GURU GHASIDAS VISHWAVIDYALAYA
(A CENTRAL UNIVERSITY, BILASPUR, C.G.)

SCHOOL OF STUDIES OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGG.

Scheme of Teaching and Evaluation 2024-25 (As Per NEP-2020)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the Academic Year 2024-25 for B. Tech. Third Year & 2025-26 for B. Tech. Forth Year)

Vision and Mission of the Institute

Vision		To be a leading technological institute that imparts transformative education to create globally competent technologists, entrepreneurs, researchers and leaders for a sustainable society
Mission	1	To create an ambience of teaching learning through transformative education for future leaders with professional skills, ethics, and conduct.
	2	To identify and develop sustainable research solutions for the local and global needs.
	3	To build a bridge between the academia, industry and society to promote entrepreneurial skills and spirit

Vision and Mission of the Department

Vision		The Department endeavours for academic excellence in Electronics & Communication Engineering by imparting in depth knowledge to the students, facilitating research activities and cater to the ever-changing industrial demands, global and societal needs with leadership qualities.
Mission	1	To be the epitome of academic rigour, flexible to accommodate every student and faculty for basic, current and future technologies in Electronics and Communication Engineering with professional ethics.
	2	To develop an advanced research centre for local & global needs.
	3	To mitigate the gap between academia, industry & societal needs through entrepreneurial and leadership promotion.

Program Educational Objectives (PEOs)

The graduate of the Electronics and Communication Engineering Program will

PEO1: Have fundamental and progressive knowledge along with research initiatives in the field of Electronics & Communication Engineering.

PEO2: Be capable to contrive solutions for electronic & communication systems for real world applications which are technically achievable and economically feasible leading to academia, industry, government and social benefits.

PEO3: Have performed effectively in a multi-disciplinary environment and have self-learning & self-perceptive skills for higher studies, professional career or entrepreneurial endeavors to be confronted with a number of difficulties.

PEO4: Attain team spirit, communication skills, ethical and professional attitude for lifelong learning.

Programme Outcomes: Graduates will be able to:

PO1: Fundamentals: Apply knowledge of mathematics, science and engineering.

PO2: Problem analysis: Identify, formulate and solve real time engineering problems using first principles.

PO3: Design: Design engineering systems complying with public health, safety, cultural, societal and environmental considerations

PO4: Investigation: Investigate complex problems by analysis and interpreting the data to synthesize valid solution.

PO5: Tools: Predict and model by using creative techniques, skills and IT tools necessary for modern engineering practice.

PO6: Society: Apply the knowledge to assess societal, health, safety, legal and cultural issues for practicing engineering profession.

PO7: Environment: Understand the importance of the environment for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics, and responsibilities and norms of the engineering practice.

PO9: Teamwork: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.

PO10: Communication: Communicate effectively by presentations and writing reports.

PO11: Management: Manage projects in multidisciplinary environments as member or a team leader.

PO12: Life-long learning: Engage in independent life long learning in the broadest context of technological change.

Programme Specific Outcomes:

PSO1: Identify, formulate and apply concepts acquired through Electronics & Communication Engineering courses to the real-world applications.

PSO2: Design and implement products using the cutting-edge software and hardware tools to attain skills for analyzing and developing subsystem/processes.

PSO3: Ability to adapt and comprehend the technology advancement in research and contemporary industry demands with demonstration of leadership qualities and betterment of organization, environment and society.

V-SEMESTER SCHEME OF TEACHING & EVALUATION 2024-25

SN	Course Type	Course Code	Course Title	Teaching Hours/week			Examination				Credits
				Theory L	Tutorial T	Practical P	Examination in Hrs	CIA Marks	SEA Marks	Total Marks	
1	Department Core	ECUETT1	LIC and its Application	3	-	-	03	40	60	100	3
2	Department Core	ECUETT2	Microprocessor &Microcontroller	3	-	-	03	40	60	100	3
3	Department Core	ECUETT3	Information Theory & Coding	3	-	-	03	40	60	100	3
4	Department Core	ECUETT4	Mobile Communication & Networks	3	-	-	03	40	60	100	3
5	Department Elective	ECUETK1	Power Electronics	3	-	-	03	40	60	100	3
		ECUETK2	Antenna for Wireless Communication								
		ECUETK3, ECUETK4, ECUETK5, ECUETK6	MOOC's Course-1,2,3,4								
6	Department Elective	ECUETK7	Digital Image Processing	3	-	-	03	40	60	100	3
		ECUETK8	Data Communication & Computer Networks								
		ECUETK9, ECUETK10, ECUETK11, ECUETK12	MOOC's Course-5,6,7,8								
7	Practical	ECUELT1	LIC and its Application Lab	-	-	2	03	25	25	50	1
8	Practical	ECUELT2	Microprocessor &Microcontroller Lab	-	-	2	03	25	25	50	1
9	Mini Project	ECUEPV1	Mini Project-2	-	-	4	03	50	50	100	2
Total				**18**	**-**	**08**	**27**	**340**	**460**	**800**	**22**

VI-SEMESTER SCHEME OF TEACHING & EVALUATION 2024-25

SN	Course Type	Course Code	Course Title	Teaching Hours/week			Examination				Credits
				Theory L	Tutorial T	Practical P	Examination in Hrs	CIA Marks	SEA Marks	Total Marks	
1	Department Core	ECUFTT1	CMOS VLSI Design	3	-	-	03	40	60	100	3
2	Department Core	ECUFTT2	Digital Signal Processing	3	-	-	03	40	60	100	3
	Department Core	ECUFTT3	Fiber Optic Communications	3	-	-	03	40	60	100	3
3	Department Elective	ECUFTK1	Cryptography and Network Security	3	-	-	03	40	60	100	3
		ECUFTK2	VLSI Fabrication Methodology								
		ECUFTK3	Estimation and Detection Theory								
		ECUFTK4, ECUFTK5, ECUFTK6,ECUFTK7	MOOC's Course-1,2,3,4								
4	Department Elective	ECUFTK8	Biomedical Instrumentation	3	-	-	03	40	60	100	3
		ECUFTK9	Microwave Theory & Techniques								
		ECUFTK10	Fundamental of Machine Learning								
		ECUFTK11, ECUFTK12, ECUFTK13,ECUFTK14	MOOC's Course-5,6,7,8								
5	Institute Core/OE	ECUFTO1, ECUFTO2, ECUFTO3,ECUFTO4	MOOC's Course-1,2,3,4	3	-	-	03	40	60	100	3
6	Practical	ECUFLT1	CMOS VLSI Design Lab	-	-	2	03	25	25	50	1
7	Practical	ECUFLT2	Digital Signal Processing Lab	-	-	2	03	25	25	50	1
8	Practical	ECUFLT3	Fiber Optic Communications Lab	-	-	2	03	25	25	50	1
9	Mini Project	ECUFPV1	Mini Project-3	-	-	4	03	50	50	100	2
Total				**18**	**-**	**10**	**30**	**365**	**485**	**850**	**23**

Credit Definition:

➢1-Hour lecture **(L)** per week per semester = **1Credit**

➢1-Hour tutorial **(T)** per week per semester = **1Credit**

➢2-Hour Practical/Drawing**(P)** per week per semester = **1 Credit**

➢**Four credit** courses are to be designed for **50** Hours of Teaching-Learning process.

➢**Three credit** courses are to be designed for **40** Hours of Teaching-Learning process.

➢**Two credit** courses are to be designed for **30** Hours of Teaching-Learning process.

➢**One credit** courses are to be designed for **15** Hours of Teaching-Learning process

Note: The above is applicable only to THEORY courses

VII-SEMESTER SCHEME OF TEACHING & EVALUATION 2025-26
(Effective from the Academic Year 2025-26)

SN	Course Type	Course Code	Course Title	Teaching Hours/week			Examination				Credits
				Theory lectures	Tutorial	Theory lectures	Examination in Hrs	CIA Marks	SEA Marks	Total Marks	
				L	T	P					
1	Department Core	ECUGTT1	Radar & Satellite Communication	3	-	-	03	40	60	100	3
2	Department Core	ECUGTT2	Adaptive Signal Processing	3	-	-	03	40	60	100	3
3	Department Core	ECUGTT3	Internet of Things	3	-	-	03	40	60	100	3
4	Department Elective	ECUGTK1	Millimeter Wave Technology	3	-	-	03	40	60	100	3
		ECUGTK2	MIMO wireless communication								
		ECUGTK3,ECUGTK4, ECUGTK5,ECUGTK6	MOOC's Course-1,2,3,4								
5	Department Elective	ECUGTK7	Applied Linear Algebra	3	-	-	03	40	60	100	3
		ECUGTK8	Wireless Sensor Networks								
		ECUGTK9,ECUGTK10, ECUGTK11,ECUGTK12	MOOC's Course-5,6,7,8								
6	Institute Core/OE	ECUGTO1,ECUGTO2, ECUGTO3, ECUGTO4	MOOC's Course-1,2,3,4	3	-	-	03	40	60	100	3
7	Seminar on Industrial training	ECUGST1	Seminar on Industrial training	-	-	-	-	50	-	50	0
8	Practical/ Project	ECUGPV1	Minor Project	-	-	8	03	50	50	100	4
Total				**18**	**-**	**08**	**21**	**340**	**410**	**750**	**22**

VIII-SEMESTER SCHEME OF TEACHING & EVALUATION 2025-26

SN	Course Type	Course Code	Course Title	Teaching Hours/week			Examination				Credits
				Theory lectures	Tutorial	Theory lectures	Examination in Hrs	CIA Marks	SEA Marks	Total Marks	
				L	T	P					
1	Practical/ Major Project	ECUHPV1	Major Project	-	-	16	03	200	200	400	8
Total				**-**	**-**	**16**	**03**	**200**	**200**	**400**	**8**

Credit Definition:
- ➢1-Hour lecture **(L)** per week per semester = **1Credit**
- ➢1-Hour tutorial **(T)** per week per semester = **1Credit**
- ➢2-Hour Practical/Drawing**(P)** per week per semester = **1 Credit**

- ➢**Four credit** courses are to be designed for **50** Hours of Teaching-Learning process.
- ➢**Three credit** courses are to be designed for **40** Hours of Teaching-Learning process.
- ➢**Two credit** courses are to be designed for **30** Hours of Teaching-Learning process.
- ➢**One credit** courses are to be designed for **15** Hours of Teaching-Learning process

Note: The above is applicable only to THEORY courses

SYLLABUS OF SEMESTER-V

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETT1	3	-	-	3 hours	40	60	100	3

LIC & ITS APPLICATIONS

Course Objectives:

- To develop basic concept of differential amplifiers & OPAMP IC 741.
- To analyze and perform different applications and frequency response of OPAMP.
- To develop the concept and analysis of active filters, phase lock loop, multiplier, timer, regulator.
- To help students develop various designs of OPAMP and its applications.
- To analyze and perform the theoretical concepts through laboratory and simulation experiments.

