, IEEE-754 Floating point, Dynamic range and precision, Relation between data word size and instruction word size, Q-notation. Basic elements of real time DSP systems, DSP Hardware

UNIT-II

Fundamentals of Programmable DSPs: Multiplier and Multiplier Accumulator, Modified Bus structures and memory access in PDSPs – Multiple access memory, multiport memory, SIMD, VLIW Architectures, Pipelining, Special addressing modes in PDSPs, On-chip peripherals.

UNIT-III

Overview of TMS320C55X: Architecture of TMS320C55X Processor, Buses, Memory map, addressing modes, Instruction set, Pipeline and parallelism, Mixed C and Assembly language programming and on-chip peripherals.

UNIT-IV

Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus

interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA). Software Development Tools-Code Composer Studio (CCS), C compiler, Assembler and Linker.

UNIT-V

Application Programs: Implementation of algorithms on DSP processors – Sine wave generators, Convolution, Correlation, FFT, FIR filter, IIR filter, Decimation and Interpolation and sub band coding of signals, Dual Tone Multi Frequency (DTMF).

Text Books:

1. Sen M. Kuo and Woon Serg Gan, "Digital Signal Processors Architectures, Implementation and Application", Pearson Practice Hall, 2013.
2. Avatar Singh and S. Srinivasan, "Digital Signal Processing Implementations Using DSP Microprocessors", Thomson Brooks, 2012.

Suggested Reading:

1. B. Ventakaramani, M. Bhaskar, "Digital Signal Processors Architecture Programming and Applications", Tata McGraw Hill, 10th reprint,2015.
2. Rulph Chassaing, "Digital Signal Processing and Application with the C6713 and C6416 DSK", A John Wiley & sons, Inc, Publication,2005.
3. Sen M. Kuo, Bob H. Lee, Wenshun Tian, "Real Time Digital Signal Processing: Implementations and Applications", Second Edition, John Wiley and sons ltd, 2006.

20EC E28

ADVANCED MICROPROCESSORS AND APPLICATIONS

(Professional Elective-V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Computer Architecture and Microprocessors

Course Objectives: This course aims to:

1. Describe the hardware and software enhancements of the 80x86 microprocessors as compared to the 8086.
2. Contrast the changes in memory management unit and paging unit when compared to 80386 and 80486 microprocessors.
3. Detail the improvements in the Pentium Pro when compared to the Pentium.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the historic evaluation of 80286,386,486
2. Explain the basic and advance Pentium features & architecture.
3. Analyze the Memory Management mechanisms employed in advanced Microprocessors.
4. Understand the concepts related to SoC Design
5. Demonstrate and design a microprocessor based applications.

Course Articulation Matrix

UNIT-I

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	-	-	-	-	-	-	-	-	2	2	-
CO2	2	1	3	1	-	-	-	-	-	-	-	2	2	2	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-	2	2	-
CO4	2	2	2	2	2	-	-	-	-	-	-	1	2	2	-
CO5	3	1	2	2	2	-	-	-	-	-	-	1	2	2	2

The 80186 and 80286 Microprocessors:

80186 Architecture, Features, Pin-Out, Peripheral Control Block, Interrupt Controller, Timers, DMA Controller, Chip Selection Unit.

Introduction to 80286 Microprocessor, Hardware Features, Additional Instructions, The Virtual Memory Machine - Real and Protected Virtual Address Modes.

UNIT-II

The 80386 and 80486 Microprocessors:

Introduction to 80386 Microprocessor, Special registers, Memory Management – Descriptors and Selectors, Descriptor tables, Protected and Virtual 8086 modes, The Memory Paging Mechanism.

Introduction to 80486 Microprocessor – Basic Architecture, Memory System.

UNIT-III

The PENTIUM Microprocessors:

Introduction to the Pentium Microprocessor, Branch Prediction Logic, Cache structure, Superscalar Architecture, Special Pentium registers, Pentium Memory Management- Paging Unit, memory Management mode, New Pentium Instructions.

Introduction to the Pentium Pro Microprocessor – Internal structure, Pin connections, The Memory System, Input/Output system, Special features.

Introduction to the Pentium II, Pentium III, Pentium 4 and Core2.

UNIT-IV

System on Chip: System-on-Chip Concept, SoC Architecture, SoC Design Flow, IP based SoC Designs, Basic Concepts of Bus-Based Communication: Bus based approach and NoC based approach, Processor selection for SoC, Embedded Processors, ASIP, Product economics and implications of SoC.

UNIT-V

Applications of Microprocessors:

Microprocessor based Aluminium Smelter Control – General Process Description of an Aluminium Smelter, Sailent Issues in Design, Smelter Controller Hardware, and Control Algorithm.

Design of Microprocessor based Pattern Scanner System – Organization of the Scanner system, Description of Scanning system, Programmed mode of operation, Memory read/write system and Start-Up Procedures.

Text Books:

1. Barry B. Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80386, 80486, Pentium, Pentium Pro, Pentium II, Pentium III, Pentium 4, and Core2 with 64 – bit extensions Architecture, Programming, and Interfacing", 8/e Pearson Education, 2009.
2. K M Bhurchandi and A K Ray, "Advanced Microprocessor and peripherals", 3/e McGraw Hill, 2013.
3. Michael J Flinn, Wayne Luk, "Computer System Design: System-on-Chip", Wiley, 2012.

