PSG INSTITUTE OF TECHNOLOGY AND APPLIED RESEARCH

COIMBATORE – 641 062

(Autonomous college affiliated to Anna University)

R2025

Courses of Study, Scheme of Assessment and Syllabi for All Semesters

for

B. Tech. - Electronics Engineering (VLSI Design and Technology)

B. TECH ELECTRONICS ENGINEERING (VLSI DESIGN AND TECHNOLOGY)
(Minimum No. of credits to be earned: 168)

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER I										
THEORY										
1	25MA101	Calculus and its Applications	3	1	0	4	40	60	100	BS
2	25PH103	Physics for Electrical Engineering	3	0	0	3	40	60	100	BS
3	25CY102	Chemistry for Electronics Engineering	3	0	0	3	40	60	100	BS
4	25EC101	Problem Solving and C Programming	3	2	0	5	40	60	100	ES
5	25HS101	English Language Proficiency	3	1	0	4	40	60	100	HS
6	25HS102	தமிழர் மரபு / Heritage of Tamils	1	0	0	1	40	60	100	HS
PRACTICALS										
7	25GE111	Design Thinking for Innovation	0	0	2	1	100	0	100	ES
8	25GE112	Engineering Graphics	0	0	4	2	60	40	100	ES
9	25BS112	Basic Sciences Laboratory	0	0	4	2	60	40	100	BS
MANDATORY COURSES										
10	25GEM01	Induction Programme*	-	-	-	Grade	-	-	-	MC
Total 30 periods			**16**	**4**	**10**	**25**	**460**	**440**	**900**	

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER II										
THEORY										
1	25MA201	Complex Variables and Transforms	3	1	0	4	40	60	100	BS
2	25PH204	Sensors for Engineering Applications	3	0	0	3	40	60	100	BS
3	25EC201	Electron Devices	3	1	0	4	40	60	100	ES
4	25EC202	Network Analysis	3	1	0	4	40	60	100	ES
5	25EC203	Object Oriented Programming with Python	2	2	0	4	40	60	100	ES
6	25HS201	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	40	60	100	HS
PRACTICALS										
7	25HS21_	Language Elective	0	0	4	2	60	40	100	HS
8	25EC211	Devices and Circuits Laboratory	0	0	4	2	60	40	100	ES
9	25EEC01	Workplace Communication Skills	0	0	2	Grade	100	0	100	EEC
MANDATORY COURSES										
10	25GEM02	Activity Point Programme I*	-	-	-	Grade	-	-	-	
Total 30 periods			**15**	**5**	**10**	**24**	**460**	**440**	**900**	

*** As per AICTE norms; Grade: Non-Credit Course**

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course; CA-Continuous Assessment; ESE – End Semester Examination.

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER III										
THEORY										
1	25MA304	Matrix Theory and Numerical Methods	3	1	0	4	40	60	100	BS
2	25EC301	Analog Electronics	3	0	0	3	40	60	100	PC
3	25EC302	Digital Electronics	3	0	0	3	40	60	100	PC
4	25EV301	Microfabrication and Semiconductor Materials	3	1	0	4	40	60	100	PC
5	25HS301	Project and Finance Management	3	0	0	3	40	60	100	HS
PRACTICALS										
6	25EC311	Analog Electronics Laboratory	0	0	2	1	60	40	100	PC
7	25EC312	Digital Electronics Laboratory	0	0	2	1	60	40	100	PC
8	25EEC02	Foundations for Problem Solving	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
9	25MC0__	Mandatory Course I	2	0	0	Grade	100	0	100	MC
10	25GEM03	Activity Point Programme II*	-	-	-	Grade	-	-	-	MC
Total 25 periods			**17**	**2**	**6**	**20**	**520**	**380**	**900**	

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER IV										
THEORY										
1	25MA404	Probability and Random Processes	3	1	0	4	40	60	100	BS
2	25EC401	Linear Integrated Circuits	3	0	0	3	40	60	100	PC
3	25EC402	Signals and Systems	3	1	0	4	40	60	100	PC
4	25EC404	Data Structures and Algorithms	3	2	0	5	40	60	100	ES
5	25EV401	CMOS VLSI Design	3	1	0	4	40	60	100	PC
PRACTICALS										
6	25EC411	Linear Integrated Circuits Laboratory	0	0	2	1	60	40	100	PC
7	25EV411	FPGA Programming Laboratory	0	0	4	2	60	40	100	PC
8	25EVE01	Mini Project I	0	0	2	1	100	0	100	EEC
9	25EEC03	Problem Solving	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
10	25MC0__	Mandatory Course II	2	0	0	Grade	100	0	100	MC
11	25GEM04	Activity Point Programme III*	-	-	-	Grade	-	-	-	MC
Total 32 periods			**17**	**5**	**10**	**25**	**620**	**380**	**1000**	

*** As per AICTE Norms Total; Grade: Non - Credit Course**

CA - Continuous Assessment; ESE – End-Semester Examination; CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE – Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER V										
THEORY										
1	25EC503	Control Systems	3	1	0	4	40	60	100	PC
2	25EV501	Computer Organization	3	0	0	3	40	60	100	PC
3	25EV502	VLSI Design for Testability	3	0	0	3	40	60	100	PC
4	25EV503	Analog IC Design	3	1	0	4	40	60	100	PC
5	25EV504	Silicon Systems Design	3	1	0	4	40	60	100	PC
PRACTICALS										
6	25EV511	Analog IC Design Laboratory	0	0	4	2	60	40	100	PC
7	25EV512	VLSI Design for Testability Laboratory	0	0	4	2	60	40	100	PC
8	25EVE02/ 25EVE03	Internship I / Community Project	0	0	0	1	100	0	100	EEC
9	25EEC04	Aptitude Skills	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
10	25GEM05	Activity Point Programme IV*	-	-	-	Grade	-	-	-	MC
Total 28 periods			**15**	**3**	**10**	**24**	**520**	**380**	**900**	

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER VI										
THEORY										
1	25EV601	Nanoscale Electronics	3	1	0	4	40	60	100	PC
2	25EV602	VLSI Physical Design	3	0	0	3	40	60	100	PC
3	25EV603	VLSI Verification Methodologies	3	0	0	3	40	60	100	PC
4	25E_P__	Professional Elective I	3	0	0	3	40	60	100	PE
5	25_O__	Open Elective I	3	0	0	3	40	60	100	OE
PRACTICALS										
6	25EV611	VLSI Fabrication and Characterization Laboratory	0	0	4	2	60	40	100	PC
7	25EV612	VLSI Verification Laboratory	0	0	2	1	60	40	100	PC
8	25EVE04	Mini Project II	0	0	2	1	100	0	100	EEC
9	25EEC05	Enhancing Problem Solving Ability with Code	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
10	25GEM06	Activity Point Programme V*	-	-	-	Grade	-	-	-	MC
Total 26 periods			**15**	**1**	**10**	**21**	**520**	**380**	**900**	

*** As per AICTE norms; Grade: Non-Credit Course**

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S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER VII										
THEORY										
1	25EV701	Microelectronic Devices and Modeling	3	0	0	3	40	60	100	PC
2	25E__P__	Professional Elective II	3	0	0	3	40	60	100	PE
3	25E__P__	Professional Elective III	3	0	0	3	40	60	100	PE
4	25E__P__	Professional Elective IV	3	0	0	3	40	60	100	PE
5	25__O__	Open Elective II	3	0	0	3	40	60	100	OE
PRACTICALS										
6	25EV711	Microelectronic Devices and Modeling Laboratory	0	0	2	1	60	40	100	PC
7	25EVE05	Project Work I	0	0	4	2	100	0	100	EEC
8	25EVE06	Internship II	0	0	0	1	100	0	100	EEC
Total 21 periods			**15**	**0**	**6**	**19**	**460**	**340**	**800**	

S. No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
			Lecture	Tutorial	Practical		CA	ESE	Total	
SEMESTER VIII										
THEORY										
1	25E__P__	Professional Elective V	3	0	0	3	40	60	100	PE
2	25E__P__	Professional Elective VI	3	0	0	3	40	60	100	PE
PRACTICALS										
3	25EVE07	Project Work II	0	0	8	4	60	40	100	EEC
	Total 14 periods		**6**	**0**	**8**	**10**	**140**	**160**	**300**	

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Summary of Credit Distribution

B. TECH ELECTRONICS ENGINEERING (VLSI DESIGN AND TECHNOLOGY)										
S. No.	**Course Category**	**Credits Per Semester**								**Total Credits**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
1	HS	5	3	3	0	0	0	0	0	**11**
2	BS	12	7	4	4	0	0	0	0	**27**
3	ES	8	14	0	5	0	0	0	0	**27**
4	PC	0	0	12	14	22	13	4	0	**65**
5	PE	0	0	0	0	0	3	9	6	**18**
6	OE	0	0	0	0	0	3	3	0	**6**
7	EEC	0	0	1	2	2	2	3	4	**14**
8	MC	0	0	0	0	0	0	0	0	**0**
TOTAL		**25**	**24**	**20**	**25**	**24**	**21**	**19**	**10**	**168**

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE – Professional; OE-Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course