UNIT-I

Basic Building Blocks for ICs & OPAMP: Basic differential amplifiers & analysis, Introduction to OPAMP**,** Ideal OPAMP characteristics, OPAMP ICs: 741Pin diagram and function, Inverting amplifier, Non-inverting amplifier, Definition of OPAMP parameters, Frequency response of OPAMP, Open loop & closed loop configuration of OPAMP and its comparisons, Voltage comparator, Zero crossing detector, Level detector.

UNIT-II

Applications of OPAMP: Introduction, Adder, Substractor/Difference amplifier, Voltage follower, Integrator, Differentiator, Comparator IC such as LM339, Window detector, Current to voltage and voltage to current converter, Instrumentation amplifier, Precision half wave rectifier, Precision full wave rectifier, Log & antilog amplifier, Schmitt trigger, Bridge amplifier, Peak detectors/Peak follower, Sample and hold amplifiers, Square wave generator, Saw-tooth wave generator, Triangular wave generator, Astable multivibrator, Monostable multivibrator, Dead zone circuit with positive output, with negative output, Precision clipper circuit, Generalized Impedance Converter (GIC) and its application.

Frequency Response of OPAMP: Open loop voltage gain as a function of frequency, Unity gain bandwidth, Close loop frequency response, Slew rate.

UNIT-III

Active Filters & PLL - Introduction to filters, Merits & demerits of active filters of over passive filter, Classification of filters, Response characteristics of filter, First order and second order active high pass, Low pass, Band pass and Band reject butterworth filters.

Phase Lock Loop: Operating principle of the PLL, Linear model of phase lock loop, Lock range and capture range, Application of the PLL, Voltage controlled oscillator (VCO).

UNIT-IV

D/A and A/D Converters & Analog Multiplier: D/A converter ladder, R-2R, A/D converters, Ramp, Continuous conversion, Flash ADC, Dual slope ADC, Successive approximation, Voltage to time converters, Timing and circuits comparisons, DAC/ADC specifications.

Analog Multiplier: Basic analog multiplication techniques, Applications of multiplier- frequency doubling, Phase-angle difference detection, Voltage dividing action, Square root of a signal, Function realization by multiplier, Amplitude modulator, Standard modulator circuit, Demodulation of AM signal.

UNIT-V

Timer & Regulators: Monolithic 555 timer, Functional diagram, Monostable and astable operation using 555 Timer, Voltage regulators: Basic configurations parameters for voltage regulators, Basic blocks of linear IC voltage regulators, Positive and negative voltage regulators, Positive and negative voltage regulators, General purpose IC regulator (723): Important features and internal structure, Switching regulators.

Text/Reference Books:

1. R. A. Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th ed. PHI, 2015
2. R. F. Coughlin and F. F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", 6th ed., PHI/Pearson, 2001.
3. M. H. Rashid, "Microelectronic Circuits Analysis and Design", Cengage Learning, 2nd ed., 2012.
4. S. Franco "Design with Operational Amplifiers and Analog Integrated Circuits", 4th ed., Tata McGraw Hill, 2016.
5. Fiore, "Opamps & Linear Integrated Circuits Concepts & applications", Cengage, 2010.

Course Outcomes:

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

CO1 Understand and analyze DC and AC characteristics of OP-Amp and is effect on output.
CO2 Illustrate and design the linear and nonlinear application of OP-Amp and its effect on output.
CO3 Design active filters and explains the working of PLL.
CO4 Comprehend the working principle of data converters and multipliers.
CO5 Demonstrate the function of timer and regulators and their applications.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETT2	3		-	3 Hours	40	60	100	3

MICROPROCESSOR & MICROCONTROLLER

Course Objectives:

- To develop basic concept of microprocessor and learn assembly language programming.
- To interfacing of interfacing chips with 8085 microprocessor.
- To understand the basic concepts of microcontroller and its interfacing.

UNIT-I

History and evolution of microprocessor and microcontroller, Microprocessor based system, Architecture and pin diagram of 8085 microprocessor, Register organization, Multiplexing concept of buses, Instruction set and assembly language instructions, Instruction data format and storage, How to write, assemble and execute a simple program, Addressing modes, Counters and time delays, Stack and subroutines.

UNIT-II

Addressing modes, Memory interfacing, I/O interfacing, Address decoding, Interrupts,

Instruction execution cycle, 8255 PPI, Various modes of operation, 8254 timer/counter, Serial communication standards.

UNIT-III

DMA controller and its operation, Interrupt controller, Architecture, pin diagram and features of ATMega328 microcontroller, I/O, Debouncing, Analog to digital convertor basics and interfacing temperature, LDR etc., Interrupts basics and programming, Timers.

UNIT-IV

PWM, DC motor, Servo motor, Stepper motor interfacing with ATMega328.

UNIT-V

Communication protocols UART, I2C, SPI and its programming.

Text/Reference Books:

1. A. K. Ray and K. M. Bhurchandani, "Advanced Microprocessors and Peripherals", TMH, 2006.
2. R. S. Gaonkar, "Microprocessor Architecture, Programming and Application with the 8085", Prentice Hall, 1984.
3. Mazidi and Mazidi, "AVR Microcontroller",
4. AVR ATMega 328 microcontroller data sheet by ATMEL

Course Outcomes:

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

CO1 Be able to write an assembly language program and project based on it.
CO2 Able to interface various peripheral chips.
CO3 Apply the knowledge of interfacing devices and its modes of operations.
CO4 Able to interface a microcontroller with the sensors and actuators and write its program.
CO5 Understand the serial communication protocols and able to write the program for it.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETT3	3	-	-	3 Hours	30	70	100	3

INFORMATION THEORY & CODING

Course Objectives:

- To develop basic concept of information and entropy
- To introduce Shannon's capacity theorem for coding
- To develop the concept and analysis channel capacity
- To introduce the concept of various channel coding techniques for error correction and detection

UNIT-I

Source Coding: Introduction to information theory, Uncertainty and information, Average mutual information and entropy, Information measures for continuous random variables, Source coding theorem, Huffman coding.

UNIT-II

Channel Capacity Coding: Channel models, Channel capacity, Channel coding, Information capacity theorem, Shannon limit, Markov sources.

UNIT-III

Error Control Coding (Channel Coding) Linear Block Codes for Error Correction & Cyclic Codes: Introduction to error correcting codes, Basic definitions, Matrix description of linear block codes, Equivalent codes, Parity check matrix, Decoding of a linear block code, Syndrome decoding, Hamming codes, Cyclic codes: Polynomials, The division algorithm for polynomials, A method for generating cyclic codes, Matrix description of cyclic codes, Burst error correction.

UNIT-IV

Convolution Codes: Introduction to convolution codes, Tree codes and trellis codes, Polynomial description of convolution codes (analytical representation), Distance notions for convolution codes, The generating function, Matrix description of convolution codes, Viterbi decoding, Distance bounds for convolution codes.

UNIT-V

Turbo Codes: Turbo codes, Turbo decoding, Distance properties of turbo codes, Convergence of turbo codes.

Text/Reference Books:

1. R. Bose, "Information Theory, Coding and Cryptography", Tata McGraw-Hill Education, 2008.
2. S. Haykin, "Digital Communications", Wiley India Edition, 2009.
3. N. Abramson, "Information and Coding", McGraw Hill, 1963.
4. M. Mansurpur, "Introduction to Information Theory", McGraw Hill, 1987.
5. R. B. Ash, "Information Theory", Prentice Hall, 1970.
6. S. Lin and D. J. Costello Jr., "Error Control Coding", Prentice Hall, 1983.

Course Outcomes:

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

CO1 Analyze the self and mutual information and apply the concept of Information theory.
CO2 Evaluate the information capacity of discrete memory-less channels and determine possible code rates achievable on such channels.
CO3 Apply linear block codes, cyclic codes for error detection and correction.
CO4 Apply convolution codes for error detection and correction.
CO5 Apply Turbo coding and decoding for error detection and correction.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETT4	3	-	-	3 Hours	40	60	100	3

MOBILE COMMUNICATION & NETWORKS

Course Objectives:

- To know the evolution of mobile communication and cell concept.
- To know the fading mechanism and types of fading and effect of fading on mobile communication.
- To know the role of equalization and diversity techniques in mobile communication.
- To know the various types of multiple access techniques.
- To know the higher generation cellular standards.

UNIT-I

Introduction to Mobile Communication: Evolution of mobile communications, Mobile radio around the world, Types of wireless communication system, Second generation cellular networks, GSM, The cellular concept-system design fundamentals: cellular system, hexagonal geometry cell and frequency reuse concept, Channel assignment strategies, Distance to frequency reuse ratio, Channel & co-channel interference reduction factor, S/I ratio consideration and calculation for minimum co-channel and adjacent interference, Handoff strategies, Umbrella cell concept, Improving coverage & capacity in cellular system: splitting, cell sectorization, Repeaters, Micro cell zone concept.

UNIT-II

Mobile Radio Propagation: Free space propagation model, The three basic propagation mechanism: reflection, diffraction, scattering, Practical link budget design, Outdoor propagation models, Indoor propagation models, Small scale multipath propagation, Impulse response model of a multipath channel, Small scale multipath measurements, Parameters of mobile multipath channels, Types of small scale fading, Time delay spread: flat & frequency selective, Doppler spread: fast & slow fading Rayleigh and Rician distributions.