Suggested Reading:

1. Douglas V Hall, SSSP Rao, "Microprocessors and Interfacing", 3/e McGraw Hill, 2012.
2. James L Antonakos, "The Intel ® Microprocessor Family: Harware and Software Principles and Applications", First edition, CENGAGE Delmar Cengage Learning, 2006.
3. Gilmore, "Microprocessors Principles and Applications", 2/e TATA McGraw Hill, 1995.
4. Shuying Ma, Jianwei Chang et.al " Progress and Applications of Embedded System in Chip Technology" IEEE 70th Electronic Components and Technology Conference (ECTC) 03-30 June 2020, Orlando, Florida, USA DOI: 10.1109/ECTC32862.2020.00262

20EC E29

PRINCIPLES OF GNSS

(Professional Elective-V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Fundamental concepts of communication are required.

Course Objectives: This course aims to:

1. Explain the basic principle of operation of GPS, GPS ephemerides and signal structure.
2. Make the students to understand various coordinate systems and highlight the effect of various errors affecting GPS signals.
3. Make the students to appreciate the significance of other GNSS systems, principle of DGPS and augmentation systems.

Course Outcomes: Upon completion of this course, students will be able to:

1. Demonstrate the fundamental concepts of communications in understanding of GPS architecture, operation and signal structure.
2. Apply the principles of orbital mechanics, time references, coordinate systems and range measurements in estimating user position.
3. Examine the effect of various error sources and satellite geometry on position estimates and analyze the suitability of a given data format.
4. Compare the architecture and working of other GNSS systems and make use of GNSS systems in a variety of civilian and defense applications.
5. Relate the knowledge of DGPS techniques in understanding augmentation systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	1	1	2	-	1	-	2	3	1	1
CO2	3	3	2	2	1	1	1	2	-	1	-	2	3	1	-
CO3	3	3	3	3	1	1	1	2	-	1	-	2	3	1	-
CO4	2	2	2	1	-	1	1	2	-	1	-	2	3	-	-
CO5	3	2	2	1	1	1	1	2	-	1	-	2	3	1	-

UNIT-I

GPS Fundamentals: Introduction to Radio Navigation system: VOR, ILS. GPS System Segments: space, control and user segments, Principle of operation, Current status of GPS satellite constellation. Orbital Mechanics: GPS ephemeris data, algorithm for computation of satellite's position from ephemeris data. Time References: solar and sidereal days, UTC time, GPS time.

UNIT-II

GPS Signals: Legacy GPS signals: Signal structure, Operating frequencies, C/A and P-Code, Navigation message, Modernized GPS signals: list of signals and their significance. Range measurements: code and carrier measurements, User position estimation with PRN codes.

Coordinate Systems: Earth Centered Earth Fixed (ECEF) coordinate system, Earth Centered Inertial (ECI) coordinate system, Geodetic coordinate system, Ellipsoid and Geoid, Regional and Global Datum, World Geodetic System (WGS-84).

UNIT-III

GPS Error Sources: Satellite clock error, ephemeris error, Receiver clock errors, satellite and receiver instrumental bias, Multipath error, receiver measurement noise, ionospheric error and tropospheric error, Klobuchar model, ionospheric delay estimation using dual frequency measurements and UERE. Dilution of precision: HDOP, VDOP, TDOP, PDOP & GDOP.

UNIT-IV

Data Formats: RINEX Observation and Navigation Data formats, NMEA format.
GNSS: Architecture, operation and signals of other navigational satellite systems Galileo, Beidou and GLONASS, QZSS.
IRNSS: Architecture and signals.

UNIT-V

Differential GPS (DGPS): Principle of DGPS, Types of DGPS: Local Area DGPS (LADPS), Wide Area DGPS (WADGPS).
GPS Augmentation Systems: Principle of operation of Satellite Based Augmentation system (SBAS) and Ground Based Augmentation System (GBAS).
GNSS Applications: Surveying, Mapping, Marine, air and land Navigation, Military and Space Application.

Text Books:

1. Elliot D Kaplan and Christopher J Hegarty, "Understanding GPS principles and applications", Artech House Publishers, 2/e Boston & London 2005.
2. Pratap Misra and Per Enge, "Global Positioning System Signals, Measurement, and Performance", Ganga- Jamuna Press, 2/e, Massachusetts, 2010.

Suggested Reading:

1. B. Hofmann-Wellenhof, H. Lichtenegger, and J. Collins, "GPS Theory and Practice", Springer Verlog, 5/e, 2008.
2. Ahmed El-Rabbany, "Introduction to GPS", Artech House Publishers, 2/e, Boston 2006.
3. Bradford W. Parkinson and James J. Spilker, "Global Positioning system: Theory and Application", Vol.II, American Institution of Aeronautices and Astronautics Inc., Washington, 1996.

20EC E30

PATTERN RECOGNITION USING MACHINE LEARNING

(Professional Elective-V)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: The student should have knowledge of probability and random variables.