LIST OF PROFESSIONAL ELECTIVE COURSES: VERTICALS

S. No.	VERTICAL I VLSI Design to Tape-out	VERTICAL II Signal Processing and Technologies	VERTICAL III IoT and Embedded Systems	VERTICAL IV Emerging Technologies
1	25ECP01 Mixed Signal IC Design	25ECP11 Advanced Digital Signal Processing	25ECP21 Real Time Operating Systems	25ECP08 VLSI Architectures for AI Applications
2	25ECP02 CAD for VLSI	25ECP12 Digital Image Processing	25ECP22 IoT based System Design	25ECP32 Quantum Computing
3	25ECP03 Low Power IC Design	25ECP13 Speech Processing	25ECP23 Artificial IOT	25ECP33 Artificial Intelligence and Machine Learning
4	25ECP04 VLSI Signal Processing	25ECP14 Software Defined Radio	25ECP24 Industrial Internet of Things and Industry 4.0	25ECP37 Cryptography and Network Security
5	25EVP01 Memory Design and Testing	25ECP15 Wavelets and its applications	25ECP25 FPGA Based Embedded Systems	25EVP31 MEMS and Microsystems
6	25EVP02 AI Optimization of VLSI Circuit Design	25ECP16 Biomedical Signal Processing	25ECP26 Robotics	25EVP32 Reconfigurable Architectures and Approximate Computing
7	25EVP03 RF IC Design	25ECP17 5G and beyond	25ECP27 Wearable Devices	25EVP33 Optoelectronics
8	25EVP04 Beyond CMOS	25ECP18 Mobile Communication	25ECP28 IoT Processors	25EVP34 IC Packing and Electro Magnetic Interference and Compatibility

LIST OF PROFESSIONAL ELECTIVE COURSES FOR MINOR DEGREE PROGRAMME

S. No.	Course Code	Course Title
1	25EVM01	Digital System Design
2	25EVM02	CMOS VLSI Technology
3	25EVM03	HDL and Synthesis
4	25EVM04	Low Power VLSI Design
5	25EVM05	VLSI Design Automation
6	25EVM06	ASIC Design
7	25EVM07	MEMS Design
8	25EVM08	VLSI Verification

LIST OF OPEN ELECTIVE COURSES

S. No.	Course Code	Course Title
1	25EVO01	Nano Technology and its Applications
2	25EVO02	MEMS
3	25EVO03	Digital Design Using HDL
4	25EVO04	ASIC Design
5	25EVO05	Semiconductor Fabrication and Characterization

25MA101 CALCULUS AND ITS APPLICATIONS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

3 1 0 4

DIFFERENTIAL CALCULUS: Functions of two variables, Limits and continuity, Partial derivatives, Chain rule, Extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. **(9+3)**

INTEGRAL CALCULUS: Double and iterated integrals over rectangles, Double integrals over general regions, Fubini's theorem, Area and volume by double integration, Reversing the order of integration, Double integrals in polar form. **(9+3)**

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS: Basic concepts, Separable differential equations, Exact differential equations, Integrating factors, Linear differential equations, Modeling - Mixing problems, Newton's law of cooling, Decay and growth problems. **(9+3)**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS: Homogeneous linear equations of second order, Homogeneous linear ODEs with constant coefficients, Euler– Cauchy equations, Solution by variation of parameters, Free oscillations mass spring systems, Electric circuits. **(9+3)**

VECTOR CALCULUS: Gradient and directional derivative of a scalar field, Divergence and curl of a vector field. Integration in vector field – Line integrals, Path independence of line integrals, Green's theorem in the plane, Divergence theorem of Gauss and Stokes' theorem. **(9+3)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. J. Hass, C. Heil, and D. W. Maurice, *'Thomas' Calculus'*, Pearson Education, New Delhi, 2018.
2. Erwin Kreyszig, *'Advanced Engineering Mathematics'*, Wiley India, New Delhi, 2018.

REFERENCES:

1. H. Anton, I. Bivens, and S. Davis, *'Calculus'* John Wiley and Sons, USA, 2016.
2. C. R. Wylie and L.C. Barrett, *'Advanced Engineering Mathematics'*. Tata McGraw-Hill, New Delhi, 2019.
3. D.G. Michael, *'Foundations of Applied Mathematics'*, Dover Publications, New York, 2013.
4. Gilbert Strang *'Calculus'*, Wellesley Cambridge Press, USA, 2017.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Calculus, Differential Equations and Vector Calculus.	**K2**
CO2	Apply the techniques of Calculus, Differential Equations and Vector Calculus to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems employing Calculus, Differential Equations and Vector Calculus.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Calculus, Differential Equations and Vector Calculus.	**-**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4					2								
@	**3**	**2**			**2**								

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25PH103 PHYSICS FOR ELECTRICAL ENGINEERING
(Common to EEE, ECE and EE-VLSI)

3 0 0 3

ELECTROMAGNETISM: Review of definitions of fundamental terms. Permeability. Forces due to currents - Uniform and non-uniform magnetic fields - Static and time-varying magnetic fields. Electromagnetic induction - Expression for induced emf. Electric fields definition of fundamental terms. Dielectric constant, Permittivity. Dielectric displacement. Gauss theorem. Electromagnetic waves. Propagation of electromagnetic waves through isotropic media. Maxwell's equations and interpretation of Maxwell's equations. **(9)**

QUANTUM MECHANICS: Wave particle duality, de Broglie waves- Heisenberg's uncertainty principle. Wave function- normalization. The wave equation - Schrodinger's equation of motion: Time dependent form, steady-state form. Particle in a box - Quantum Tunneling and applications: Zener diode and Tunnel diode. **(9)**

ELECTRICAL PROPERTIES: Conducting materials-quantum free electron theory -Fermi Dirac Statistics-Band theory of solids-the density of states. Dielectrics-types of polarization-measurement of dielectric permittivity-Loss Factor-Dielectric loss mechanisms. **(9)**

PHYSICS OF SEMICONDUCTORS: P type and N type semiconductors-the effective mass. Electrical conductivity in P type and N type semiconductors - P-N junction, rectifier equation. Hall effect and its applications. Hetero junction-Quantum well, wire, dots- Optical properties of Semiconductors: LD, LED, Photo diode. Introduction to MEMS. **(9)**

MAGNETIC PROPERTIES: Types of magnetic materials-domain theory-hysteresis- hard and soft magnetic materials-Applications-eddy current brakes, regenerative braking. Magnetic lenses, Magnetostriction. Superconductivity –Meissner's effect- Josephson junction, SQUID magnetometer, applications. **(9)**

Total L: 45 periods

TEXTBOOKS

1. William D Callister Jr, *'Materials Science and Engineering-An Introduction'*. John Wiley and Sons Inc., 10th Edition, New York, 2018.
2. Arthur Beiser, *'Concepts of Modern Physics'*, Tata McGraw Hill, India, 2017.
3. Richard Wolfson, *'Essential University Physics'*, Vols 1 and 2. Pearson Education, Singapore, 2021.

REFERENCES:

1. Rolf E. Hummel, *'Electronic Properties of Materials'*. Springer, 2013.
2. Van Vlack, *'Elements of Material Science and Engineering'*. Pearson Education India, 2008.
3. S.M. Sze, *'Physics of Semiconductor Devices'*. John Wiley and Sons, USA, 4th Edition, 2021.
4. D. Halliday and R. Resnick and Walker, *'Fundamentals of Physics'*, John Wiley and sons, 12th edition, 2021.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the fundamental concepts of electromagnetism, quantum mechanics, electrical properties, semiconductors, and magnetic materials, focusing on their principles and applications in engineering.	K2
CO2	Apply mathematical models to calculate electromagnetic field parameters, quantum states, carrier concentration in semiconductors, dielectric behavior, and magnetic flux in engineering systems.	K3
CO3	Analyze the performance of materials and devices based on their electrical, magnetic, and quantum properties, using appropriate equations and measurement techniques.	K4
CO4	Prepare a report or presentation on the applications of quantum mechanics, semiconductor devices, dielectric behaviour, and magnetic materials in modern electronic systems, emphasizing their operational principles and practical uses.	K5

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4						1			1		1		
@	**3**	**1**				**1**			**1**		**1**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25CY102 CHEMISTRY FOR ELECTRONICS ENGINEERING
(Common to ECE and EE-VLSI)

3 0 0 3

ELECTRONIC MATERIALS: Inorganic semiconductors – Elemental – Si and Ge - band theory, doping, compound semiconductors – band gap engineering – applications. Organic semiconductors – conjugated polymers – mechanism of charge transport, doping, states of aggregation, material properties – thermal, mechanical, electrical, chemical, electrochemical. Applications – OLED, OPV – working principle. Liquid crystalline materials – display application. **(9)**

PROCESSES IN ELECTRONICS MANUFACTURE: Microchip fabrication – overview, photoresists – chemistry, types. Fabrication facilities – clean rooms - maintenance, ultrapure water– specification, production processes – ion exchange, reverse osmosis, continuous electro-deionisation. PCB fabrication – electroless and electroplating of copper – principle, bath chemistries and process parameters, formation of copper track on plastic board. **(9)**

ELECTRONICS PACKAGING AND PROTECTION: Packaging materials-encapsulants and underfills - adhesives – chemical types, application methods, factors influencing adhesion, soldering alloys – phase diagrams, lead free alloys, phase change materials for cooling. Conducting inks for printed electronics - metal and carbon based – graphene, CNT– synthesis, structure, electrical properties. Corrosion in electronics – types, protection – vapour phase inhibitors. **(8)**

ELECTROCHEMICAL POWER SOURCES: Electrochemical cells – emf, electrode potential, dependence of emf on electrolyte concentration – Nernst equation. Batteries–performance characteristics. Materials, construction, reactions, characteristics of Leclanche cell, primary lithium batteries, lead - acid battery and lithium-ion batteries. Supercapacitors – EDLC – fundamentals, electrode materials, electrolytes, pseudo capacitors– materials. **(10)**

CHEMICAL SENSORS: Sensors – basic components. Electrochemical sensors- potentiometric transducers – principle, ion-selective electrodes – configurations, response functions and selectivity, applications – potentiometric titrations, water quality monitoring - pH, Hardness, fluoride ion sensors Amperometric transducers – principle, application - glucose biosensors, conductivity sensors – principle – application in conductometric titrations. Colorimetric sensors - Beer-Lambert's law, components, application - determination of ferric ion in water sample. Chemi-resistive sensors - principle, application – environmental monitoring – CO2 sensor. Microelectrodes for sensors – fabrication. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Shashi Chawla, *'A Textbook of Engineering Chemistry'*, 1st Edition, New Delhi, Dhanpat Rai and Co.,6th Edition, 2022.
2. J.M.G. Cowie and Valeria Arrighi, *'Polymers: Chemistry and Physics of Modern Materials'*, CRC Press, London, 3rd edition, 2016.