UNIT-III

Receiver Structure: Diversity receivers-selection and MRC receivers, RAKE receiver, Modulation techniques: Minimum shift keying, Gauss ion MSK, M-ary QAM, M-ary FSK, Orthogonal frequency division multiplexing, Performance of digital modulation in slow-flat fading channels and frequency selective mobile channels, Equalization: survey of equalization techniques, linear equalization, non-linear equalization, Algorithms for adaptive equalization, Diversity techniques, RAKE receiver, Performance measures- probability of outage, average SNR, average symbol/bit error rate.

UNIT-IV

Multiple Access Techniques for Wireless Communication: Introduction, FDMA, TDMA, CDMA:DS-SS, FH-SS, Space division multiple access, Capacity of a cellular systems, Contention-based multiple access schemes (ALOHA and CSMA).

UNIT-V

Higher Generation Cellular Standards: Evolution of wireless LANs, Wireless LAN topologies, IEEE 802.11 standards, Wireless LAN applications, Trunking and grade of service (GOS). Enhancements in 3G standards, Architecture and representative protocols in 4G standard, Introduction to 5G and 6G.

Text/Reference Books:

1. T. S. Rappaport, "Wireless Communication-Principles & Practice," 2nd ed., Pearson Education India, 2010.
2. V. Garg, "Wireless Communications and Networking," Morgan Kaufmann Publishers, 2008.

3. K. Feher, "Wireless Digital Communication: Modulation and Spread Spectrum Applications," PHI, 1995.
4. W. C. Y. Lee, "Mobile Communications Engineering," Mc Graw Hill Publications, 1982.
5. J. Goldsmith, "Wireless Communications," Cambridge Univ. Press, 2005.
6. D. Tse and P. Vishwanath, "Fundamentals of Wireless Communications," Cambridge Univ. Press, 2005.
7. R. Pandya, "Mobile & Personal Communication System," Wiley–Blackwell, 1999.

Course Outcomes:

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

CO1 Explain basic concepts of the cellular concept and assess practical handoff considerations, interference and system capacity.
CO2 Compare mobile radio propagation with large-scale path loss and demonstrate types of small-scale fading.
CO3 Analyze the fundamentals of equalization and diversity in a communication receiver.
CO4 Demonstrate an ability to explain multiple access techniques for wireless communication.
CO5 Explain the architecture, functioning, protocols, capabilities and application of various wireless communication networks.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETK1	3	-	-	3 Hours	40	60	100	3

POWER ELECTRONICS

Course Objectives:

• To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
• To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
• To provide strong foundation for further study of power electronic circuits and systems.

UNIT-I

Introduction: Concept of power electronics, application of power electronics, uncontrolled converters, advantages and disadvantages of power electronics converters, power electronics switches. **Thyristors:** Thyristors, V-I characteristics, and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.

UNIT-II

Phase controlled converter: Principle of operation of single phase and three phase half wave

half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters.

UNIT-III

DC- DC converter: Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers and switching mode regulators.

UNIT-IV

Inverter: Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverters with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. Brief idea of Resonant Pulse inverters.

UNIT-V

AC voltage controllers: Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads.

Principle of operation of cycloconverters, circulating and non-circulating mode of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconverter.

Text/Reference Books:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2009.
3. Power Electronics by P.S. Bhibmra, Khanna Publishers.
4. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications, 2002.
5. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009
6. P.C Sen, 'Thyristor DC Drives', John wiely and sons, New York, 1981.

Course Outcomes:

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

CO1 Relate basic semiconductor physics and mathematics to Describe basic operation of power semiconductor device and compare performance of various power semiconductor devices, passive components and switching circuits.

CO2 Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields.

CO3 Formulate and analyze a DC-to-DC converter at the system level and assess the performance.

CO4 Design and analyze inverter circuits and derive for typical solutions to reduce harmonics to improve its efficiency.

CO5 Understand the working voltage controllers and cycloconverters and recognize the role of power electronics in domestic and industrial applications.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETK2	3	-	-	3 Hours	40	60	100	3

ANTENNAS FOR WIRELESS COMMUNICATION

Course Objectives:

- To learn the fundamental parameters of the antenna.
- To learn about the working principle of modern antennas like micorstrip patch antenna.
- To analyze the principle of aperture antennas
- To learn about the design of antenna for modern communication system
- To learn about the simulation and fabrication of the antenna

UNIT-I

Fundamental Concepts: Physical concept of radiation, Radiation pattern, Near-and far-field regions, Effective aperture, Polarization, Input impedance, Efficiency, Friis transmission equation.

UNIT-II

Micro Strip Antennas: Basic characteristics of micro strip antennas, Feeding methods, Methods of analysis, Design of rectangular and circular patch antennas, Techniques to improve the bandwidth and gain of microstrip antenna.

UNIT-III

Antenna for Space Applications: Parabolic reflector and cassegrain antennas, Horn antenna, Broadband antennas-Log-periodic and Yagi-Uda antennas, Frequency independent antennas, Broadcast antennas.

UNIT-IV

Antenna for Communication Applications: Narrow band, Multiband and broadband antenna, Antenna for 4G and 5G communication, Planar arrays**,** Smart antennas-concept and benefits of smart antennas.

UNIT-V

Simulation and Measurement: Design of antenna in simulation software, Measurement of antenna parameters, Introduction of fabrication methods.

Text/Reference Books:

1. J. D. Kraus, "Antennas", McGraw Hill, 1988.
2. C. A. Balanis, "Antenna Theory-Analysis and Design", John Wiley, 1982.
3. R. E. Collin, "Antennas and Radio Wave Propagation", McGraw Hill, 1985.
4. I. J. Bahl and P. Bhartia, "Micro Strip Antennas", Artech House, 1980.
5. R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill, 2005.

Course Outcome:

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

CO1 To conduct investigation of the antenna with an understanding of the fundamental parameters of antennas.

CO2 To design and analyze microstrip patch antenna.

CO3 To evaluate broadband and high gain antennas for various applications.

CO4 To analyze the fundamentals of different types of modern antennas.

CO5 To simulate and fabricate the antenna.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1		1								3		
CO2	3	3	2	2	3		2					1	3	2	2

CO3	**3**	**3**	**2**	**2**			**2**						**3**	**2**	**2**
CO4	**3**	**3**	**2**	**2**		**2**	**2**					**2**	**3**		
CO5	**3**	**3**	**2**	**2**	**3**							**1**	**3**	**2**	**2**

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETK7	3	-	-	3 Hours	40	60	100	3

DIGITAL IMAGE PROCESSING

Course Objectives:

1. To introduce students to the Basic concepts and analytical methods of analysis of digital images.
2. To Study fundamental concepts of Digital Image Processing and basic relations among pixels.
3. To Study different Spatial and Frequency domain concepts.
4. To understand Restoration process of degraded image and Multi resolution processing.
5. To understand image compression and Segmentation Techniques.

Pre-Requisites: signals and systems

UNIT-I

Introduction: Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System.

Digital Image Fundamentals: Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some basic Relationships between Pixels.

UNIT-II

Image Enhancement in the Spatial Domain: Some Basic Gray Level Transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing spatial Filters, Sharpening spatial Filters.

Image Enhancement in the Frequency Domain: Introduction to the Fourier Transform and the Frequency Domain, Smoothing frequency-domain Filters, Sharpening Frequency-domain Filters, Homomorphic Filtering, Implementation.

UNIT-III

Image Restoration: A Model of the Image Degradation/Restoration Process, Linear, Position- Invariant Degradations, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. Wavelets and Multi resolution Processing: Multi resolution Expansions, Wavelet Transforms in one Dimension, The Fast Wavelet Transform, Wavelet Transforms in Two Dimensions.

UNIT-IV

Image Compression: Image Compression Models, Error-free Compression, Lossy Compression, Image Compression Standards.

Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.

UNIT-V

Image Compression: Compression Techniques: Study of redundancies in images and methods for their removal, including Huffman and arithmetic coding. Discussion on error-free and lossy compression methods, predictive coding, and transform-based compression techniques like JPEG and JPEG 2000 standards.

Text/References Books

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing. Prentice Hall India/Pearson Education.
2. A.K.Jain, Fundamentals of Digital Image Processing. Prentice Hall India.
3. Madhuri.A.Joshi, Digital Image Processing, PHI.
4. Sonka, Image Processing, Analysis and Machine Vision. Cengage Publications.
5. Fundamentals of Digital Image Processing, Anna durai,Shanmuga lakshmi.

Course Outcomes:

At the end of this course student will:
CO1 Understand different components of image processing system.
CO2 Describe various image transforms, enhancement techniques using various processing methods.
CO3 Illustrate the compression and segmentation techniques on a given image.
CO4 Demonstrate the filtering and restoration of images(pixels) with examples,
CO5 Illustrate the various schemes for image representation and edge detection techniques with examples.

Course Outcomes and their mapping with Programme Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUETK8	3		-	3 hours	40	60	100	3

DATA COMMUNICATION & COMPUTER NETWORKS

Course Objectives:

- To understand the basic concepts of data communication, layered model, protocols and interworking between computer networks.
- To learn the error detection and correction techniques and data flow control.
- To learn the switching and multiplexing.
- To understand and apply the TCP/IP protocol suite.
- To understand the Ethernet and Wi-Fi protocol and different networking devices.

UNIT-I

Introduction of a Data Communication and Internet: OSI reference model, TCP/IP model, Analog and digital transmission, Parallel and serial transmission, Asynchronous and synchronous transmission, Application layer: Principles of network applications, The Web and hyper text transfer protocol, File transfer protocol, Electronic mail, Domain name system, Peer-to-peer file sharing, Layering concepts.

UNIT-II

Error Control: Review of different types of line encoding, Unipolar, Polar, Bipolar, AMI, and Manchester codes, Error detection: Parity check, vertical redundancy check (VRC), longitudinal redundancy check (LRC), cyclic redundancy check (CRC), Check sum, Error correction:

Hamming code.
Data link control: Flow control and error control, Automatic repeat request (ARQ): stop-and-wait, Go-back-n, Sliding-window, Selective-reject, Framing, HDLC.