Course Objectives: This course aims to:

1. Model of pattern recognition using decision theory.
2. Develop of linear models for classification problems.
3. Analyze the unsupervised learning models and also clustering.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the concepts of pattern recognition.
2. Apply the parametric and linear models for classification.
3. Design algorithms using neural networks for machine learning problems.
4. Implementation of Support Vector Machines (SVM) algorithm for real time applications.
5. Evaluate various unsupervised clustering techniques.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	-	-	-	-	-	2	-	-
CO2	3	2	1	2	2	-	-	-	-	-	-	1	3	2	1
CO3	3	2	3	2	3	-	-	-	-	-	1	2	3	2	2
CO4	3	2	3	2	3	-	-	-	-	-	1	1	3	2	2
CO5	3	2	3	2	2	-	-	-	-	-	2	2	3	3	2

UNIT-I

Introduction to Pattern Recognition: Pattern Recognition Systems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Bayesian Decision Theory, continuous Features, Minimum Error rate classification, Classifiers, Discriminant Functions and Decision surfaces, Bayesian Decision Theory- Discrete Features. Maximum-Likelihood and Bayesian parameter estimation: Maximum Likelihood estimation, Bayesian estimation.

UNIT-II

Linear Models: Linear Models for Regression: Linear Basis Function Models, The Bias -Variance Decomposition, Bayesian Linear Regression, Linear Models for Classification: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, Bayesian Logistic Regression.

UNIT-III

Neural Network: Feed forward operation and classification: Multilayer Networks, back propagation algorithm: Network learning, Training protocols, Learning Curves, error surfaces, practical techniques for improving back propagation, additional networks and training methods, Adaboost, Deep Learning.

UNIT-IV

Linear Discriminant Functions: Decision surfaces: Two category case and multi category case, two-category Linearly separable case, Minimum- squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machines.

UNIT-V

Algorithm Independent Machine Learning: lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.

Unsupervised Learning and Clustering: k-means clustering, fuzzy k-means clustering, Hierarchical clustering.

Text Books:

1. C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001.

Suggested Reading:

1. B. Yagnanarayana, Artificial Neural Networks, Prentice Hall, New Delhi, 2007.

20BT O01

BIOLOGY FOR ENGINEERS

(Open Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: The school level basic knowledge in Fundamental science is required.

Course Objectives: This course aims to:

1. Understand the milestones reached by human in the field of biology.
2. Understand the human body and its parts.
3. Understand the human anatomy and medical devices.
4. Understand types of advanced therapies.
5. Understand the treatment of toxic pollutants in the environment.
6. Understand genome sequencing and NGS.

Course Outcomes: Upon completion of this course, students will be able to:

1. Appraise the values of Biology in classical and modern time
2. Develop modern instruments related to skeletal, nervous, and circulatory system
3. Apply concept of respiratory, excretory and assisted reproductive process for developing related instruments
4. Illustrate the modern interdisciplinary tools related to medical biotechnology and bioremediation
5. Summarize the basic knowledge about nucleic acids, proteins and their sequencing

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	2	2	-	-	-	-	2	-	-	-
CO2	1	-	-	-	2	-	1	-	-	-	-	-	1	1	1
CO3	1	-	1	-	2	-	1	1	-	-	-	-	1	1	-
CO4	2	1	1	-	2	-	2	-	-	1	-	-	1	2	1
CO5	1	1	1	-	1	-	1	-	-	1	-	1	-	-	-

UNIT-I

Introduction to Biology: Classical Vs Modern Biology; Importance of Biological Science and Historical developments; Origin of Life, Urey Miller Experiment, Spontaneous Generation Theory; Three Domains of Life; Principle and Applications of Microscope (Light and Electron Microscope), Prokaryotic and Eukaryotic Cell- Structure and their differences.

UNIT-II

Human Anatomy and Functions-I: Human organ systems and their functions; Skeletal System-Bones, Tendon, Ligaments, principle and applications in knee replacement; Nervous System - Structure of Brain, Spinal Cord, Neuron, Neurotransmitters, Synapse, Alzheimer's - a case study, principle and applications of Imaging Techniques (CT & MRI scans); Circulatory System - Heart structure and functions, principle and applications of cardiac devices (Stent and Pacemaker), Artificial heart, blood components and typing, haemocytometer.

UNIT-III

Human Anatomy and Functions-II: Respiratory Systems - Lung structure and function, principle and applications of Peak Flow Meter, ECMO (Extra Corporeal Membrane Oxygenation); Excretory Systems-Kidney structure and function, principle and applications of Dialysis; Prenatal diagnosis; Assisted reproductive techniques- IVF, Surrogacy.

UNIT-IV

Medical Biotechnology and Bioremediation: Cells of Immune System, Etiology of cancer, Cancer treatment (Radiation Therapy); Stem Cells and its Clinical applications; Scaffolds and 3D printing of organs; Bio sensors and their applications; Parts of bioreactor and its types; Bioremediation.