REFERENCES:

1. Bansi D. Malhotra, *'Handbook of Polymers in Electronics'*, Rapra Technology Ltd., UK, 1st edition, 2002.
2. Peter Van Zant, *'Microchip Fabrication: A Practical Guide to Semiconductor Processing'*, McGraw Hill, 6th edition, 2014.
3. Derek Pletcher and Frank C. Walsh, *'Industrial Electrochemistry'*, Chapman and Hall, 2nd edition, 1993.
4. Florinel-Gabriel Banica, *'Chemical Sensors and Biosensors – Fundamentals and Applications'*, 1st edition, John Wiley and Sons Ltd., 2012

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Learn the chemistry of engineering materials and analytical devices	**K2**
CO2	Utilize the suitable materials for electronics engineering applications	**K3**
CO3	Analyze the properties of electronics materials for the fabrication of electronic devices	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1						1	1				
@	**3**	**1**						**1**	**1**				

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC101 PROBLEM SOLVING AND C PROGRAMMING
(Common to ECE and EE-VLSI)

3 2 0 5

INTRODUCTION TO PROBLEM SOLVING: Analyzing and Defining the Problem - Algorithm - Flow Chart – Program development steps -Types of programming language. C: The C character set - Identifiers and keywords - Data types – Constants - Variables - Declarations -input and output functions-preprocessor directives. **(6+3)**

OPERATORS AND EXPRESSIONS: Arithmetic operators - Unary operators - Relational operators - logical operators - Assignment operators - Conditional operators- bitwise operators - comma operator - sizeof operator - precedence and associativity- Library functions CONTROL STATEMENTS: simple if, if.else, nested if .. else, elseifladder, switch case - while - do while - for - nested loops - break – continue – goto statements. **(12+9)**

ARRAYS: Defining an array - Processing an array - Multi dimensional arrays–strings-string operations **(10+6)**

FUNCTIONS: Function prototype - Defining a function – function call - Passing arguments to a function –nested function – recursive function- Storage classes - auto - static - extern and register variables**.** **(7+4)**

STRUCTURES: Definitions - Processing a structure – Array and structures – Nested structures - Structures and functions. Pointers: Definition - Pointer Arithmetic – types of pointer - const pointer, pointer to a constant, void pointer, null pointer. **(10+8)**

Total L: 45+ T: 30: 75 periods

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, *‘C How to Program: With an Introduction to C++’*, Pearson Education, 8th edition, 2018.
2. Ajay Mittal, *‘Programming in C - A Practical approach’*, Pearson, New Delhi, 2010

REFERENCES:

1. B. Gottfried, *‘Programming with C, McGraw Hill Education’*, New Delhi, 2018.
2. Herbert Schildt, *‘C: The Complete Reference’*, McGraw Hill, New Delhi, 2017.
3. B.W. Kernighan and D.M. Ritchie, *‘C Programming Language (ANSI C)’*, Prentice Hall of India, New Delhi, 2013.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Understand and use basic C programming concepts to develop C programs.	**K2**
CO2	Develop modular programs using Functions, Arrays, Pointers, Strings, Structures, Unions and manage file data efficiently.	**K3**
CO3	strengthening their analytical thinking by evaluating and improving upon existing code, identifying areas for optimization and potential errors.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3				3			3	3		3	3	3
CO3		2			2			2	2		2	2	2
CO4			1		1			1	1		1	1	1
@	**3**	**2**	**1**		**3**			**3**	**3**		**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25HS101 ENGLISH LANGUAGE PROFICIENCY
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

3 1 0 4

VOCABULARY: Etymology-Prefixes and suffixes–Synonyms–Antonyms–Guessing meanings from context–Word formation- Single-word substitutes- Different forms of a word– Phrasal verbs–Collocations. **(9+3)**

LISTENING AND SPEAKING: Understanding listening – Listening techniques - Introducing oneself and others –Seeking and sharing information– Description-Conversation skills– Extempore speaking– Speech practice in varied formal contexts. **(9+3)**

GRAMMAR: Wh-questions – Yes/no questions– Parts of speech – Articles– Prepositions– Gerunds–Conjunctions-Degrees of comparison– Tenses– Modal verbs – Adverbs - Direct and indirect questions. **(9+3)**

READING: Reading strategies: Skimming and scanning, predicting– Reading comprehension: techniques – Practice reading. **(9+3)**

WRITING: Discourse markers – Dialogue writing - Completing sentences – Jumbled sentences – Paragraph writing –Writing compare & contrast paragraphs – Letter writing. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. K. N. Shoba and Lourdes Joavani Rayen, *‘Communicative English’*. Cambridge University press, Cambridge, 2021.
2. Raymond Murphy, *‘Intermediate English Grammar’*. Cambridge University Press, New Delhi, 2020.
3. Dr. M. Sambaiah, *‘Technical English an integrated text book’*. Wiley India Pvt. Ltd., 2025.

REFERENCES:

1. Raymond Murphy, *‘English Grammar in Use’*. Cambridge University Press, New Delhi 2020.
2. N. P. Sudharshana and C. Savitha, ‘*English for Engineers*’. Cambridge University Press, New York, 2018.
3. Helen Naylor with Raymond Murphy, ‘*Essential English Grammar*’. Cambridge University Press, New Delhi, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Demonstrate the ability to recognize and use a wide range of vocabulary and key grammatical structures accurately, while developing inferential reading skills to comprehend, interpret, and analyze written texts across diverse contexts.	**K2**
CO2	Organize their ideas logically in essay writing, develop paragraphs with clear topic sentences and adapt their letter- writing skills to various real-world scenarios.	**K3**
CO3	Develop and demonstrate clear and confident speaking skills in formal and informal contexts.	

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1									3				
CO2									3				
CO3									3		2		
@									**3**		**2**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25HS102 தமிழர் மரபு
(Common to CIVIL, CSE, CS&AM, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

1 0 0 1

மொழி மற்றும் இலக்கியம்: இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச்சார் பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு. **(3)**

மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை: நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரி முனையில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வியல் கோவில்களின் பங்கு. **(3)**

நாட்டுப்புறக்கலைகள் மற்றும் வீரவிளையாட்டுகள்: தெருக்கூத்து, கரகாட்டம், வில்லுப் பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள். **(3)**

தமிழர்களின் திணைக்கோட்பாடுகள்: தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்க கால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி. **(3)**

இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: இந்தி விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப் பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப் படிகள் – தமிழ் புத்தகங்களின் அச்சு வரலாறு. **(3)**

Total L: 15 periods

25HS102 HERITAGE OF TAMILS
(Common to CIVIL, CSE, CS&AM, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

1 0 0 1

LANGUAGE AND LITERATURE: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan. **(3)**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE: Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils. **(3)**

FOLK AND MARTIAL ARTS: Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils. **(3)**

THINAI CONCEPT OF TAMILS: Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas. **(3)**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books. **(3)**

Total L: 15 periods

TEXT – CUM – REFERENCE BOOKS:

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே. கே. பிள்ளை (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.)
7. Historical Heritage of the Tamils (Dr. S. V. Subrahmanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies).
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the Dravidian language family, outline the features of Tamil classical literature, and explain the development of Tamil art, sculpture, and temple-related traditions in a historical context.	**K2**
CO2	Demonstrate the cultural relevance of Tamil folk and martial arts, apply the concepts of Sangam landscape classification to social contexts, and relate Tamil contributions to India's freedom struggle, cultural legacy, and Siddha medicine.	**K3**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1									3				
CO2									3		2		
@									**3**		**2**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25GE111 DESIGN THINKING FOR INNOVATION
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 2 1

Foundations of Design Thinking: History & Origins: Roots in Creative Problem Solving: Traces back to mid-20th century practices in architecture, engineering, and psychology. Herbert Simon's "Sciences of the Artificial" (1969): Introduced design as a way of thinking distinct from scientific inquiry. IDEO and the Rise of Human-Centered Design: Popularized design thinking as a repeatable, user-focused innovation process. Stanford school's Influence: Helped institutionalize design thinking in education and entrepreneurship.