UNIT-III

Switching: Classification and requirements of switches, Circuit Switching, Time-division switching, Space-division switching, Crossbar switch and evaluation of blocking probability, 2-stage, 3-stage and n-stage networks, Packet switching (virtual circuit and datagram approach), Message switching, Blocking in packet switches.
Multiplexing: TDM, FDM, and WDM, Synchronous digital hierarchy (SDH)/SONET, Frame relay, Asynchronous transfer mode (ATM).

UNIT-IV

TCP/IP Protocol Suite: Transport layer: Connectionless transport-user datagram protocol, Connection oriented transport–transmission control protocol, Congestion control and resource allocation: Issues in resource allocation, Queuing disciplines, TCP congestion control, Congestion avoidance mechanisms and quality of service.
Network layer: Virtual circuit and datagram networks, Internet protocol, IPv4 header format, Logical addressing, IPv4 addressing, Routers, Routing algorithms, Distance vector routing, Link state routing, Broadcast and multicast, ARP and ARP.

UNIT-V

Physical Layer, Medium Access and Logical Link Sub Layer: Random access, Controlled access, Multiple access protocols, ALOHA, CSMA/CD, CSMA/CA, Local area networks (LAN), IEEE 802 standards, Ethernet, IEEE 802.3, IEEE 802.5, IEEE 802.11 (Wi-Fi), Token bus, Token ring, Networking devices hubs, Switches and routers.

Text/Reference Books:

1. W. Stallings, "Data and computer communications", 9th ed., Pearson Education, India, 2013.
2. B. A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 4th ed., 2017.
3. J.F. Kurose and K. W. Ross, "Computer Networking – A top down approach featuring the Internet", Pearson Education, 6th ed., Pearson Education, 2017.
4. L. Peterson and B. Davie, "Computer Networks–A Systems Approach" 5th ed., Morgan Kaufmann, 2011.
5. T. Viswanathan, "Telecommunication Switching System and Networks", Prentice Hall Ltd., 1994.

A. Tanenbaum, "Computer networks", 6th ed., Prentice Hall, 2022.

6. D. Comer, "Computer Networks and Internet/TCP-IP", 8th ed., Prentice Hall, 2007.

Course Outcomes:

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

CO1 Understand the basics of data communication and networking, the layered architecture of open system interconnection (OSI) and its application layer.
CO2 Apply the error detection and correction techniques and analyse the flow control and error control mechanisms using standard data link layer protocols.
CO3 Discuss and use the different switching and multiplexing techniques.
CO4 Analyse TCP/IP and their protocols. Design subnets and calculate the IP addresses to fulfil network requirements of an organization.
CO5 Analyze the features and operations physical layer, MAC and LLC sublayer. Recognize the different internet devices and their functions.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

CO4	**3**	**3**	**2**	**3**	**3**	**3**			**3**	**1**		**2**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**3**	**3**	**3**			**3**	**1**		**2**	**3**	**3**	**3**

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUELT1	-	-	2	2 hours	25	25	50	1

LIC & ITS APPLICATIONS LAB

Course Objectives:

1. To develop basic operations of IC 741.
2. To design and implement different linear and nonlinear applications of OPAMP.
3. To design different filter, oscillator, and waveform generator circuits using OPAMP ICs.
4. To design different multivibrator, modulator circuits using IC 555.

LABORATORY KITS/ LTSPICE or EQUIVALENT SOFTWARE

1. To use IC 741 as Inverting and Non-inverting Amplifier and to study the effect of frequency on the performance (frequency response) of OPAMP IC 741.
2. To use IC 741 as Adder and Subtractor circuit.
3. To use IC 741 as an Integrator and Differentiator and to study corresponding effect of frequency on the performance (frequency response).
4. To study IC 741 performance as LOG and ANTI-LOG Amplifier.
5. To design and study the performance of Timer IC 555 as Multivibrator: i) Astable, ii) Bistable and iii) Monostable modes of operation.
6. To design and study IC 741 and IC 555 performance as Schmitt Trigger Circuit.
7. To design and study IC 741 performance as Low-Pass Filter of 1^{ST} and 2^{ND} order.
8. To design and study IC 741 performance as High-Pass Filter of 1^{ST} and 2^{ND} order.
9. To design and study IC 741 performance as Wide and Narrow Band-Pass Filter of 1^{ST} and 2^{ND} order.
10. To design and study IC 741 performance as Phase-Shift Oscillator.
11. To design and study IC 741 performance as Wein-Bridge Oscillator.
12. To design and study IC 741 performance as Half-wave Rectifier.
13. To design and study IC 741 performance as Full-wave Rectifier.
14. To design and study Timer IC 555 performance as PWM Modulator.

Course Outcomes:

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

CO1 Design and develop different linear and nonlinear applications of OPAMP.
CO2 Implement different multivibrator circuits.
CO3 Demonstrate and design filter using OPAMP ICs.
CO4 Demonstrate and design oscillator and waveform generator circuits using OPAMP ICs.
CO5 Implement different multivibrator circuits.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**1**	**1**	**1**	**1**			**2**			**3**	**2**		**1**

CO2	3	2	1	1	1	1			2			3	2		1
CO3	3	2	1	1	1	1			2			3	2		1
CO4	3	2	1	1	1	1			2			3	2		1
CO5	3	2	1	1	1	1			2			3	2		1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUELT2	-	-	2	2 hours	25	25	50	1

MICROPRESSOR & MICROCONTROLLER LAB

Course Objectives:

- To understand assemble language programming.
- To be able to write assembly language program to perform an experiment.
- To be able to write C code to implement an experiment using ATMega328.
- To be able to design microcontroller based projects.

LIST OF EXPERIMENTS:

1. Program to move a data block without overlap.
2. Program to execute ascending/descending order.
3. Program to add N one byte numbers.
4. Write ALP to load the Hexadecimal numbers 9BH and A7H I register D and E respectively, add the numbers. If sum is greater than FFH, display 01 at memory location 2050H otherwise display the sum
5. Program to add BCD numbers
6. program to subtract two 8 bit numbers
7. Program to implement multiplication by successive addition method
8. Program to implement HEX up counter
9. Program to implement HEX down counter
10. Program to implement square wave generation using DAC
11. Program to implement triangular wave generation using DAC
12. Program to display using seven segment display scrolling.
13. Program to display ASCII equivalent of the key pressed
14. Program to control the speed and direction of stepper motor.
15. Write a program to add a data byte located at offset 0500H in 2000H segment to another data byte available at 0600H in the same segment and store the result at 0700H in the segment.
16. Add the contents of the memory location 2000H: 0500H to contents of 3000H:0600H and store the result in 5000H:0700H.
17. Program to multiply 25 by 10 using the technique of repeated addition
18. Write a program to load the accumulator with the values 55H and complement the accumulator 700 times.
19. Write a program to add the first ten natural numbers.
20. To add two numbers such as 25H and 34H, and the result is saved in other register.
21. LED and switch interfacing with ATMega 328.
22. Analog sensor interfacing with ATMega328.
23. DC motor, servo motor interfacing with ATMega 328.
24. Relay, LCD interfacing with ATMega328.

25. UART, I2C communication between two ATMega328.

Course Outcomes:

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

CO1 Understand assembly language program.
CO2 Analyze and implement microprocessor-based system.
CO3 Understand microcontroller C code.
CO4 analyze and implement microcontroller program to perform an experiment.
CO5 Design microcontroller-based projects.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

SYLLABUS OF SEMESTER-VI

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTT1	3	-	-	3 hours	40	60	100	3

CMOS DIGITAL VLSI DESIGN

Course Objectives:

- To utilize modeling of various semiconductor devices in the design of digital VLSI circuits.
- To understand MOS inverter static characteristics.
- To grasp the concepts of static and dynamic CMOS logic circuits
- To enhance the theoretical, mathematical, and physical analysis of digital VLSI circuits, ensuring a thorough understanding of their concepts, operation, analysis, and design.
- To impart knowledge of verilog HDL language

UNIT-I

MOS Transistor: MOS structure, MOS system under external bias, Structure and operation of MOS transistor, MOSFET current-voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances.

UNIT-II

MOS Inverter Static Characteristics: Introduction, Resistive-load Inverter, Inverter with n-type MOSFET load, CMOS Inverter, Delay-time Definitions, Calculation of delay times.

UNIT-III

Combinational Circuits: Introduction, MOS logic circuits with depletion nMOS loads, CMOS logic circuits, Complex logic circuits, CMOS transmission gates (Pass gates), Complementary pass transistor logic.

UNIT-IV

Sequential & Dynamic Logic Circuits: Behavior of bistable elements, SR latch circuit, Clocked latch and flip-flop circuits, CMOS D-latch, Basic principles of pass transistor circuits, Dynamic CMOS transmission gate logic, Dynamic CMOS logic, High performance dynamic CMOS circuits.

UNIT-V

Verilog HDL: Introduction and popularity of verilog HDL, Lexical conventions, Data types, Modules & ports, Structural, dataflow and behavioral modeling of combinational and sequential logic circuits.

Text/Reference Books:

1. S. M Kang & Y. Leblebici, "CMOS Digital Integrated Circuits: Analysis & Design", 2nd ed., TMH, 2003.
2. N. H. E. Weste, D. Harris, and A. Banerjee "CMOS VLSI Design- A Circuits and Systems Perspective", 4th ed., Pearson Education, 2010.
3. J. P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley-India, 2006.
4. W. Wolf, "Modern VLSI Design: System on Silicon", 2nd ed., Prentice Hall, 1998.
5. S. Palnitkar, "Verilog HDL A guide to Digital Design and Synthesis", 2nd ed., Pearson India, 2003.
6. M. D. Ciletti, "Advanced Digital Design with the Verilog HDL, 2nd ed., PHI, 2009.