UNIT - V

Bioinformatics: Nucleic acid composition, Genetic Code, Amino acid, Polypeptide, Levels of protein structure, Homolog, Ortholog and Paralog, Phylogenetics, Genome Sequencing, Human Genome Project, Next generation sequencing.

Text Books:

1. Champbell, N.A., Reece, J.B., Urry, Lisa, Cain, M,L., Wasserman, S.A., Minorsky, P.V., Jackson, R.B., "Biology: A global approach", Pearson Education Ltd, Edition 11, 2017.
2. Shier, David, Butler, Jackie, Lewis, Ricki., "Hole's Human Anatomy & Physiology"., McGraw Hill 2012.

Suggested Reading:

1. Bernard R. Glick, T. L. Delovitch, Cheryl L. Patten, "Medical Biotechnology", ASM Press, 2014.

20CS O08

BASICS OF MACHINE LEARNING

(Open Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to:

1. To learn Machine Learning algorithms.
2. To learn to work with data's, preparing datasets for real world problems
3. To study various machine learning algorithms.
4. To analyze data using machine learning techniques.
5. To become familiar with usage of time series and deep learning approaches.

Course Outcomes: Upon completion of this course, students will be able to:

1. Define the basic concepts related to Python and Machine Learning
2. Describe the feature engineering methods, regression techniques and classification methods
3. Apply Python packages for data visualization, text and time series data analysis using NLP toolkit
4. Evaluate and interpret the results of the various machine learning techniques
5. Solve real world problems using deep learning framework.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	-	-	-	1	1	2	1
CO2	3	2	1	1	1	-	-	-	-	-	-	1	2	1	-
CO3	2	2	2	1	1	-	-	-	-	-	-	1	2	1	1
CO4	2	2	2	1	1	-	-	-	-	-	-	1	1	1	2
CO5	2	2	3	1	1	-	-	-	-	-	-	1	2	2	2

UNIT - I

Introduction to Machine Learning: Introduction, types of learning, Machine Learning process.
Introduction to Python: Features, sources and installation of Python, IDEs, Basics of Python, Data Structures and loops.

UNIT - II

Feature Engineering: Introduction to Features and need of feature Engineering, Feature extraction and selection, Feature Engineering Methods, Feature Engineering with Python. Principal component analysis (PCA).
Data Visualization: Various charts, histograms, plots.

UNIT - III

Regression: Simple and multiple regressions, Model assessment, various types of errors, errors, ridge regression, Lasso regression, non-parameter regression.
Classification: Linear classification, logistic regression, Decision Trees, Random Forest, Naïve Bayes, Support Vector Machines (SVM).

UNIT - IV

Unsupervised Learning: Clustering, types of clustering, K-Means clustering, Hierarchical clustering.
Text Analysis: Basic text analysis with Python, regular expressions, NLP, text classification.
Time Series Analysis: Date and time handling, window functions, correlation, time series forecasting

UNIT - V

Neural Network and Deep Learning: Neural network- gradient descent, activation functions, parameter initialization, optimizer, loss function, deep learning, deep learning architecture, memory, deep learning framework.
Recommender System: Recommendation engines, collaborative filtering.

Text Books:

1. Abhishek Vijavargia "Machine Learning using Python", BPB Publications, 1st Edition, 2018.
2. Tom Mitchel "Machine Learning", Tata McGraw Hill, 2017.

Suggested Reading:

1. Marsland, S. "Machine Learning: An Algorithmic Perspective" 1st Edition, Chapman and Hall/CRC, 2009. https://doi.org/10.1201/9781420067194
2. Yuxi Liu, "Python Machine Learning by Example", 2nd Edition, PACT, 2017.

Online Resources:

1. https://www.guru99.com/machine-learning-tutorial.html
2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm
3. https://www.tutorialspoint.com/python/
4. https://docs.python.org/3/tutorial/
5. https://www.geeksforgeeks.org/machine-learning/

20ME O07

INTELLECTUAL PROPERTY RIGHTS

(Open Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: No prerequisite is required.

Course Objectives: This course aims to:

1. Fundamental aspects of IP.
2. Salient features of IPR acts.
3. The methods of registrations of Intellectual property.
4. Awareness for innovation and its importance of protection.
5. The changes in IPR culture and techno-business aspects of IPR.

Course Outcomes: Upon completion of this course, students will be able to:

1. Understand the evolution of IP, working of organization's at global level to protect and promote IP.
2. Familiarize with the patent filing process at national and international level.
3. Draw the logical conclusion of research, innovation and patent filing.
4. Compare different kinds of IP and their patenting system.
5. Understand the techno-legal-business angle of IP, infringement and enforcement mechanisms for protection.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	-	1	-	-	-	2	-	-	1
CO2	-	-	-	-	-	3	-	1	-	-	-	2	-	-	1
CO3	-	-	-	-	-	3	-	1	-	-	-	2	-	-	1
CO4	-	-	-	-	-	3	-	1	-	-	-	2	-	-	1
CO5	-	-	-	-	-	3	-	1	-	-	-	2	-	-	1

UNIT-I

Introduction: Definition of intellectual property, the need for intellectual property rights (IPR), kinds of intellectual property rights, IPR in India – genesis and development, IPR abroad, importance of WTO, TRIPS agreement, patent cooperation treaty, Berne and universal copyright conventions.