Variations of Design Thinking Phases: IDEO's 3-Phase Model: Inspiration, Ideation, Implementation A flexible, non-linear approach emphasizing creativity and action. Stanford school's 5-Phase Model: Empathize, Define, Ideate, Prototype, Test A structured yet iterative framework centered on user empathy. Double Diamond Model (Design Council UK): Divides the process into Discover, Define, Develop, and Deliver—highlighting divergent and convergent thinking.

Related Concepts & Frameworks: Human-Centered Design (HCD): Focuses on designing solutions that deeply resonate with users' needs and contexts. Systems Thinking: Encourages understanding the broader ecosystem and interdependencies within a problem space. Agile & Lean UX: Integrates design thinking with iterative development and minimal viable experimentation. Service Design: Applies design thinking to orchestrate holistic user experiences across touchpoints. Participatory Design: Involves stakeholders directly in the design process to ensure relevance and inclusivity.

EMPATHIZE: Apply Human-Centric Design Principles: Focus on designing solutions that prioritize user needs, experiences, and values throughout the process. Consult Experts: Engage with subject matter experts to gain foundational knowledge about the problem space. Competitive Analysis: Identify & studying similar products or services to identify gaps and opportunities. Stakeholder Interviews: Engaging with people who influence or are affected by the product or service. Conduct Observations: Observe users in their natural environment to understand behaviors, challenges, and interactions. Engage with Users: Use interviews, conversations, and other methods to connect with users and hear their stories. Immerse Yourself: Step into the users' context to experience their environment and challenges firsthand. Create Empathy Maps: Visualize what users say, think, feel, and do to synthesize insights. Identify User Needs and Pain Points: Extract meaningful patterns and needs from user interactions and observations. Set Aside Assumptions: Approach the research with an open mind, suspending personal biases and preconceptions. Document Insights: Capture quotes, observations, and emotional cues to inform the next stage (Define). **(6)**

DEFINE: Organize Research Findings: Review and structure the data collected during the Empathize stage. Analyze Observations: Identify patterns, themes, and insights from user interactions and behaviors. Craft a Human-Centered Problem Statement: Frame the problem from the user's perspective, focusing on their needs—not business goals. Avoid Business- Centric Framing: Refrain from defining problems based on company objectives alone (e.g., market share). Persona Development: Synthesizing research into user personas to guide design decisions. Use Empathy to Guide Definition: Ensure the problem statement reflects real user challenges and motivations. Develop Point-of-View Statements: Create concise summaries that capture who the user is, what they need, and why. Prepare for Ideation: Formulate "How Might We" questions to spark creative thinking in the next phase. **(6)**

IDEATE: Review the Problem Statement: Revisit the user-centric problem defined in the previous stage to guide ideation. Explore Multiple Perspectives: Encourage diverse viewpoints to broaden the range of potential solutions. Use Ideation Techniques: Apply methods like Brainstorming, Brain writing, SCAMPER, and Worst Possible Idea to spark creativity. Encourage Free Thinking: Create a judgment-free space to generate as many ideas as possible without filtering. Expand the Problem Space Push boundaries and explore unconventional or extreme ideas to uncover hidden opportunities. Refine and Select Ideas: Use evaluation techniques to identify promising concepts that address user needs effectively. Prepare for Prototyping: Choose ideas that are feasible and impactful to develop into tangible prototypes in the next stage. **(6)**

PROTOTYPE: Build Low-Cost Prototypes: Create simple, scaled-down versions of the product or its features to explore ideas. Experiment with Solutions: Implement different solutions from the Ideate stage into prototypes for testing. Test Internally and Externally: Share prototypes with team members, other departments, or a small group of users. Observe User Interactions: Watch how users engage with the prototypes to uncover usability issues and insights. Evaluate and Iterate: Accept, refine, or discard prototypes based on user feedback and performance. Identify Limitations: Discover constraints and challenges in the proposed solutions through hands-on testing. Gain Deeper User Understanding: Learn how users think, feel, and behave when interacting with the product. **(6)**

TEST: Conduct Rigorous Testing: Evaluate the complete product using the most promising prototypes. Observe Real User Interactions: Study how users behave, think, and feel while using the product. Gather Feedback and Insights: Collect qualitative and quantitative data to assess usability and effectiveness. Identify Remaining Issues: Detect limitations, pain points, and areas for improvement. Refine and Iterate: Use test results to improve the product and revisit earlier stages if needed. Redefine Problems if Necessary: Reframe or adjust problem statements based on new insights. Enhance Understanding of Users: Deepen empathy and knowledge of user needs through real-world testing. **(6)**

Design Thinking & Customer Centricity: A human-centered approach that blends empathy and innovation to create solutions that truly resonate with customer needs. Practical Examples of Customer Challenges: Real-world scenarios where customers face friction, unmet needs, or emotional disconnects in their product or service journey. Use of Design Thinking to Enhance Customer Experience: Applying iterative problem-solving and user insights to craft experiences that are intuitive, delightful, and deeply relevant. Parameters of Product Experience: Key dimensions like usability, accessibility, emotional impact, and consistency that shape how customers perceive and interact with a product. Alignment of Customer Expectations with Product Design: Ensuring that every design decision reflects what customers value, expect, and aspire to achieve through the product.

Total P: 30 periods

TEXT BOOKS:

1. T. Brown, *‘Change by Design’*. Harper Business, 2009.
2. J. Liedtka and T. Ogilvie, *‘Designing for Growth’*, Columbia Business School Publishing, 2011.

REFERENCES:

1. T. Kelley and D. Kelley, *‘Creative Confidence’*. Crown Business, 2013.
2. Stanford d. School resources: https://dschool.stanford.edu/
3. https://apphaus.sap.com/toolkit/methods#design-thinking

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Apply empathy-driven research to understand user needs.	**K3**
CO2	Develop and test prototypes to refine innovative solutions to the real-world problems.	**K4**
CO3	Frame actionable problem statements and generate creative ideas.	**K5**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3					3	3	3	3	-	3		
CO2		2				2	2	2	2	-	2		
CO3			1			1	1	1	1	-	1		
@	**3**	**2**	**1**			**3**	**3**	**3**	**3**		**3**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25GE112 ENGINEERING GRAPHICS
(Common to EEE, ECE, ICE and EE-VLSI)

0 0 4 2

INTRODUCTION TO ENGINEERING GRAPHICS (4)

1. Introduction to Engineering Graphics.
2. Lettering practice as per BIS.
3. Principles of Dimensioning.

ORTHOGRAPHIC PROJECTIONS (40)

1. Introduction to Orthographic Projections.
2. Drawing multiple views from pictorial views of objects.
3. Projection of points.
4. Projection of straight lines (only First angle projections) inclined to both the principal planes.
5. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.
6. Projection of simple solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.

SECTION OF SOLIDS (8)

1. Section of simple solids in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other and obtaining true shape of section.

ISOMETRIC PROJECTIONS (8)

1. Isometric projection of simple solids in simple vertical positions.

Total P: 60 periods

TEXT BOOKS:

1. N. D. Bhatt, *'Engineering Drawing'*. Charotar Publishing House Pvt. Ltd., 55th Edition, 2025.
2. K. C. John, *'Engineering Graphics for Degree'*. Prentice Hall India Publishers, 2009.
3. K. V. Natarajan, *'A Text book of Engineering Graphics'*. Dhanalakshmi Publications, 34th Refined Edition, 2021.

REFERENCES:

1. K. Venugopal and V. Prabhu Raja, *'Engineering Graphics'*. New Age International Publishers, 17th Edition, 2024.
2. *'Bureau of Indian Standards'*. Engineering Drawing Practices for Schools and Colleges SP 46-2003, BIS, New Delhi, 2003.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply projection techniques to create basic shapes, solids, and sectioned objects.	**K3**
CO2	Use the standards and specifications for engineering drawing.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2											2		
@	**3**										**2**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25BS112 BASIC SCIENCES LABORATORY
(Common to EEE, ECE, Mech and EE-VLSI)

0 0 4 2

PHYSICS (ANY EIGHT EXPERIMENTS):
1. Measurement of hall coefficient of a semiconductor using Hall Effect setup.
2. Determination of Young's modulus of the material - Uniform Bending
3. Determination of electrical resistivity of a given material using four probe setup.
4. Determination of wavelength of laser using diffraction grating - LASER.
5. Determination of Thickness of a thin wire – Air wedge method.
6. Study of I -V characteristics of solar cell and determination of its efficiency.
7. Determination of velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
8. Determination of Planck's constant and work function of a metal - Photoelectric Effect.
9. Determination of bandgap of a semiconductor – Post office box.
10. Determination of force in members of Truss Bridge.
11. Validation of Faraday's Law of induction.
12. Interpreting the working mechanism of spirometer, CO2 sensor, Venturi tube and heart rate sensor.
13. Demonstration:
14. Determination of Numerical Aperture and Acceptance angle - Optical Fiber
15. Study the energy loss of a ferrite magnetic material specimen by B-H curve.