Course Outcomes

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

CO1 Comprehend the fundamental of MOS transistor and short channel effects.
CO2 Design a MOS inverter with different loads and analyze static characteristics.
CO3 Illustrate and design CMOS combinational circuits.
CO4 Comprehending and designing sequential and dynamic logic circuits.
CO5 Design an application using Verilog HDL.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1			1	1		2	3	1	2

CO2	3	3	2	1	1	1			1	1		2	3	1	2
CO3	3	3	3	1	1	1			1	1		2	3	3	2
CO4	3	3	3	1	1	1			1	1		2	3	3	2
CO5	3	3	1	1	1	1			1	1		2	3	1	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTT2	3	-	-	3 hours	40	60	100	3

DIGITAL SIGNAL PROCESSING

Course Objectives:

- To summarize and analyze the concepts of signals, systems in time and frequency domain with corresponding transformations
- To introduce the diverse structures for realizing digital filters.
- To develop the understanding the concept of design and implementation of digital filters.
- To develop basic idea of multi rate filter bank design.
- To utilise the appropriate tools for design and realization of signal processing modules

UNIT-I

Basic Elements of Digital Signal Processing: Introduction of discrete time signals and systems, Discrete time Fourier transform (DTFT), Discrete Fourier series (DFS), Discrete Fourier transform (DFT), Fast Fourier transform (FFT) using DIT and DIF algorithms, Inverse FFT using DIT and DIF algorithms, Circular convolution, Correlation, MATLAB programs based illustrations.

UNIT-II

Realization of Systems: Realization of discrete time systems, Structures for infinite impulse response (IIR) and finite impulse response (FIR) systems, Basic realization block diagram and signal flow graph, Realization of IIR filter: Direct forms structure, Transposed structure, Cascade structure, Parallel structure, Lattice structure, Ladder structure, Realization of FIR filter: Direct forms structure, Cascade structure, linear phase realization, Lattice structure.

UNIT-III

FIR Filter Design: Linear phase response, Symmetric and anti-symmetric, Design characteristics of FIR filters, Frequency response of FIR filters, Design FIR filter by window functions: Rectangular, Triangular, Hanning, Hamming, Blackman & Kaiser, Design FIR filter by frequency sampling method, MATLAB programs-based illustrations for FIR filters.

UNIT-IV

IIR Filter Design: Transformation of analog filter to digital filters by: Approximation of derivatives, Impulse invariance method, Bilinear transformation method, Design of digital butterworth and chebyshev filter, Frequency transformations in analog and digital domain, MATLAB programs based illustrations for IIR filters.

UNIT-V

Techniques for DSP Applications: Introduction of multi rate system, Sampling rate conversion, Decimation, Interpolation, Sampling rate alteration, Poly-phase decomposition, Digital filter bank, Short Time Fourier transform (STFT), Discrete cosine transform (DCT), Wavelet transform, Application of DSP: speech and image, MATLAB programs-based illustrations.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer-based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas, and W. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.
7. A. Kumar, "Digital Signal Processing", PHI 2013.

Course Outcomes

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

CO1 Represent signals mathematically in discrete-time, and in the frequency domain.
CO2 Realize digital filters by use of systematic structure to simplify the complexity of the system.
CO3 Design and develop digital filters for various applications.
CO4 Analyze different signals using multi-rate systems.
CO5 Apply digital signal processing modules for the analysis of real-life signals.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTT3	3		-	3 hours	40	60	100	3

FIBER OPTICS COMMUNICATIONS

Course Objectives

1. To introduce the concept of signal propagation through the optical fiber.
2. Discuss the channel impairments like losses and dispersion
3. To learn the various components of optical fiber Communication system.
4. Discuss the concept of optical networking and signal booster devices.
5. To familiar with the concept of advance optical communication system.

UNIT-I

Introduction to optical communication, principle of light transmission, propagation of light in to fiber, mode theory of a cylindrical waveguide, Ray model.

UNIT-II

Different types of optical fibers, Modal analysis of a step index fiber.
Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

UNIT-III

Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsitivity, noise, optical receivers, Optical link design - BER calculation, power penalties.

UNIT-IV

Optical switches - coupled mode analysis of directional couplers, electro-optics switches.
Optical amplifiers - EDFA, Raman amplifier.WDM and DWDM systems. Principles of WDM

networks.

UNIT-V

Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and solition based communication.

Text/Reference Books

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

Course Outcomes:

Upon successful completion of the course, the students will be able to

1. Demonstrate the optical fiber communication system, fiber structure, propagation and transmission properties of an optical fiber.
2. Analyze the losses and propagation characteristics of an optical signal in different types of fibers.
3. Demonstrate the functionality of elements of optical fiber system and analyse the performance of the elements.
4. Estimate the power budget of the system and can understand the designing of the link.
5. Understand the different techniques to improve the efficiency of the system.

Course Outcomes and their mapping with Program Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTK1	3		-	3 hours	40	60	100	3

CRYPTOGRAPHY AND NETWORK SECURITY

Course Objectives:

- To understand the fundamentals of cryptography. To learn the block ciphers principal and data encryption standard (DES) algorithms.
- To learn the modular arithmetic and theory of prime numbers required in encryption.
- To learn and understand the public key cryptography and understand the key exchange algorithms.
- To learn and understand the Hash function and digital signature.
- To understand the necessary approaches and techniques to build and operate secure computer networks and system. And, analyze the web security, secure socket layer (SSL), IPv4 sec.

UNIT-I

Introduction to Cryptography and Block Ciphers: Introduction to security attacks- services and mechanism, Introduction to cryptography, Conventional encryption, Classical encryption

techniques: substitution ciphers and transposition ciphers, Cryptanalysis, steganography, Modern block ciphers: Block ciphers principals, Shannon"s theory of confusion and diffusion, Fiestal structure, Data encryption standard (DES), Strength of DES, Differential and linear crypt analysis of DES-block cipher modes of operations, Triple DES.

UNIT-II

Confidentiality and Modular Arithmetic: Confidentiality using conventional encryption, Traffic confidentiality, Key distribution, Random number generation, Introduction to graph, Ring and field, Prime and relative prime numbers, Modular arithmetic, Fermat's and Euler's theorem, Primality testing, Euclid's algorithm, Chinese remainder theorem, Discrete algorithms.

UNIT-III

Public Key Cryptography and Authentication Requirements: Principles of public key crypto systems, RSA algorithm, Security of RSA, Key management, Diffle-Hellman key exchange algorithm, Introductory idea of elliptic curve cryptography, Elgamel encryption, Message authentication and hash Function: Authentication requirements, Authentication functions, Message authentication code, Hash functions, Birthday attacks, Security of hash functions and MACS**.**

UNIT-IV

Integrity Checks and Authentication Algorithms: MD5 message digest algorithm, Secure hash algorithm (SHA), Digital signatures: Digital signatures, Authentication protocols, Digital signature standards (DSS), Proof of digital signature algorithm, Authentication applications: Kerberos and X.509, Directory authentication service, Electronic mail security-pretty good privacy (PGP), S/MIME.

UNIT-V

IP Security & Key Management and Web & System Security: IP Security: Architecture, Authentication header, Encapsulating security payloads, Combining security associations, Key management, Web security: https and IPv4/6 security, Secure socket layer (SSL) and transport layer security, Secure electronic transaction (SET), System security: Intruders, viruses and related threads, Firewall design principals, Trusted systems.

Text/Reference Books:

1. W. Stallings, "Crpyptography and Network security Principles and Practices", 4th ed., Pearson, 2005.
2. C. Kaufman, R. Perlman, and M. Speciner, "Network Security: Private Communications in a Public World", 2nd ed., Pearson 2016
3. W. Trappe and L. C. Washington, "Introduction to Cryptography with coding theory", 2nd ed., Pearson, 2005.
4. D. Stinson, "Cryptography Theory and Practice", 2nd ed., Chapman & Hall/CRC, 2018.
5. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill, 2007.
6. W. Mao, "Modern Cryptography – Theory and Practice", 1st ed., Pearson Education, 2005.

Course Outcomes:

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

CO1 Illustrates the cryptography basics, algorithms and classify the symmetric encryption techniques and illustrate various private key cryptographic techniques.

CO2 Explain the mathematical background for cryptography such as the modular arithmetic's and public key cryptosystem to protect the data over network.

CO3 Identify different protocols for effective key management, distribution and authentication in public key infrastructure. Understand key management issues and algorithms.

CO4 Analyze the important Hash function and apply the digital signature in real world application.

CO5 Illustrate the IP network security threats, and Identify factors driving the need for information security. classify the threats and develop a security model to prevent, detect and overcome from the attacks.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTK2	3		-	3 hours	40	60	100	3

VLSI FABRICATION METHODOLOGY

Course Objectives:

- To introduce the brief concept of fabrication technology of both BJT & MOS.
- To learn difficulties in single crystal development and wafer design.
- To learn different epitaxial growth techniques and their associated problems.
- To introduce the concept of Si atomic structure, atomic planes and structural defects.

UNIT-I: Introduction to VLSI

Brief overview of processing steps of BJT & MOSFET fabrication; Concept of photolithography; Epitaxy; Self-aligned Technique, Polysilicon & its advantages etc.

UNIT-II: Silicon Crystal Structure

Basics of Crystal structure and its types and different formations, Hard sphere model of Diamond lattice and its Packing densities, Concept of misfit factor and its importance, Details of Crystal plane-Miller's indices, packing densities, interplane distances and angles between the planes, V-groove etching concept, Direction of line on Si-wafer.

Defects in Crystal structure: Point defects, Line defects, Area dislocation, Volume defects.

UNIT-III: Crystal growth of Si

Carbothermic Reduction process, Bridgemann Technique and its problems, Czochralski technique, its thermodynamics and effect of Pull rate on wafer size. Dopant incorporation in Si crystal: Segregation coefficient, O_2 incorporation and its removal.

UNIT-IV: Crystal refinement & wafer preparation

Zone refining technique and its advantages, Wafer preparation, Gettering process and Metallic contaminant removal. **Epitaxy:** Types, 3 cardinal rules and their importance, Liquid phase epitaxy, Vapour Phase Epitaxy, Reactor configuration.

UNIT-V: Chemical Vapour Deposition for Si epitaxy

Silane route, Doping during epitaxy- auto doping, Molecular Beam epitaxy.