UNIT-II

Patents: Definition of patent, commercial significance , term of patent, patentable subject- matter, rights and obligations of patentee, searching of existing patents, drafting of patent, specification of patent, filing of a patent, the different layers of the patent system (national, regional and international options), compulsory licensing and licenses of rights, revocation of patents, differences between utility model and patent.

UNIT-III

Industrial designs: Definition of designs, registration of design, rights and duties of proprietor of design, piracy of registered design.

Trademarks: Meaning of trademarks, purpose of protecting trademarks, registration of trademarks, passingoff, assignment and licensing of trademarks, infringement of trademarks.

Geographical indications: Definition, differences between GI and trademarks.

UNIT-IV

Copy right: Nature and scope of copy right, term of copyright, subject matter of copyright, rights conferred by copyright, publication, broad casting, telecasting, computer program, database protection, assignment and transmission of copyright, infringement of copy right trade secrets and know-how agreement.

UNIT-V

Enforcement of intellectual property rights: Infringement of intellectual property rights, enforcement measures, emerging issues in intellectual property protection, case studies of patents and IP Protection.
Unfair competition: What is unfair competition, relationship between unfair competition and intellectualproperty laws.

Text Books:

1. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd., 2006.
2. B.L. Wadehra, Law relating to Patents, Trade Marks, Copyright, Designs &Geographical Indications, Universal law Publishing Pvt Ltd., India, 2000.
3. P.Narayanan, Law of Copyright and Industrial Designs; Eastern law House, New Delhi, 2010.

Suggested readings:

1. Cronish W.R, Intellectual Property Patents, Copyright, Trade Marks and Allied rights,Sweet & Maxwell,1993.
2. P. Narayanan, Intellectual Property Law, Eastern Law Edn., 1997.

20IT O01

OBJECT ORIENTED ROGRAMMING USING JAVA

(Open Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Programming for problem solving.

Course Objectives: This course aims to:

1. To familiarize with fundamentals of object-oriented programming paradigm.
2. To impart the knowledge of string handling, interfaces, packages and inner classes.
3. To acquaint with Exception handling mechanisms and Multithreading.
4. To gain knowledge on collection framework, stream classes.
5. To familiarize web application environment using Servlets and JSP

Course Outcomes: Upon completion of this course, students will be able to:

1. To understand fundamentals of object-oriented programming paradigm.
2. To apply knowledge of string handling, interfaces, packages and inner classes.
3. To implement Exception handling mechanisms and Multithreading.
4. To demonstrate knowledge on collection framework, stream classes.
5. To develop web applications using Servlets and JSP.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	-	-	-	-	-	-	1	-	-	-	1	-
CO2	-	2	1	1	-	-	-	-	-	-	-	-	-	1	-
CO3	-	1	1	1	-	-	-	-	-	-	3	-	-	1	-
CO4	1	2	1	1	-	-	-	-	-	-	3	1	-	-	-
CO5	1	2	1	2	3	-	-	1	3	-	3	1	-	1	-

UNIT-I

OOP concepts: Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

Introduction to Java: Java's Magic: The Byte code, The Java Buzzwords, Simple Java Programs, Java Primitive Types, Arrays: How to create and define arrays, Basic Operators, Control statements.

Introducing Classes: Declaring objects, methods, Constructors, this keyword, Method Overloading and Constructor Overloading, Objects as parameters, Returning objects, Use of static and final keywords.

UNIT-II

Inheritance: super and subclasses, Member access rules ,super keyword**,** Method overriding, Dynamic method dispatch , Abstract classes, using final with inheritance , Introduction to Object class.

Packages: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

Interfaces: Defining and implementing interfaces, Nested Interfaces. **Strings Handling:** String & StringBuffer classes, String Tokenizer class and Wrapper classes and conversion between Objects and primitives.

Inner classes in Java: Types of inner classes, Creating static / non-static inner classes, Local and anonymous inner classes.

UNIT-III

Exception Handling in Java: what are Exceptions? Exception types**,** Usage of try, catch, throw, throws and finally clauses,

writing your own exception classes. **Multi-threading in Java:** The java Thread Model, how to create threads, Thread class in java, Thread priorities, Thread synchronization.
Generics: What are Generics? Generic classes, bounded types, Generic methods and interfaces.

UNIT-IV
Collections Framework: Overview of Collection Framework, Commonly used Collection classes – Array List, Linked List, Hash Set, Linked Hash Set, Tree Set, Collection Interfaces –Collection, List, Set, Sorted Set, Accessing a collection via an Iteration, Storing user-defined classes in collections, Map Interfaces and
Classes, Using a comparator. Legacy classes – Vector, Hash table, The Enumeration interface.
Input/Output : How to read user input (from keyboard) using scanner class, Stream classes, Input Stream, Output Stream, File Input Stream, File Output Stream, Reader and Writer, File Reader, File Writer classes. File class.