REFERENCES:

1. Department of Physics, Physics Laboratory Observation, 2025.
2. Jerry D Wilson, A. Cecilia and Hernandez Hall, *'Physics Laboratory Experiments'*. Boston, Cengage Learning, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Relate the scientific principles, compare the experimental results with theoretical calculations, and apply graphical analysis to visualize the importance of precise measurements.	**K3**
CO2	Analyze the experimental result outcomes using analytical and experimental skills for various engineering materials and applications.	**K4**

CHEMISTRY (ANY EIGHT EXPERIMENTS):
1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of strength of acids in a mixture of acids using conductivity meter.
3. Determination of strength of given hydrochloric acid using pH meter.
4. Estimation of iron content of the given solution using potentiometer.
5. Corrosion experiment-weight loss method.
6. Electroplating of copper and Nickel and determination of coulombic efficiency.
7. Designing a battery and determination of its characteristics.
8. Construction of phase diagram of a simple eutectic system.
9. Determination of kinematic viscosity and acid value of a lubricating oil.
10. Anodizing of aluminium and determination of thickness of anodised film.

Total P: 60 periods

REFERENCES:

1. J Mendham, Vogel's Textbook of *'Quantitative Chemical Analysis'*. 6th Edition, Pearson Education, 2009.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Demonstrate the measurement of water quality parameters in the given water sample	**K3**
CO2	Analyze the properties of materials for Engineering applications	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO3	3												
CO4		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25GEM01 INDUCTION PROGRAMME
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

All students shall undergo an induction programme at the beginning of the first semester for a duration of three weeks as per the guidelines of All India Council for Technical Education (AICTE). A student completing the induction programme will be awarded a completed grade in the grade sheet, and only the students who complete the induction programme shall be considered as eligible for award of degree subject to satisfying other conditions. A student who does not complete the induction programme in the first semester shall redo the same in the subsequent semester.

SEMESTER II

25MA201 COMPLEX VARIABLES AND TRANSFORMS

(Common to CIVIL, EEE, ECE, ICE, MECH and EE- VLSI)

3 1 0 4

COMPLEX DIFFERENTIATION: Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. **(9+3)**

COMPLEX INTEGRATION: Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic functions, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). **(9+3)**

LAPLACE TRANSFORMS: Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, unit step function, second shifting theorem, Dirac's delta function, periodic functions, differentiation and integration of transforms, solving ODEs with constant coefficients and initial value problems. **(6+2)**

FOURIER ANALYSIS: Fourier series – arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. **(12+4)**

PARTIAL DIFFERENTIAL EQUATIONS: Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by Fourier series. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Erwin Kreyszig, *'Advanced Engineering Mathematics'*. Wiley India, New Delhi, 2018.
2. G. Z. Dennis, *'Advanced Engineering Mathematics'*. Jones and Bartlett Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. G. Z. Dennis and D. S. Patrick, *'A first course in Complex Analysis with Applications'*. Jones and Bartlett Pvt. Ltd., New Delhi, 2015.
2. C. R. Wylie and L. C. Barret, *'Advanced Engineering Mathematics'*. Tata McGraw-Hill, New Delhi, 2019.
3. Peter V.O Neil, *'Advanced Engineering Mathematics'*. Cengage, New Delhi, 2018.
4. G. D. Dean, *'Advanced Engineering Mathematics with MATLAB'*. CRC Press, USA, 2017.

COURSE OUTCOMES:

At the end of this course students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**K2**
CO2	Apply the techniques of Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems employing Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										3		
CO3		2						2	2				
CO4					2								
@	**3**	**2**			**2**			**2**	**2**		**3**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25PH204 SENSORS FOR ENGINEERING APPLICATIONS
(Common to CSE, ECE and EE-VLSI)

3 0 0 3

STRAIN AND PRESSURE MEASUREMENT: Resistance strain gauge, piezoelectric pressure sensor, characteristics. Electronic circuits for strain gauge, load cells. Interferometer, Fibre-optic pressure sensor. capacitance pressure sensor. **(9)**

ELECTRONIC SENSORS: Inductive, capacitive and ultrasonic based proximity sensors Reed switch, Hall-effect switching sensors, capacitive based humidity sensor, liquid level detectors, flow sensors, smoke sensors. **(9)**

MOTION SENSORS: Capacitor plate sensor, Inductive sensors, LVDT Accelerometer systems, rotation sensors, piezoelectric devices for motion sensing, Hall effect-based speed sensor. **(9)**

LIGHT Sensors: Color temperature, light flux, photo sensors, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber-optic sensors and their applications. LIDAR working principle and automotive applications. **(9)**

Thermal Sensors: Bimetallic strip, semiconductor-based temperature sensor, thermocouples, Resistance thermometers, thermistors, PTC and NTC thermistors and their applications. Infrared sensors: bolometer, Pyroelectric detector, photodiodes and phototransistor. **(9)**

Total L: 45 periods

TEXT BOOKS:
1. Ian R Sinclair, *'Sensors and Transducers'*. Newnes publishers, 3rd edition, 2011.
2. Krzysztof Iniewski, *'Smart Sensors for Industrial Applications'*. CRC Press Taylor and Francis, 2019.
3. E. O. Doebelin, *'Measurement Systems, Application and Design'*. McGraw Hill, 7th Edition, 2019.

REFERENCES:
1. Jack P Holman, *'Experimental Methods for Engineers*'. McGraw Hill, USA, 8th edition, 2012.
2. Jacob Fraden, *'Handbook of Modern Sensors: Physics, Design, and Applications'*. Springer, 5th edition, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working principles and characteristics of various sensors, including strain, pressure, motion, light, and thermal sensors, and their applications in engineering systems.	**K2**
CO2	Apply theoretical concepts to calculate the response of various sensors, such as strain gauges, capacitive sensors, and thermistor, in practical engineering applications.	**K3**
CO3	Analyze sensor data to assess performance in different environments, using appropriate methods to measure strain, motion, temperature, light, and other physical parameters.	**K4**
CO4	Prepare a report or presentation on the applications of different types of sensors in real-world engineering systems, emphasizing the comparison of their operating principles and advantages.	

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		1											
CO4						1			1		1		
@	**3**	**1**				**1**			**1**		**1**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC201 ELECTRON DEVICES
(Common to ECE and EE-VLSI)

3 1 0 4

SEMICONDUCTOR PHYSICS: Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors. Carrier transport: diffusion current, drift current, mobility and resistivity, Poisson and continuity equations, generation and recombination of carriers. **(6+3)**

SEMICONDUCTOR DIODE: Theory of PN Junction Diode and Zener diode – Characteristics, Temperature dependence- Break down mechanisms- Diode Resistance- Diode Capacitance- Diode Models- Rectifiers- Clipper- Clamper- Voltage regulator- Tunnel Diode, Varactor Diodes. **(10+3)**

BIPOLAR JUNCTION TRANSISTOR: Transistor types - Transistor Action - Current Components – Configurations – Transistor as a Switch and Amplifier - Small Signal Low Frequency Hybrid and π Model - Ebers Moll Model - DC and AC Load Lines - Operating Point - Bias stability, Bias Methods, Bias Compensation. **(9+3)**

FIELD EFFECT TRANSISTORS: JFET – Operation and Characteristics, MOSFET: Physical Operation, Current—Voltage Characteristics, Threshold voltage equations – MOS device equations, MOSFET as an Amplifier and Switch, MOS Capacitor, Small-Signal Operation and Models, MOSFET Configurations and Biasing- Second order effects. **(10+4)**

SPECIAL SEMICONDUCTOR DEVICES: Thyristor Family, UJT- Operation, Characteristics and Applications - Opto Electronic Devices and applications- Laser diode - Photo diodes - Photo Transistors - Light emitters – Organic LED – Liquid Crystal Displays – FINFETs, MESFETs, HEMT. **(10+2)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. J. Millman, C. C. Halkias and J. Satyabrata, *'Electronic Devices and Circuits'*. McGraw Hill Education (I) P Ltd., Chennai 2019.
2. T. L. Floyd, *'Electronic Devices and Circuits'*. Pearson, Chennai, 2021.

REFERENCES:

1. R. L. Boylestad and L. Nashelsky, *'Electronic Devices and Circuit Theory'*. Pearson, Chennai, 2021.
2. David A. Bell, *'Electronic Devices and Circuits'*. Oxford University Press, New Delhi, 2021.
3. Sedra and Smith, *'Microelectronic Circuits'*. Oxford University Press, New Delhi, 7th Edition, 2022.
4. Neil.H.E.Weste and Kamran Eshranghian, '*Principles of CMOS VLSI Design - A System Perspective'*.Pearson, Noida, 2017.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the underlying physics and structural design of semiconductor devices, and relate them to practical applications.	**K2**
CO2	Compute the critical device parameters of the device for different configurations.	**K3**
CO3	Analyse the operation of the device under varying operating conditions.	**K4**
CO4	Solve a case study pertaining to BJT and FET circuits in real time as a team and present their inference	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4								1	1		1	1	1
@	**3**	**2**						**1**	**1**		**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC202 NETWORK ANALYSIS
(Common to ECE and EE-VLSI)

3 1 0 4

DC CIRCUIT ANALYSIS: Charge and Current, Voltage, Power and Energy, Network Elements - Current and Voltage sources. Ohm's Law - Resistive circuits - Series and Parallel reduction method and analysis. Voltage and Current division. Source Transformation. Wye-Delta transformation. AC circuit analysis: Average and RMS values - Phasor representation of variables - Power triangle and average power - Resonance, magnetically coupled circuits. **(10+3)**