Text/Reference Books:

1. VLSI Technology, S. M. Sze, McGraw Hill Book Co.
2. VLSI Fabrication Principles, S.K.Gandhi, John Wiley and Sons, NY.
3. VLSI Technology, Chen, Wiley, March.
4. Principles of Microelectronics Technology, D. Nagchoudhary, Wheeler (India).
5. Silicon VLSI Technology: Fundamentals, Practice & Modeling, Plummer, Deal , Griffin, PH, 2001.
6. Microchip Fabrication, P. VanZant, MH, 2000.

Course Outcome:

At the end of the course, students will demonstrate the ability to:
1. Explain the concept of fabrication technology.
2. Analyze the challenge of single crystal development and wafer design.
3. Apply the epitaxial growth techniques and their associated problems.
4. Explain the concept of Si atomic structure, atomic planes.
5. Explain the structural defects and their effects on wafer quality.

Course Outcomes and their mapping with Programme Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTK3	3		-	3 hours	40	60	100	3

ESTIMATION AND DETECTION THEORY

Course Objectives:

- To introduce the concepts of estimation and detection theory.
- To introduce the use of estimation bounds.
- To introduce the concepts of classical and Bayesian estimators like ML, LS, and MMSE to students.
- To introduce the concept of likelihood ratio test and GLRT.
- Exposing the students to applications of estimation and detection is another important goal.

UNIT-I

Introduction: Introduction of estimation in signal processing, Minimum variance unbiased estimation, Unbiased estimators, Minimum variance criterion, Existence of minimum variance unbiased estimator, Cramer-Rao lower bound (CRLB), Scalar parameters, Signal in white Gaussian noise.

UNIT-II

Linear Model and Estimation: Linear models, General minimum variance unbiased estimation, Sufficient statistic, Finding minimum variance unbiased estimators, Best linear unbiased estimators (BLUE), Finding the BLUE, Signal processing example.

UNIT-III

Likelihood Estimation: Maximum likelihood estimators (MLE), Finding the MLE, Properties of the MLE, MLE for transformed parameters, Extension to a vector parameter, Introduction to least square (LS) approach, Linear least square estimation, Geometrical interpretations of LS estimation, Some examples.

UNIT-IV

Bayesian Estimation: Bayesian estimators, Priors and posteriors probabilities, Choosing a prior PDF, General Bayesian estimators, Minimum mean square estimators (MMSE), Maximum A Posteriori (MAP) estimators, Linear MMSE estimation.

UNIT-V

Detection and Decision: Basics of statistical decision theory, Simple hypothesis testing, Likelihood ratio testing, Neyman-Pearson detectors, Detection of known signals in noise,

Composite hypothesis testing, Generalized likelihood ratio tests (GLRTs), Deterministic signals with unknown parameters.

Text/Reference Books:

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory, vol. I" Prentice-Hall, 1993.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory, vol. II" Prentice-Hall, 1998.
3. H. Vincent Poor, "An Introduction to Signal Detection and Estimation" Springer, 2nd ed., 1998.
4. H. L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley, 1968.

Course Outcomes:

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

CO1 Illustrate the knowledge of estimation and detection theory.
CO2 Comprehend different estimation and detection techniques like ML, LS, MMSE.
CO3 Elucidate and analyze problems that involve estimation of the signal parameters.
CO4 Compare and evaluate the performance of different estimation technique.
CO5 Comprehend the concept of detection theory in presence of noise signals.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTK8	3		-	3 hours	40	60	100	3

BIO-MEDICAL INSTRUMENTATION

Course Objectives:

- To introduce a fundamental of transducers as applicable to physiology.
- To explore the human body parameter measurements setups.
- To measure non-electrical parameter of human body.
- To make the students understand medical imaging techniques.
- To make the students understand the devices used in diagnosing the disease.

UNIT-I

Physiology and Transducers: Cell and its structure, Resting and action potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, Transmitters and neural communication, Cardiovascular system, Respiratory system, Basic components of a biomedical system, Transducers, Selection criteria, Piezo-electric, Ultrasonic transducers, Temperature, measurements.

UNIT-II

Electro-Physiological Measurements: Electrodes: limb electrodes, floating electrodes, micro, needle and surface electrodes, Amplifiers: preamplifiers, differential amplifiers, chopper amplifiers, ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms, Electrical safety in medical environment: leakage current-Instruments for checking safety

parameters of biomedical equipment.

UNIT-III

Non-electrical Parameter Measurements: Measurement of blood pressure, Cardiac output, Heart rate, Heart sound pulmonary function measurements, Blood gas analyzers: pH of blood, measurement of blood pCO2, finger-tip oximeter, measurements.

UNIT-IV

Medical Imaging: Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, Ultrasonography, Endoscopy, Different types of biotelemetry systems and patient monitoring.

UNIT-V

Assisting and Therapeutic Equipment: Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart lung machine, Audio meters, Dialyzers.

Text/Reference Books:

1. R. S. Khandpur, "Hand Book of Bio-Medical Instrumentation", Tata McGraw Hill, 2003.
2. L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, "Bio-Medical Instrumentation and Measurements", 2nd ed., Pearson Education, 2002.
3. J. Webster, "Medical Instrumentation", John Wiley & Sons, 1995.
4. L. A. Geddes, L. E. Baker, "Principles of Applied Bio-Medical Instrumentation", Wiley & Sons, 1975

Course Outcomes:

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

CO1 Understand the physiology of biomedical system.
CO2 Measure biomedical and physiological information.
CO3 To know and understand measurements of non-electrical parameter of human body.
CO4 To know and understand measurements in devices used in medical imaging and biotelemetry.
CO5 Discuss the application of electronics in therapeutic area.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTK9	3		-	3 hours	40	60	100	3

MICROWAVE THEORY & TECHNIQUES

Course Objectives:

- To understand the concepts of waveguides and modes.
- To understand the basic concept of various types of guiding structure and passive components at microwave.
- To understand the concepts and working principles of microwave active components.
- To understand the concepts and working principles of microwave system design and antenna.
- To understand the applications and effect of microwave in various system.

UNIT-I

Introduction to Microwaves: Microwave frequency bands, Applications of microwaves, Concept of mode, Features of TEM, TE and TM modes in rectangular and circular waveguide, Losses associated with microwave transmission, Introduction of microwave systems.

UNIT-II

Analysis of RF and Microwave Transmission Lines: Coaxial line, Strip line, Micro strip line, Scattering Parameters, Passive Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Resonator.

UNIT-III

Microwave Active Components: Microwave semiconductor devices: Gunn diodes, IMPATT diodes, Schottky barrier diodes, PIN diodes, Microwave tubes: Klystron, Travelling wave tube amplifier, Magnetron.

UNIT-IV

Microwave Design Principles: Impedance transformation, Impedance matching, Introduction of microwave filter design, Microwave antennas, Introduction of antennas for ground-based systems, Airborne and satellite systems, Introduction of planar antennas for microwave frequency.

UNIT-V

Microwave Measurements: Power, frequency, impedance and noise measurement at microwave frequency, Noise figure, Electromagnetic interference and electromagnetic compatibility (EMI & EMC), Modern trends in microwaves engineering, Microwave imaging, Effect of microwaves on human body.

Text/Reference Books:

1. R. E. Collins, "Microwave Circuits," 2nd ed., John Wiley & Sons, Inc., 2001.
2. S. Y. Liao, "Microwave Devices and Circuits," 3rd ed., Pearson Education, 2003.
3. D. M. Pozar, "Microwave Engineering," John Wiley & Sons, 2001.
4. R. K. Shevgaonkar, "Electromagnetic Waves," Tata McGraw Hill, 2005.
5. S. Das, "Microwave Engineering," 2nd ed., Oxford Higher Education, 2015

Course Outcomes:

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

CO1 Comprehend the need of various microwave system components and their properties.
CO2 Evaluate the various guiding structures and passive components along with their properties.
CO3 Appreciate that during analysis/synthesis of microwave active systems, the different mathematical treatment is required compared to general circuit analysis.
CO4 Analyze to design the microwave devices.
CO5 Evaluate the measurement of microwave properties and will learn latest development in microwave technology.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFTK10	3		-	3 hours	40	60	100	3

FUNDAMENTAL OF MACHINE LEARNING

Course Objectives:

- To review and strengthen important mathematical concepts required for ML.
- Introduce the concept of learning patterns from data.
- Introduce the linear regression technique and SVM.
- Introduce the basic neural network and provide background knowledge for deep learning.
- Introduce a few standard clustering techniques.

UNIT-I

Introduction: Basic definitions, Types of learning, Hypothesis space and inductive bias, evaluation, Cross-validation, Linear regression, Decision trees, Overfitting.

UNIT-II

Instance based learning, Feature reduction, Collaborative filtering-based recommendation, Probability, Probability and bayes learning, Naive bayes' classifier.

UNIT-III

Supervised Learning: Logistic regression, Support vector machine (SVM), Kernel function.

UNIT-IV

Neural network: Perceptron, Multilayer network, Back propagation, Introduction to deep neural network.

UNIT-V

Computational learning theory, PAC, Sample complexity, VC dimension, Ensemble learning. Clustering: k-means, Adaptive hierarchical clustering, Gaussian mixture model.

Text/Reference Books

1. K. P. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2011.
3. T. Mitchell, "Machine Learning", McGraw Hill, 2017.
4. T. Hastie, R. Tibshirani, and J. Friedman, "The Elements of Statistical Learning", 2nd ed., 2011.
5. Y. Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.

Course Outcomes:

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

CO1 Identify and classify elementary machine learning concepts.
CO2 Apply Bayesian concepts in learning data.
CO3 Apply support vector machine concept on discrete data set.
CO4 Explain neural networks and identify the role of deep learning in a large data set.
CO5 Apply basic clustering techniques for a given data set.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFLT1	-		2	2 hours	25	25	50	1

CMOS VLSI DESIGN LAB

Course Objectives:

- To familiarize with the CAD tool to write HDL programs.
- To gain the basic language features of verilog HDL and their role in digital logic design.
- To learn simulation and synthesis of digital design.
- To study the data, behavioral and structural modeling types of combinational and sequential circuits.