UNIT-V
Java Servlets: Overview of Java Servlet API, Servlet Implementation, Servlet Configuration, Servlet Exceptions, Servlet Life cycle, Request and Response methods, Approaches to Session tracking, Servlet Context, Servlet Collaboration.
JSP Basics: Introduction to JSP, Directives, Scripting Elements, Standard Actions.
Databases: Connect servlet to MySQL, Connect JSP to MySQL.

Text Books:
1. Herbert Schildt, "Java: The Complete Reference", 8th Edition, Tata McGraw Hill Publications, 2011.
2. Kathy Sierra, Bryan Basham, Bert Bates, ―Head First Servlets and JSP‖, 2nd Edition, O'Reilly Media, Inc, 2008.

Suggested Reading:
1. E Balagurusamy "Programming with JAVA", 6th Edition , Tata McGraw-Hill Publishing company Ltd,2019.
2. Sachin Malhotra & Saurabh Choudhary, "Programming in Java", 2nd Edition, Oxford University Press, 2014.
3. C. Thomas Wu, "An introduction to Object-oriented programming with Java", 4th Edition, Tata McGraw-Hill Publishing company Ltd.,2010. 4. Kathy Sierra, Bert Bates, "Head First Java: A Brain-Friendly Guide"2nd Edition, O'Reilly,2005

Web Resources:
1. https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html.
2. http://nptel.ac.in/courses/106106147/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-092- introduction-to-programming-in-java-january-iap-2010/lecture-notes/

20MT O03

QUANTUM COMPUTING

(Open Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of Number theory and cryptography

Course Objectives: This course aims to:

1. To learn Quantum bits and compute mathematical foundation
2. To understand the evaluation of the quantum bits.
3. To learn Quantum operations by building blocks of Quantum programming
4. To know the basics of Quantum logic gates and circuits
5. To learn Quantum Algorithms by various Techniques.

Course Outcomes: Upon completion of this course, students will be able to:

1. Compute basic mathematical operations on Quantum bits.
2. Will be able to execute Quantum operations of Quantum computing
3. To built quantum programs
4. Develop quantum Logical gates and circuits.
5. Develop the quantum algorithm

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	0	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	2	0	-	-	-	-	-	-	-	-	-	-	-	2
CO3	2	2	0	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	2	2	-	-	-	-	-	2	-	-	-	-	2
CO5	2	2	2	2	-	-	-	-	-	2	2	-	-	-	2

UNIT-I

Math Foundation for Quantum Computing: Introduction of Vector Space, Subspaces, Basis and Finite Dimensions. Vectors and orthogonality, inner product and Outer product and Hilbert Spaces. Formation of Matrices by Linear Transformation. Linear Independent and dependent Vectors. Unitary operators and projectors, Eigen values and Eigen Vectors.

UNIT-II

Introduction to Quantum Computing: Quantum Mechanics (Huygens wave theory ,Photo electric effect De-Broglie hypothesis and Heisenberg's uncertainty Principle), Origin of Quantum Computing, Overview of major concepts in Quantum Commuting Qubits and multi-qubits states, Bra-ket notation, Quantum Superposition Motivation for Studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave

UNIT-III

Building Blocks for Quantum Program: Block sphere representations, Multi-qubits, Inner and outer product of Multiple of qubits, Tensor product, Quantum Entanglement, Quantum Teleporation (EPR Model) and Bell State.

UNIT-IV

Quantum Logical gates and Circuits: Pauli, Hadamard, Phase shift, controlled gates, AND, OR and NAND gate, C-Not, CCNOT gate Introduction of Fourier Transform and Discrete Fourier transform.

UNIT-V

Quantum Algorithms: Z-Transform. Basic techniques exploited by quantum algorithms (Amplitude amplification, Quantum Fourier Transform, Quantum Phase estimation, Quantum walks), Major Algorithms (Shore's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch-Jozsa Algorithm).

Text Books:

1. David McMahon, "Quantum Computing Explained", WILEY-INTERSCIENCE, 2008

Suggested Readings:

1. Michael A. Nielsen and Isaac L. Chaung, "Quantum Computation and Quantum Information", Cambridge University Press, 10/e, 2010

20CS O09

FUNDAMENTALS OF DBMS

(Open Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to:

1. To learn data models, conceptualize and depict a database system using E-R diagrams.
2. To understand the internal storage structures in a physical DB design.
3. To learn the fundamental concepts of transaction processing techniques.

Course Outcomes: Upon completion of this course, students will be able to:

1. Classify the difference between FMS and DBMS; describe the roles of different users and the structure of the DBMS. Design the database logically using ER modeling
2. Outline the schema of the relational database and key constraints. Develop queries using DDL, DML and DCL of SQL.
3. Identify the inference rules for functional dependencies and apply the principles of normal forms to decompose the relations in a database.
4. Summarize the concepts of dense, sparse, ISAM and B+ tree indexing and get familiar with states and properties of transactions.
5. Interpret the locking, time stamp, graph and validation-based protocols for concurrency control.
6. Summarize log-based recovery techniques to increase the robustness of the database, identify to resolve the deadlocks in the transactions.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	-	-	-	-	-	-	-	1	2	1
CO2	3	3	3	1	-	-	-		-	-	-	-	2	1	-
CO3	2	2	3	-	-	-	-	-	-	-	-	-	2	1	1
CO4	1	2	2	2	-	-	-	-	-	-	-	-	1	1	2
CO5	3	3	2	1	-	-	-	-	-	-	-	-	2	2	2

UNIT - I

Introduction: Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Users and Administrators Database System Architecture, Application Architectures.