NETWORKS THEOREMS: Kirchoff‟s Laws -Source Transformation - Duality - Mesh and Nodal analysis-Superposition, Thevenin's and Norton's, Maximum power transfer, Reciprocity theorem, Tellegen's theorem. **(8+3)**

TRANSIENTS: Source free RL and RC circuits, Transient Response of RL and RC circuits for DC excitation and Sinusoidal excitation. Frequency Domain Analysis: Transient Response of RL, RC, RLC circuits for DC and Sinusoidal excitation using Laplace transform. **(9+4)**

ANALYSIS OF TWO PORT NETWORK: Network functions of single-port network, Driving point and transfer function of Two- port networks, Poles and Zeros of network functions Network Parameters-Impedance, admittance, transmission and hybrid, Conversion formulae. Properties – reciprocity and symmetry - Equivalents of T, Π, Ladder, bridged T and Lattice networks. **(10+3)**

FILTERS AND ATTENUATORS: Passive Filters - Low Pass, High Pass, Band Pass and Band Stop filters – Constant K and m- derived filter – Attenuators – T type, Π type, Lattice Attenuator. **(8+2)**

Total L:45 + T:15= 60 periods

TEXT BOOKS:

1. R. Singh, *'Network Analysis and Synthesis'*. McGraw-Hill Education, New Delhi, 2019.
2. C. Alexander and M.N.O. Sadiku, '*Fundamentals of Electric Circuits'*. Tata McGraw Hill, New Delhi, 2020

REFERENCES:

1. A. Sudhakar and Shyammohan S. Pillai, *'Circuits and Networks Analysis and Synthesis'*. McGraw Hill, New Delhi, 2020.
2. Abhijit Chakrabarthy, *'Circuit Theory Analysis and Synthesis'*. Dhanpath Rai and Sons, New Delhi, 2019.
3. M. Nahvi and J. A. Edminister, *'Theory and Problems Electric circuits'*. Tata McGraw Hill, New Delhi, 2017.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic laws and theorems required for electric and magnetic circuits	**K2**
CO2	Apply suitable laws and network theorems such as to electric and magnetic circuits to compute various electrical parameters.	**K3**
CO3	Examine the various electrical parameter obtained in a circuit by applying basic laws and theorems with the values obtained by simulating the circuit in SPICE simulators.	**K4**
CO4	Present a case study to evaluate the performance of practical circuits in power systems, communication and electronics.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		2										2	2
CO4			1					1	1		1	1	1
@	**3**	**2**	**1**					**1**	**1**		**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC203 OBJECT ORIENTED PROGRAMMING WITH PYTHON
(Common to ECE and EE-VLSI)

2 2 0 4

BASICS: Python - Variables – Executing Python from the Command Line - Editing Python Files - Python Reserved Words - Comments – Simple Input and Output—Indenting. Data types: Numeric, Boolean Data Types. Conditional Statements: if Statements – Loops: while Loop – break and continue – for Loop -String data type – methods. **(10+3)**

COLLECTIONS: Lists, Tuples - Sets – frozen sets-Mapping types: Dictionaries-Standard Modules: math- sys-time – dir function. **(6+6)**

FUNCTIONS: Definition – Passing parameters to a Function - recursive functions –Scope – Passing Functions to a Function – Lambda functions- Modules: Creating modules. Introduction to numpy –Matplotlib. **(6+6)**

FILE ORGANIZATION: Access Modes: Writing data to a File – Reading data from a file – seek –tell- Error Handling: Run Time Errors – Exception Model - Exception Hierarchy - Handling Multiple Exceptions – raise exceptions. **(6+6)**

OBJECT ORIENTED FEATURES: Principles of Object Orientation – Creating Classes, objects – Instance Methods –Special Methods – Class Variables – Inheritance – Polymorphism – Type Identification. **(6+6)**

Total L: 30 + T: 30 = 60 periods

TEXT BOOKS:

1. Mark Summerfield, *'Programming in Python 3: A Complete introduction to the Python Language'*. Addison-Wesley Professional, 2009.
2. Reema Thareja, *'Python Programming: Using Problem Solving Approach'*. Oxford university Press, 2017.

REFERENCES:

1. Wesley J Chun, *'Core Python Applications Programming'*. Prentice Hall, 2012.
2. Allen B Downey, *'Think Python'*. O'Reilly, 2012.
3. Martin C. Brown*, 'PYTHON: The Complete Reference'*. McGraw-Hill, 2018

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the fundamental Python programming concepts and Object-oriented principles.	**K2**
CO2	Apply object-oriented design and problem-solving techniques to develop efficient solutions for real world and complex computational problems.	**K3**
CO3	Interpret the Python programs for their correctness, efficiency, and appropriateness to given problem contexts.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				3			3	3		3		
CO3		2			2			2	2		2		
@	**3**	**2**			**3**			**3**	**3**		**3**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25HS201 தமிழரும் தொழில்நுட்பமும்
(Common to CIVIL, CSE, CS&AM, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

1 0 0 1

நெசவு மற்றும் பானைத் தொழில்நுட்பம்: சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள். **(3)**

வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள், சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை. **(3)**

உற்பத்தித் தொழில் நுட்பம்: கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணங்கள் – நாணயங்கள் அச்சடித்தல்- மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள். **(3)**

வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம். **(3)**

அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம். **(3)**

Total L: 15 periods

25HS201 TAMILS AND TECHNOLOGY
(Common to CIVIL, CSE, CS&AM, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

1 0 0 1

WEAVING AND CERAMIC TECHNOLOGY: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries **(3)**

DESIGN AND CONSTRUCTION TECHNOLOGY: Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period. **(3)**

MANUFACTURING TECHNOLOGY: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. **(3)**

AGRICULTURE AND IRRIGATION TECHNOLOGY: Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society. **(3)**

SCIENTIFIC TAMIL & TAMIL COMPUTING: Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project. **(3)**

Total L: 15 periods

TEXT BOOK

1. V Priyadharshini, '*தமிழரும் தொழில்நுட்பமும் (Tamils and Technology)*'. VK publications, Sivakasi.

REFERENCE BOOKS

1. கே. கே. பிள்ளை, தமிழக வரலாறு - மக்களும் பண்பாடும் - (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.)
7. Historical Heritage of the Tamils (Dr. S. V. Subrahmanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies).
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify the significance of ancient Tamil technologies in weaving, pottery, metallurgy, and architecture, with emphasis on traditional design and construction methods across historical periods.	**K2**
CO2	Use insights from traditional Tamil knowledge systems in agriculture, irrigation, and marine sciences, and connect the development of Tamil language to its applications in digital platforms and computing.	**K3**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							1		1		1		
CO2							1		1		1		
@							**1**		**1**		**1**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

LANGUAGE ELECTIVE

25HS211 COMMUNICATION SKILLS FOR ENGINEERS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 4 2

COMMUNICATION CONCEPTS: Process of Communication – Inter and Intrapersonal Communication – Essentials for effectiveness. **(9)**

ORAL COMMUNICATION: Oral presentations with visual aids and Group discussions. **(16)**

FOCUS ON SOFT SKILLS: Etiquette – Work Place etiquette – Telephone etiquette- Body Language – Critical Reasoning and Conflict Management based on Case Studies – Group Communication- Meetings -Interview Techniques. **(14)**

TECHNICAL WRITING: Technical Writing Principles - Style and Mechanics - Technical Definitions – Physical, Functional and Process Descriptions – Technical Report Writing – Preparing Instructions – Interpretation of Technical Data. **(14)**

BUSINESS CORRESPONDENCE: Writing Emails, Preparing Resumes. **(7)**

Total P: 60 periods

TEXT BOOKS:
1. Course materials prepared by the Faculty, Department of English, PSG Institute of Technology and Applied Research.

REFERENCES:

1. Jeff Butterfield, *'Soft Skills for Everyone'*. Cengage Learning, New Delhi, 2020.
2. Sabina Pillai and Agna Fernandez, *'Soft skills and Employability Skills'*. Cambridge University Press, New Delhi, 2019.
3. Prashant Sharma, *'Soft Skills Personality Development for Life Success'*. BPB Publications, New Delhi, 2021.
4. K. N. Shoba and D. Praveen Sam, *'Technical English'*. Cambridge University Press, New York, 2020.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Produce clear and concise technical reports, compose professional and effective emails and develop well-structured and impactful resumes	**K2**
CO2	Plan, organize, and deliver engaging and informative presentations using appropriate visual aids and participate positively in group discussions	**K3**
CO3	Resolve disagreements constructively, embody professional conduct and a strong work ethic and apply critical thinking to generate effective solutions	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							3		3		3		
CO2							1				1		
CO3							3		3		3		
@							**3**		**3**		**3**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25HS212 BASIC GERMAN
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 4 2

Guten Tag! - Learning: To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages; **Vocabulary:** related to the topic; **Grammar:** W – Questions, Verbs & Personal pronouns I.

Freunde, Kollegen und ich - Learning: To speak about hobbies, jobs, learn numbers from 20; **Vocabulary:** related to the topic; **Grammar:** Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural.

In der Stadt – Learning: To know places, buildings, question, know transport systems, understand international words; **Vocabulary**: related to the topic; **Grammar:** Definite & indefinite articles, Negotiation, Imperative with Sie.