LIST OF EXPERIMENTS:

1. To design and simulate various gates using verilog HDL.
2. To design and simulate half adder using verilog HDL.
3. To design and simulate full adder using verilog HDL.
4. To design and simulate encoder using verilog HDL.
5. To design and simulate decoder using verilog HDL.
6. To design and simulate multiplexer using verilog HDL.
7. To design and simulate demultiplexer using verilog HDL
8. To design and simulate parity generator using verilog HDL.
9. To design different types of flip flops using verilog HDL.
10. To design and different types of counters using verilog HDL.

Course Outcomes:

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

CO1 Demonstrate knowledge on HDL design flow.
CO2 Comprehend of verilog's modeling types, modules, functions, and how to simulate and synthesize related programs.
CO3 Design and develop the combinational circuits using data flow and behavioral modeling.
CO4 Design and develop the sequential circuits using data flow and behavioral modeling.
CO5 Synthesize combinational and sequential circuits on programmable ICs and test the hardware.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFLT2	-		2	2 hours	25	25	50	1

DIGITAL SIGNAL PROCESSING LAB

Course Objectives:

- To develop basic signal operation such as linear and circular convolution.
- To implement different transformation algorithms
- To design FIR and IIR filters using different methods.
- To analyze the concept of sampling rate conversion
- To implement real DSP modules for real time application

LIST OF EXPERIMENTS:

1. To generate the random sequences and determine the correlation.
2. To verify linear and circular convolutions.
3. To compute DFT of sequence and its spectrum analysis.
4. To implement 8-point FFT algorithm.
5. To design of FIR filters using rectangular window techniques.
6. To design of FIR filters using triangular window techniques.
7. To design of FIR filters using Kaiser Window.
8. To design of Butterworth IIR filter.
9. To design of Chebyshev IIR filter.
10. To generate the down sample (decimation) by an Integer factor.
11. To generate the up sample (interpolation) by an Integer factor.
12. To remove the noise in 1-D and 2-d signals.

Course Outcomes:

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

CO1 Design and develop basic modules for signal generation and its operation
CO2 Demonstrate the applications of FFT to DSP.
CO3 Implement digital filters for various applications of DSP.
CO4 Implement multirate system
CO5 Analyze effect of DSP systems.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUFLT3	-		2	2 hours	25	25	50	1

FIBER OPTIC COMMUNICATIONS LAB

Course Objectives:

• Align light waves into small optical components with high precision
• Calculate and simulate the attenuation and signal degradation due to intermodal and intramodal distortion.
• Calculate power coupling losses due to connectors, splices, source output pattern and fiber numerical aperture.
• Understand, compute and simulate the modes in step index fiber and graded index fiber.
• Understand the reliability issues of the highly delicate optical devices.

LIST OF EXPERIMENTS:

1. To establish Analog Link Set up.
2. To establish voice link set up.
3. To transmit and receive PAM signal.
4. To perform the propagation loss measurement.

5. To perform the bending loss measurement.
6. To find the Numerical aperture.
7. To find the VI characteristics of LED and detector.
8. To establish Digital link set up.
9. To study bit error rate.
10. Study of Pulse Position Modulation and Demodulation.

Course Outcomes:

At the end of the course, the students will able to:
CO1 :Apply knowledge of optical communication to various application areas
CO2: Optical fiber is compatible for both analog and digital data transmission.
CO3: VI characteristics of LED and photo diode.
CO4: Performance of optical fiber in presence of dispersion.
CO5: Performance of optical fiber in comparison to the copper wire system in presence of EMI.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS2O3
CO1	3	2	2	2	3				2			3	3	3	2
CO2	3	2	2	2	3				2			3	3	3	2
CO3	3	2	2	2	3				2			3	3	3	2
CO4	3	2	2	2	3				2			3	3	3	2
CO5	3	2	2	2	3				2			3	3	3	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

SYLLABUS OF SEMESTER-VII

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTT1	3		-	3 hours	40	60	100	3

RADAR & SATELLITE COMMUNICATION

Course Objectives:

- To know the evolution of satellite communication and its concept
- Understand the orbital and functional principles of satellite communication systems.
- Analyse and evaluate a satellite link and suggest enhancements to improve the link performance.
- Select an appropriate modulation, multiplexing and multiple access schemes for a given satellite communication link.
- Understand the basics and functional principles of different types of RADAR.

UNIT-I

Introduction to Satellite Communication: Principles and architecture of satellite communication, Brief history of satellite systems, Advantages, Disadvantages, Applications and frequency bands used for satellite communication.

UNIT-II

Orbital Mechanics: Orbital equations, Kepler's laws, Apogee and perigee for an elliptical orbit, Evaluation of velocity, Orbital period, Angular velocity etc. of a satellite, Concepts of solar day and sidereal day, Satellite sub-systems: Study of architecture and roles of various sub-systems of a satellite system such as telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, Power sub-systems etc.

UNIT-III

Typical Phenomena in Satellite Communication: Solar eclipse on satellite & its effects, Remedies for eclipse, Sun transit outage phenomena & its effects and remedies, Doppler frequency shift phenomena and expression for doppler shift, Satellite link budget, Flux density and received signal power equations, Calculation of system, Noise temperature for satellite receiver, Noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.

UNIT-IV

Modulation and Multiple Access Schemes: Various modulation schemes used in satellite communication, Meaning of multiple access, Multiple access schemes based on time, frequency, and code sharing namely TDMA, FDMA and CDMA.

UNIT-V

RADAR: Introduction, Radar block diagram and operation, Radar frequencies, Simple form of radar equation, Prediction of range performance, Minimum detectable signals, CW radar, Tracking radar, MTI radar.

Text/Reference Books:

1. T. Pratt, C. W. Bostian, and J. E. Allnutt, "Satellite Communications," Wiley India, 2nd ed., 2002.
2. T. T. Ha, "Digital Satellite Communications," Tata McGraw Hill, 2009.
3. D. Roddy, "Satellite Communication," 4th ed., McGraw Hill, 2009.

Course Outcomes:

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

CO1 Visualize the architecture of satellite systems as a means of high speed, high range communication system

CO2 Analyze various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget, modulation and multiple access schemes.

CO3 Solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.

CO4 Explain how satellite is controlled to become stationary w.r.t a point on the earth.

CO5 Explain how a single satellite is shared by large number of earth stations on the earth.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTT2	3		-	3 hours	40	60	100	3

ADAPTIVE SIGNAL PROCESSING

Course Objectives:

Objective of the course are to make Students will able:

- To identify a random process and formulate to extract desired information
- To visualize the domain of adaptive signal processing
- Introducing of least mean squares adaptive filters for processing signals
- To develop algorithms meeting application specific performance criteria
- To implement the adaptive algorithms in software/Hardware

Unit–I:

Review of Random Processes: Probability, random variables, random processes Optimization theory and, correlation and covariance matrices, power spectrum, cross power spectrum, ergodicity, time averages, white noise and Gaussian processes.

Unit-II:

Optimal FIR filters: real and complex valued optimal filters, principle of orthogonality, minimum mean square error, wiener- Hopf equations, error performance surface, steepest descent algorithm.

Unit-III:

Least mean square (LMS) algorithm: convergence of LMS algorithm; normalized LMS, affine projection, Limitations of LMS algorithm

Unit-IV:

Recursive least squares (RLS): formation of RLS based adaptive filters, Moore-Penrose pseudo inverse, matrix inversion lemma, Development of the RLS transversal adaptive filter, properties, variants of the RLS family.

UNIT-V:

Application of Adaptive filters: Channel equalization, echo cancellation, interference cancellation, line enhancement, beam forming.

Text/Reference Books:

1. Ali H. Sayed, "Adaptive Filters", John Wiley & Sons, NJ, 2008.
2. Ali H. Sayed, "Fundamentals of Adaptive Filtering", Wiley student edition,2016.
3. D. G. Manolakis, V.K. Ingle, S.M. Kogon, "Adaptive Signal Processing", McGraw-Hill, 2000.
4. S. Haykin and T. Kailath, "Adaptive Filter Theory", Pearson Education, 2005.
5. B. Widrow and S. D. Sterns, "Adaptive Signal Processing", Pearson Education, 2002.

6. J. Benesty, Y. Huang, "Adaptive Signal processing: Applications to Real World Problems", Springer , 2003.
7. Tulay Adali and Simon Haykin, "Adaptive Signal Processing: Next-Generation Solutions", Wiley-India edition, 2010.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 Identify a random process and formulate to extract desired information
- CO2 Visualize the domain of adaptive signal processing.
- CO3 Develop methods for analysis of non-stationary signals using least mean squares and least squares approaches
- CO4 Develop methods for analysis of non-stationary signals using Recursive least squares approaches
- CO5 Develop adaptive algorithms meeting application specific performance criteria

Course Outcomes and their mapping with Programme Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTT3	3		-	3 hours	40	60	100	3

INTERNET OF THINGS

Course Objectives

1. To understand the basic concepts of Internet of things.
2. To empower students to build network applications in LAN
3. To empower students to design IoT applications.

UNIT-I

Introduction to IoT, its applications, layered architecture, and potential challenges. Types of computing in IoT. IP addressing schemes, types of IPs, casting and its types. MAC and IP addressing. Subnet and masking.

UNIT-II

Introduction to sensors and its specifications using data sheet calculations needed to create an IoT application. Introduction to Bluetooth and AT commands to configure the Bluetooth in master and slave mode, RF modules and exercise to create local area network with it.

UNIT-III

Introduction to the concepts like SSID, BSSID, access point soft access points, station, etc. configuring and programming NODEMCU as a soft access point, station, identify the number of stations surrounding a station, debug mode, network scan using NODEMCU, assigning static IP to a NODEMCU, concept of MDNS and its programming.

UNIT-IV

Introduction to machine to machine communication protocol like HTTP, MQTT. Programming

HTTP webserver, create and send HTML webpage through the server to a HTTP client. AJAX and web socket programming to implement machine to machine communication.

UNIT-V

Use HTML, CSS, and Java script to implement an IoT application. Setup open source IoT platform e.g. Things speak, yenen cloud, Adafruit cloud server etc.