Database Design and E-R Model: Basic concepts, Constraints, E-R Diagrams, E-R Design Issues, Extended E-R Features, Specialization and Generalization.

UNIT - II

Relational Model: Structure of Relational Databases, Database Schema, Keys.

Structured Query Language: Overviews, SQL Data Types, SQL Queries, Data Manipulation Language Set Operations, Aggregate Functions, Data Definition Language, Integrity Constraints, Null Values, Views, Join Expression. Index Definition in SQL.

UNIT - III

Relational Database Design: Undesirable Properties in Relational Database Design, Functional Dependencies, Trivial and Nontrivial Dependencies, Closure of Set of Functional Dependencies, Closure of Set of Attributes, Irreducible Set of Functional Dependencies, Normalization – 1NF, 2NF, and 3NF, Dependency Preservation, BCNF, Comparison of BCNF and 3NF.

UNIT - IV

Indexing: Basic concepts, Dense and Sparse Indices, Secondary Indices, Tree-Structured Indexing, Indexed Sequential Access Method (ISAM), B+ Tree Index Files.

Transaction Management: Transaction Concept – ACID Properties, States of Transaction, Implementation of Atomicity and Durability, Serializability, Recoverability.

UNIT - V

Concurrency Control: Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols.

Deadlocks Handling: Deadlock Prevention, Deadlock Detection and Recovery.

Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery.

Text Books:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "Database System Concepts", Sixth Edition, McGraw-Hill International Edition, 2011.
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", Eight Edition, Pearson Education, 2006.

Suggested Reading:

1. Raghu Ramakrishnan, JohnnesGehrke, "Database Management Systems", Third Edition, McGraw Hill, 2003.
2. Ramez Elmasri, Durvasul VLN Somayazulu, Shamkant B Navathe, Shyam K Gupta, "Fundamentals of Database Systems", Fourth Edition, Pearson Education, 2006.

20ECC24

ELECTRONIC DESIGN AND AUTOMATION LAB

Instruction	2 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Digital design fundamentals and synthesis & simulation concepts

Course Objectives: This course aims to:

1. Simulate and synthesize combinational and sequential logic circuits
2. Simulate switch level modules
3. Learn implementation procedure for any design on FPGA and to study the speed, power and area constraints of FPGA/CPLD

Course Outcomes: Upon completion of this course, students will be able to:

1. Demonstrate the process steps required for simulation /synthesis
2. Develop HDL codes/scripts with appropriate syntax
3. Apply an appropriate modelling style to describe various combinational and sequential circuits in Verilog HDL
4. Examine the successful execution of the codes/ schematic using various Simulation Tools
5. Build various digital circuits on hardware boards like FPGA.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	1	1	-	-	2	2	-	-	2	1	3	1
CO2	-	-	-	1	2	-	-	2	2	-	-	2	1	3	1
CO3	1	1	1	1	2	-	-	2	2	-	-	2	1	3	1
CO4	-	-	-	1	3	-	-	2	2	-	-	2	1	3	1
CO5	-	-	-	1	1	-	-	2	2	-	-	2	1	3	1

List of Experiments

Part A

Write VERILOG Code, Simulate and Implement the following on FPGA:

1. Code Converters.
2. Encoders, Decoders, Priority Encoder and Comparator.
3. Registers/Counters.
4. Sequence Detector using Mealy and Moore type state machines.
5. Any application of UDP.
6. Tasks and Functions.

Note:

1. All the codes should be implemented appropriately using Gate level, Dataflow and Behavioural Modelling.
2. All the programs should be simulated using test benches.

Part B

Switch Level Modelling of CMOS circuits: Basic Logic Gates: Inverter, NAND and NOR.

1. Half Adder and Half Subtractor.
2. 4x1 Multiplexer.
3. 2x4 Decoder.
4. Design of NAND Gate using Simulation tool.
5. Design of NOR Gate using Simulation tool.
6. Design and layout of Inverter using Simulation tool.

Structured Enquiry Program:

1. Design and simulate a high-speed adder using Verilog HDL

Open- ended Enquiry:

1. Simulate a design using System Vivado and implement the same on Zynq Evaluation Development Board.

Suggested Reading:

1. Michal D. Ciletti, "Advanced digital design with Verilog HDL", Pearson Edition, 2011.
2. Samir Palnitkar, "Verilog HDL-A Guide to Digital Design and Synthesis", Pearson 2nd edition, 2003.
3. Cadence Design Systems (Ireland) Ltd., "Cadence manual", 2013.

20ECC25

MICROCONTROLLERS LAB

Instruction	2 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Basic knowledge of programming in C language.