Guten Appetit! – Learning: To speak about food, shop, converse; **Vocabulary:** related to the topic; **Grammar:** Sentence position, Accusative, Accusative with verbs.

Tag für Tag and Zeit mit Freunden – Learning: To learn time related expressions, speak about family, ask excuse, fix appointments on phone, birthdays, understand & write invitations, converse in the restaurant; **Vocabulary:** related to the topic; **Grammar:** Preposition – am, im, um, von…bis, Possessive articles, Modal verbs.

Total P: 60 periods

TEXT BOOK:

1. Dengler, Stefanie et al., '*Netzwerk A1.1*', Klett-Langenscheidt Gmbh, München, 2013.

REFERENCES:

1. Dengler, Stefanie et al., '*Netzwerk A1'*, Klett-Langenscheidt Gmbh München, 2013.
2. Sandra Evans, Angela Pude, Franz Specht, '*Menschen A1'*. Hueber Verlag ,2012.
3. Hermann Funk, Christina Kuhn, Silke Demme '*Studio d A1*', Goyal Publishers & Distributors Pvt. Ltd., 2009.
4. Rosa-Maria Dallapiazza, Eduard von Jan, '*Til Schönherr*'. Tangram Aktuell 1 (Deutsch als Fremdsprache), Max Hueber Verlag, 2004.

25HS213 BASIC JAPANESE
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 4 2

Orientation Session, Geographic & Socio, economic perspective to Japan, Japanese people and culture and Basic greetings and responses.

Basic script, Method of writing hiragana and katakana, and Combination sounds and simple words.

Topic marker "wa", Desu / dewa arimasen cupolas, Interrogative particle "ka", Grammar particles "mo", "no", "Introducing some one: "Kochira wa ~" and Self introductions: Hajimemashite"

Demonstratives "Kore", "Sore", "Are", Demonstrative "Kono", "Sono", "Ano", Possessive noun particle "no" and Japanese apartments: Greeting your neighbor.

Place markers "Koko", "Soko", "Asoko", Direction markers "Kochira", "Sochira", "Achira" and Japanese department stores: Asking for and buying something.

Asking for and telling the time, Particle "ni (at)" for time, kara (from) ~ made (until), Particle "to (and)", Time periods: Days of the week, months, time of day, Verbs (Present / future and past tense) and Telephone enquiry: Asking for a phone no. And business hours.

Destination particle "e", Particles "de (mode of transportation)" and "to (with) and Japanese train station: Asking for Fare and track no. / types of trains.
Direct object particle "o", Particle "de (place of action)", Verbs ("~masen ka", "~mashou") and "Ohanami" Cherry blossom viewing.

Particle "de (by means of)", Particle "ni (to)", Aaemasu (give) and Moraimasu (receive) and Visiting a Japanese house.
Adjectives ("i" and "na" type), Adjectives (Positive and negative usage), Particle "ga (however, but), "Dore

which?)" and Leaving a room, thanking someone for hospitality.

Likes and dislikes, Potential verbs (wakarimasu and dekimasu), "Kara (~ because)", Adverbs and Asking someone out over the phone.

Verbs denoting presence: "Imasu" and "arimasu", Particle "ni (in)", "Dare (who?)", Adverbs ("Chikaku ni ~ "), Particle "dare mo (negative ~ no one)" , Dare ka (anyone), dare ga (who) , Nani ka (anything) , nani ga (what) - ~ya (and) ~ nado (etc.) and Asking for directions.

Counters and Counting suffixes.

Introduction to Adjectives (na and ii type), Different usages of adjectives, Comparison, Likes and dislikes and Going to a trip.

Need and desire (ga hoshii), Wanting to … (Tabeti desu), Going for a certain purpose (mi – ni ikimasu) and Choosing from a menu.

Verb groups, I, II and III and Exercises to group verbs.

Please do (te kudasai), Present continuous tenses (te imasu), Shall I? (~ mashou ka) and Describing a natural phenomenon (It is raining).

To grant permission (~te mo ii desu), Asking for permission (~ te mo ii desu ka) and Should not do (~ te waikemasen) Describing a continuing state and Describing a habitual action.

Roleplays in Japanese.

A demonstration on usage of chopsticks and Japanese tea party.

Total P: 60 periods

TEXT BOOK

1. *'Minna no nohongo – Romaji ban'*, (first 10 lessons of this book).

REFERENCE

1. *'Minna no Nihongo I Honsatsu Roma – ji ban'* (Main Textbook Romanized Version), International publisher A Corporation,Tokyo, Indian distributor – Goyal Publishers & Distributors, New Delhi.

Third ACM

25EC211 DEVICES AND CIRCUITS LABORATORY
(Common to ECE and EE-VLSI)

0 0 4 2

LIST OF EXPERIMENTS:

1. Verification of Kirchhoff's Voltage and Current laws
2. Verification of Thevenin's theorem and Maximum Power Transfer Theorem
3. PN Junction Diodes and Rectifier circuits
4. Wave shaping circuits: Clippers and clampers
5. Zener Voltage Regulator
6. Evaluation of BJT Hybrid parameters
7. BJT Biasing Techniques
8. MOSFET Characteristics and its application as a switch
9. Verification of theorems – Superposition, Reciprocity
10. BJT and FET Characteristics
11. Characteristics of Thyristor Family Devices

AUGMENTED EXPERIMENTS*

1. Application circuits based on BJT.
2. Application circuits based on FET.
3. Application based on optoelectronic devices.
4. Design of Relaxation oscillator using UJT.

Total P: 60 periods

REFERENCES:

1. ECE Department Laboratory Manual, 2025

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Conduct experiments and verify the characteristics of various electronic devices	**K3**
CO2	Design various electronic circuits for the given specification and verify their characteristics for analog applications.	**K4**
CO3	Simulate various analog electronic circuits using SPICE	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3							3				3	3
CO2		3						3				3	3
CO3					2			2				2	2
@	**3**	**3**			**2**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EEC01 WORKPLACE COMMUNICATION SKILLS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 2 0

BUILDING COMMUNICATION SKILLS:

1. Introduction to Workplace Communication
2. Profile Building for Internships
3. English in the Workplace (Grammar & Vocabulary)
4. Professional Communication (Speaking & Writing)
5. Workplace Communication Tools
6. Career Exploration
7. Resume Update

Total P: 30 periods

REFERENCES:

1. P. C. Wren and H. Martin, *'High school English Grammar and Composition'*. S Chand Publishing, New Delhi, 2017.
2. Norman Lewis, *'Word Power Made Easy'*. Goyal Publisher, New Delhi, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the importance of soft skills for employability and fine tune their writing skills – Resume writing	**K2**
CO2	Present with clarity and coherence while speaking in formal contexts.	**K3**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2									3		3		
@									**3**		**3**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

SEMESTER-III

25MA304 MATRIX THEORY AND NUMERICAL METHODS
(Common to CIVIL, EEE, ECE, ICE, MECH and EE-VLSI)

3 1 0 4

EIGENVALUES AND EIGENVECTORS: Eigenvalues and eigenvectors of a real matrix – characteristic equation, properties - diagonalization - quadratic forms, reduction to canonical form by orthogonal reduction - Errors and approximations in numerical methods, power method for dominant eigenvalue. **(10+3)**

LINEAR ALGEBRIAC SYSTEM OF EQUATIONS AND NONLINEAR EQUATIONS: System of linear equations – Gauss elimination method, Crouts method, Gauss Seidal iterative method, Roots of equations - false-position method, Newton-Raphson method, Graeffe's root squaring method. **(8+3)**

INTERPOLATION, DIFFERENTIATION AND INTEGRATION: Newton 's forward and backward interpolating polynomials, Lagrange and Newton's divided difference interpolating polynomials. Numerical differentiation, numerical integration - Newton-Cotes formulae, Trapezoidal rule, Simpson 's 1/3 rule. **(12+4)**

ORDINARY DIFFERENTIAL EQUATIONS: Taylor-series method, Euler method, 4th order Runge-Kutta method, multi-step method – Milne's method. **(6+2)**

PARTIAL DIFFERENTIAL EQUATIONS: Finite difference: elliptic equations – Laplace equation, Poisson equation – Liebmann method, parabolic equations – heat conduction equation – Crank Nicolson 's method, hyperbolic equations – vibrating string. (**9+3)**

Total L: 45+T: 15 = 60 periods

TEXT BOOKS:

1. David C Lay, Judi J McDonald, Steven R Lay, *'Linear Algebra and its Applications'*, Pearson Education, New Delhi, 2021.
2. Steven C Chapra and Raymond P Canale, *'Numerical Methods for Engineers'*, Tata McGraw Hill, New Delhi, 2021.