Text/Reference Books:

1. IoT fundamentals Networking technologies protocols and used cases for the internet of things by David Hanes, Ciscopress.com.
2. MQTT essential-A light weight IoT protocol, Gaston C. Hillar, Pact publication
3. Internet of things with ESP 8266, Macro Schwartz, Pact publication

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Understand the basic concepts of internet of things its layered architecture.
CO2: Able to create and design IoT applications.
CO3: Able to Understand various IoT protocols.
CO4: Develop IoT solutions for real life problems.
CO5: Apply the knowledge of IoT to interface sensors with microcontroller board.

Course Outcomes and their mapping with Program Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTK1	3		-	3 hours	40	60	100	3

MILLIMETER WAVE TECHNOLOGY

Course objective

- To understand the characteristics of millimeter wave technology
- To understand the concepts and working principles of various guiding structures at millimeter wave technology.
- To study the design of antenna for millimeter wave applications.
- To learn the analysis of passive components at millimeter wave
- To understand the basic concept of active devices and link design at millimeter wave.

UNIT-I

Introduction to Millimeter Wave Technology: Advantages and challenges of millimeter wave technology, Millimeter wave applications, Sources of losses at millimeter wave, Dielectric loss, Conduction loss, Radiation surface wave losses, Phase and group velocity, Slow and fast waves, TEM, TE and TM modes

UNIT-II

Guiding Structure: Transmission lines, Parallel plate guide, Rectangular wave guide, Microstrip lines, High frequency limitation of microstrip lines, Conductor backed CPW, Substrate integrated waveguide (SIW).

UNIT-III

Antennas at Millimeter Wave Frequency: Antennas parameters, Printed millimeter wave antennas, Dipole and slot antenna, Loop antennas, Printed millimeter wave array antennas, On chip antennas: design and challenges.

UNIT-IV

Passive Components: Dielectric resonators, Dielectric resonators antenna and its modes, filters, Directional coupler, Different types of couplings, Power divider.

UNIT-V

Active Components: PIN diode, Gunn diode, IMPATT diode, FET, MOSFET, Comparison of solid-state devices, Noise and link budget, Friss transmission equation, Millimeter wave systems, Noise figure for cascaded system elements.

Text/Reference Books:

1. S. Rappaport, R. W. Heath, R. C. Daniels, and J. N. Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
2. K.C. Huang and Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, 2011.
3. M. K. Mondal, "NPTEL Lectures on Millimeter Wave Technology," IIT Kharagpur, 2021.

Course Outcomes:

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

CO1 Realize the need of millimeter wave technology for communication.
CO2 Comprehend the selection of suitable guiding structure at millimeter wave technology.
CO3 Design of antenna for millimeter wave frequency.
CO4 Analyze the various passive devices at mm wave systems.
CO5 Comprehend the principle of active devices and design of millimeter wave system.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTK2	3		-	3 hours	40	60	100	3

MIMO WIRELESS COMMUNICATION

Course Objectives:

- To understand the evolution of wireless communication.
- To conceptualize the idea and need of MIMO communication systems.
- To study the role of multipath in wireless communication
- To learn an aptitude for modeling MIMO channels.
- To understand spatial multiplexing.

UNIT-I

Review of Linear Algebra, Probability, and Stochastic Processes: Vector spaces, Four fundamental vector spaces of the matrix, Rank-Nullity theorem, Eigen values and Eigen vectors, Singular value decomposition, Probability spaces, Random variables and random

vectors, Distributions and densities, Conditional distributions and densities, Independent random variables, Transformation of random variables, Covariance matrix, Central limit theorem, Strict-sense stationary random process, Wide sense stationary random process, Correlation matrix, White random process.

UNIT-II

Overview of MIMO Communications: Introduction to MIMO, Introduction to spatial diversity and spatial multiplexing, MIMO capacity formula, MIMO system model, Application of MIMO capacity.

UNIT-III

Multipath Channel: Phenomenology of multipath channels, Power law propagation, Impulse response of a multipath channel, intrinsic multipath channel parameters, Classes of multipath channels, Statistics of small-scale fading.

UNIT-IV

MIMO Channel: MIMO channels in LOS geometry, Antenna spacing and scattering angle, Alamouti Coding and space-time coding, Maximal ratio receive combining (MRRC), Maximum likelihood decoding in MRRC and Alamouti receivers, Performance results, Space-time coding.

UNIT-V

Spatial Multiplexing: Overview of spatial multiplexing, BLAST architecture, Broadband MIMO, Narrowband and broadband MIMO channel estimation.

Text/Reference Books:

1. J. R. Hampton, "Introduction to MIMO Communications", Cambridge, U.K.: Cambridge University Press, 2013.
2. D. W. Bliss and S. Govindasamy, "Adaptive Wireless Communications: MIMO Channels and Networks", Cambridge, U.K.: Cambridge University Press, 2013.
3. S. Haykin and M. Moher, "Modern Wireless Communications", Upper Saddle River, NJ: Pearson, 2005.
4. A. Goldsmith, "Wireless Communication", Cambridge, U.K.: Cambridge University Press, 2005.
5. H. Jafarkhani, "Space-Time Coding: Theory and Practice", Cambridge, U.K.: Cambridge University Press, 2005.

Course Outcomes:

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

CO1 Design precoders for MIMO communication systems..
CO2 Design MIMO communication transceivers with and without channel state information.
CO3 Analyze the fundamentals of spatial diversity in a communication Receiver.
CO4 Design space-time codes for MIMO systems
CO5 Analyze and design optimum MIMO Communication systems for given channel conditions.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTK7	3		-	3 hours	40	60	100	3

APPLIED LINEAR ALGEBRA

Course Objectives:

- To develop basic concept of matrix algebra.
- To introduce different methods for matrix analysis.
- To develop the concept and analysis of Eigen values Eigen vectors and their relevance.
- To introduce the concept of linear transformation operators.

UNIT-I

Introduction to Vectors and Linear Equations: Vectors and linear combinations, Lengths and dot products matrices and linear equations, Gaussian elimination, Rules for matrix operations, Row-reduced echelon form, Rank of a matrix, Solution set of a linear system, Trace, Determinant of a matrix, Properties of determinants, Inverse matrices, Matrix factorization.

UNIT-II

Vector Spaces and Subspaces and Orthogonality: Properties of vector space and subspaces, Rank, Nullspace, The complete solution AX= B, Independence, Basis of a vector space, Dimension, Linear span and linear independence, Dimensions of the four subspaces, Orthogonality of the four subspaces, Projections and least Square, Gram-Schmidt orthonormalization process, QR Decomposition.

UNIT-III

Eigenvalues and Eigenvectors: Introduction to Eigenvalues, Characteristic polynomial, Eigenvalues of square matrices, Eigen vectors, Invariant subspaces, Diagonalization a matrix, Upper and lower-triangular matrices, Symmetric matrices.

UNIT-IV

Positive Definite Matrices Tests for positive definite matrices, Similar matrices, Singular Value Decomposition (SVD).

UNIT-V:

Simulation using Python or MATLAB: Solving system of linear equations, Rank of matrix, Eigen value decomposition, Matrix factorization, Singular value decomposition.

Text/Reference Books:

1. Strang, Gilbert,"Introduction to Linear Algebra",4th/5th Edition, Wellesley-Cambridge Press.
2. Axler, Sheldon, "Linear Algebra Done Right", 2nd/3rd edition, Springer.
3. K.Hoffman and R.Kunze, "Linear Algebra", 2nd Edition, Prentice- Hall of India, 2005.
4. Lipschutz S, Lipson M. "Schaum's outline of theory and problems of linear algebra" McGraw: Hill Book Company. 2001.

Course Outcomes:

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

CO1 Illustrate the knowledge of system of linear equations.
CO2 Comprehend the analysis of various matrix operations and operators.
CO3 Elucidate and analyze the structure of matrices.
CO4 Analyze the concepts of matrix algebra and their application in real world problems.
CO5 Comprehend the concepts by performing simulations.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1					3	1		2	3	1	2
CO2	3	3	2	3	3	3			3	2		2	3	2	3

CO3	3	3	2	3	3	3			3	2		2	3	3	3
CO4	3	3	2	3	3	3			3	2		2	3	3	3
CO5	3	3	3	3	3	3			3	3		2	3	3	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUGTK8	3		-	3 hours	40	60	100	3

WIRELESS SENSOR NETWORKS

Course Objectives:

- To Understand Wireless Sensor Network Fundamentals.
- To Explore Network Architectures and Design Principles.
- To Analyze Communication Protocols like various MAC protocols and routing protocol.
- To Examine Infrastructure Establishment Techniques.
- To Familiarize with Sensor Network Platforms and Tools.

UNIT-I

Overview of wireless sensor networks: Single Node Architecture, Hardware Components, Network Characteristics, unique constraints and challenges, Enabling Technologies for Wireless Sensor Networks Types of wireless sensor networks.

UNIT-II

Architectures: Network Architecture, Sensor Networks Scenarios, Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts, Internet to WSN Communication.

UNIT-III

Communication Protocols: MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts – SMAC, BMAC Protocol, IEEE 802.15.4 standard and ZigBee, the Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols, Energy Efficient Routing, Issues in designing a routing protocol, classification of routing protocols, table driven, on-demand, hybrid, flooding, hierarchical and power aware routing protocols.

UNIT-IV

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT-V:

Sensor Network Platforms and Tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Operating Systems and Execution Environments introduction to Tiny OS and nesC Node level software platforms, Node level Simulators, State centric programming.

Text/Reference Books:

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005
2. Feng Zhao & Leonidas J.Guibas, "Wireless Sensor Networks An Information Processing Approach", Elsevier, 2007
3. Waltenegus Dargie , Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", John Wiley & Sons Publications, 2011
4. Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.

Course Outcomes:

At the end of the course, students will be able to:
CO1 Explain the challenges and technologies for wireless sensor networks
CO2 Design network architectures for different scenarios and evaluate their performance based on specific design principles and optimization goals
CO3 To analyze various MAC and routing protocols, comparing their advantages and limitations in different WSN applications
CO4 To Implement Topology Control and Synchronization Techniques
CO5 Utilize Sensor Network Platforms and Programming Tools.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

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

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**