Course Objectives: This course aims to:

1. Develop and understand the 8051 and ARM7 C programming
2. Understand the usage of Integrated Development Environment (Keil)
3. Control the operation of various peripherals using 8051 and ARM7 microcontroller

Course Outcomes: Upon completion of this course, students will be able to:

1. Develop the programs of 8051 and ARM using their respective instruction set.
2. Understand the usage of various debugging tools available to program different microcontrollers
3. Build code for 8051 and ARM7 to interface various input/output modules
4. Analyze the hardware and software interaction and integration.
5. Design and develop the 8051 and ARM 7 based embedded systems for various applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	2	2	2	3	-	-	-	-	-	-	-	-	2	2	-
CO2	3	2	3	3	3	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	3	-	-	-	-	-	-	2	3	3	2
CO4	3	2	3	3	3	-	-	-	-	-	-	2	2	2	3
CO5	3	2	3	3	3	2	1	-	2	-	1	2	3	2	3

List of Experiments

II. 8051 Programming

1. Familiarity and use of 8051 microcontroller trainer kit, Keil IDE and simple programs under different addressing modes.
2. Assembly programming using instruction set
3. Timer and counter operations and programming using 8051.
4. Interfacing applications using LED, switch, relay and buzzer.
5. Generation of waveforms using DAC by interfacing it with 8051.
6. Stepper motor interfacing.
7. LCD interfacing.
8. Development of Embedded 'C' Code based on the module specifications. (under Structured enquiry)

III. ARM7 Programming

1. Study and use of LPC214x Microcontroller trainer kit and simple programs using its instruction set
2. Interfacing applications using LED, switch, relay and buzzer.

3. DC Motor interfacing.
4. Programming on-chip ADC.
5. Waveform generation using internal DAC.
6. Development of Embedded 'C' Code based on the module specifications. (under Structured enquiry)

IV. Design an experiment related to the Embedded Application of your choice using 8051/ARM based architectures. (under Open ended enquiry)

Suggested Reading:

1. Mazidi M.A, Mazidi JG & Rolin D. Mckinlay, "The 8051 Microcontroller & Embedded Systems using Assembly and C", 2/e, Pearson Education, 2007.
2. Philips semiconductors, "ARM 7 (LPC 214x) user manual", 2005.

20ECC26

MINI PROJECT

Instruction	2P Hours per Week
Duration of SEE	--
SEE	--
CIE	50 Marks
Credits	1

Prerequisite: Knowledge of Electronic circuits and Communication systems

Course Objectives: This course aims to:

1. To enable students learning by practical realization.
2. To develop capability to analyse and solve real world problems.
3. To develop technical writing and presentation skills.

Course Outcomes: Upon completion of this course, students will be able to:

1. Formulate mini project proposal through literature survey.
2. Plan, design and analyze the proposed mini project.
3. To simulate and execute the mini project for validation.
4. Enhance oral presentation skills.
5. Prepare and submit the mini project report.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	2	3	2	2	-	2	1	1	3	-	2	3	2	3	2
CO2	1	3	2	2	-	-	-	-	3	-	1	2	1	3	2
CO3	-	2	1	2	2	-	-	-	3	-	-	-	-	2	1
CO4	-	-	-	-	-	-	-	-	3	3	1	-	-	-	-
CO5	-	-	-	1	-	-	-	-	3	3	1	-	-	-	-

The students are required to choose emergent technology topic for mini project related to domain. The students have to design and simulate/ implement as per the given schedule. Students have to give oral presentation in presence of department review committee, finally report of the mini project work has to be submitted for evaluation.

Schedule

S. no	Description	Duration
1	Problem identification/selection	**2 weeks**
2	Preparation of abstract	**1 Week**
3	Design, implementation and testing of the project	**7 Weeks**
4	Documentation and mini project presentation	**4 Weeks**

Guidelines for the Evaluation

S. no	Description	Maximum Marks
1	Weekly Assessment	**20**
2	PPT preparation	**5**

3	Presentation	**10**
4	Queries and Answers	**5**
5	Documentation of mini project	**10**
	Total	**50**

Guidelines:

1. Each student will be allotted to a faculty supervisor for mentoring.
2. Mini projects maybe targeted to achieve practical competences.
3. Mini projects shall have inter-disciplinary/ industry relevance.
4. All the results obtained are to be clearly presented and documented with the reasons/explanations.

20EG C03

EMPLOYABILITY SKILLS

(BE/BTech V & VI semester - Common to all Branches)

Instruction	2 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: No specific prerequisite is required

Course Objectives: This course aims to:

1. Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

Course Outcomes: Upon completion of this course, students will be able to:

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to mange time effectively and deal with stress.
4. Mak**e** the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	2	2	2	-	-	-	1
CO2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO4	-	2	-	-	-	-	-	2	-	-	2	-	-	-	1
CO5	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1

UNIT I

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences-Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT II

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT

UNIT III

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management-
Corporate Culture – Grooming and etiquette-Statement of Purpose (SOP).

UNIT IV

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT V

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Text Books:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005
2. Dr. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006
3. Edgar Thorpe and Showick Thorpe , "Objective English", 2nd edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010

Suggested Reading:

1. Gulati and Sarvesh, " Corporate Soft Skills", New Delhi: Rupa and Co. , 2006
2. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004
3. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal, 2018
4. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989