REFERENCES:

1. Curtis F Gerald and Patrick O Wheatly, *'Applied Numerical Analysis'*. Pearson Education, New Delhi, 2017.
2. Rizwan B, *'Introduction to Numerical Analysis Using MATLAB'*. Infinity Science Press, Hingham, 2010.
3. Richard L. B and Douglas J. F, *'Numerical Analysis'*. Thomas Learning, NewYork, 2017.
4. Howard Anton, Chris Rorres, Anton Haul, *'Elementary Linear Algebra'*. Wiley India, New Delhi, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Matrix Theory and Numerical Methods.	**K2**
CO2	Apply the techniques of Matrix Theory and Numerical Methods to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems using Matrix Theory and Numerical Methods.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Matrix Theory and Numerical Methods.	**-**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4					2								
@	**3**	**2**			**2**								

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC301 ANALOG ELECTRONICS
(Common to ECE and EE-VLSI)

3 0 0 3

POWER SUPPLIES: Half wave and Full wave Rectifiers - Calculation of Ripple factor, Regulation, Rectification efficiency and TUF - Filters - L, C , L-Section and Pi - Voltage Regulators - Series and Shunt - Current limiting and protection circuits. **(9)**

SINGLE STAGE AMPLIFIERS AND TUNED AMPLIFIERS: BJT and MOSFET amplifiers - calculation of input and output impedance, voltage gain – Low and High Frequency Response of BJT and MOSFET Amplifier - Analysis of single tuned amplifiers. **(9)**

DIFFERENTIAL AMPLIFIERS: BJT and MOSFET Current Mirrors- Simple, Widlar, Wilson - Differential amplifier- Differential and common mode gain - CMRR - Circuits for improving CMRR using active load - Cascode and Darlington amplifiers. **(9)**

POWER AMPLIFIERS AND FEEDBACK AMPLIFIERS: Classification of Power Amplifiers-Class A/B/AB/C/D - Single ended and Push-pull configuration - Feedback Concepts - Effect of negative feedback on voltage and current feedback amplifier circuits. **(9)**

OSCILLATORS AND MULTIVIBRATORS: RC and RL integrator and differentiator circuits- Barkhausen criteria – Sinusoidal oscillators - RC, LC and Quartz – Frequency stability of oscillators - non-sinusoidal oscillators - Multivibrators - Bistable, Monostable and Astable -Schmitt Trigger. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Jacob Millman, Christos C Halkias and Satyabrata Jit, '*Electronic Devices and Circuits'*, McGraw Hill Education, 4th Edition, 2015.
2. Sedra and Smith, '*Microelectronic Circuits'*, Oxford University Press, NY, USA, 7th Edition, 2017.

REFERENCES:

1. Millman J and Taub H, '*Pulse, Digital and Switching waveforms'*, McGraw Hill International, 2011.
2. Donald L Schilling and Charles Belove, 'Electronic Circuits', Tata McGraw-Hill, 3rd Edition, 2002.
3. Allen Mottershed , '*Electronic Devices and Circuits'*, Prentice Hall of India, 2009.
4. David A Bell, '*Electronic Devices and Circuits'*, Prentice Hall of India, New Delhi, 2008.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the working principle of various Electronic Circuits.	**K2**
CO2	Compute the required parameters for the given Electronic Circuits.	**K3**
CO3	Analyze analog electronic circuits by evaluating the behavior and interaction of individual components to determine required parameters	**K4**
CO4	Design analog electronic circuits for a given specification.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										3	3
CO4			1		1							1	1
@	**3**	**2**	**1**		**1**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC302 DIGITAL ELECTRONICS
(Common to ECE and EE-VLSI)

3 0 0 3

NUMBER SYSTEMS AND BOOLEAN ALGEBRA: Number systems - Arithmetic operations-computer codes – Boolean algebra – basic postulates and theorems - canonical forms- Standard representation of logic functions- K-maps and Quine McClusky method- Introduction to Verilog. **(9)**

COMBINATIONAL LOGIC DESIGN: Binary / BCD adders, Subtractors, encoders, decoders, multiplexers and demultiplexers -Carry look ahead adder – Multiplier - magnitude comparator – ALU - Verilog implementation of Combinational logic circuits. **(9)**

SYNCHRONOUS SEQUENTIAL CIRCUITS: Flip-flops- latches - Shift registers- Design and analysis of clocked sequential circuits- synchronous counters- Sequence detector - state reduction techniques- Verilog implementation of Synchronous Sequential circuits. **(9)**

ASYNCHRONOUS SEQUENTIAL CIRCUITS: Fundamental and pulse mode circuits-Binary / BCD Ripple counter – Races -Hazards. Verilog implementation of Asynchronous sequential circuits. **(8)**

PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES: Classification of memories, Read/write operations- Memory decoding and expansion, Static and Dynamic RAM- PLDs- Architecture and implementation - Digital logic families -Characteristics - TTL, ECL and CMOS logic – Applications of PLDs. **(10)**

Total L: 45 periods

TEXT BOOKS:

1. Morris Mano, and M.D. Ciletti, '*Digital Design: with an introduction to Verilog HDL, VHDL and system Verilog'*, Pearson, New Delhi, 6th Edition, 2018.
2. Joseph Cavanagh, '*Digital Design and Verilog HDL Fundamentals'*, CRC Press, 2017.

REFERENCES:

1. Charles Roth and Lizykurian john, '*Digital Systems Design using Verilog'*, Cengage India private limited, 1st Edition, 2016.
2. Floyd T L, 'Digital Fundamentals', Pearson education, New Delhi, 11th Edition, 2017.
3. A Anandkumar, '*Fundamentals of Digital circuits'*, 4th Edition, Prentice Hall of India, New Delhi, 2016.
4. B.S Sonde, '*Introduction to System Design using Integrated circuits'*, New Age international Publishers, 2nd Edition,1992.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the core concepts of building blocks of Digital Electronic Circuits and Systems.	**K2**
CO2	Apply concepts and choose suitable logic blocks to realize digital logic functions.	**K3**
CO3	Analyze the combinational and sequential circuits to arrive at suitable conclusions	**K4**
CO4	Design digital circuits for the given application and implement in Verilog.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												1	1
CO2	3											3	3
CO3		3										3	3
CO4			1		1							1	1
@	**3**	**3**	**1**		**1**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV301 MICROFABRICATION AND SEMICONDUCTOR MATERIALS

3 1 0 4

FUNDAMENTALS OF SEMICONDUCTORS: Crystal properties and Growth of semiconductors: Crystal lattices, Bulk crystal Growth, Epitaxial Growth, Energy bands and charge carriers in semiconductors: Bonding forces and energy bands in solids, Charge carriers in semiconductors, Carrier concentrations, Drift of carriers in Electric and Magnetic Fields, Hall effect, Fermi level at equilibrium, Intrinsic vs Extrinsic semiconductors, Excess carriers in semiconductors, Diffusion and recombination, Diffusion length, Properties of Silicon and compounds, Gallium Arsenide, Metals used in IC fabrication.

(12+4)

THIN FILM GROWTH AND MATERIAL FORMATION: Top-Down and Bottom-Up Approach, Wafer Cleaning, Silicon Oxidation Techniques: Thermal Oxidation process, Deal-Groove model of oxidation, types of oxidation techniques, growth mechanism, factors affecting the growth mechanisms, dry & wet oxidation. Film deposition: Chemical Vapour deposition, Physical Vapour deposition, Polysilicon deposition, Dielectric deposition. **(12+4)**

PATTERNING, DOPING AND MATERIAL REMOVAL: Diffusion: Basic diffusion process, Extrinsic diffusion, Lateral diffusion, Ion Implantation: Range of Implanted Ions, Implant damage and Annealing, Tilt-Angle Ion Implantation. Photolithography: Optical lithography, Photoresists, Masks, Pattern Transfer. Etching: Wet Chemical Etching, Dry Etching, Isotropic and Anisotropic etching.

(6+2)

MEMS AND CASE STUDIES: LIGA process, Bulk and Surface Micromachining, Case studies: MEMS cantilever, Basic MOS Capacitor, MOSFET fabrication process, CMOS, FinFET Technology and process Integration. **(8+3)**

CHARACTERIZATION TECHNIQUES: Resistivity: Two-Point verses Four-Point Probe, Carrier and doping density: Capacitance-Voltage(C-V) characterization, Current-Voltage (I-V) characterization, Optical characterization: Introduction to Ellipsometry,Scanning probe microscopy: SEM, TEM, AFM. **(7+2)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. Ben Streetman and Sanjay Banerjee, '*Solid State Electronic Devices'*, Prentice Hall, 7th Edition 2015.
2. Jan M. Rabaey and Anantha Chandrakasan, '*Digital Integrated Circuits: A Design Perspective'*, Prentice Hall of India, 2016.
3. Tai-Ran Hsu, '*MEMS & Microsystems Design and Manufacture'*, Tata McGraw-Hill Education, 2002.
4. Neil H.E. Weste and David Harriis, '*CMOS VLSI Design_ A Circuits and Systems Perspective'*, Addison-Wesley, 4th Edition, 2011.

REFERENCES:

1. Stephen D. Senturia, '*Microsystem design'*, Springer (India), 2006.
2. Douglas A. Pucknell and Kamran Eshraghian, *'Basic VLSI Design'*, Prentice Hall of India, 3rd Edition 2011.
3. Amar Mukherjee, *'Introduction to nMOS and CMOS VLSI System Design'*, Prentice Hall, 1986.
4. Sung-Mo Kang and Yusuf Leblebici, '*CMOS Digital Integrated Circuits: Analysis and Design'*, McGraw Hill Education, 4th Edition, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of semiconductor physics to analyze the behavior of charge carriers under electric and magnetic fields in intrinsic and extrinsic semiconductors.	**K2**
CO2	Apply microfabrication techniques to develop basic devices, MOS capacitors, and MOSFETs.	**K3**
CO3	Analyze various material properties and device characterization techniques to interpret electrical and physical properties critical to semiconductor device performance	**K4**
CO4	Simulate microfabrication process and semiconductor devices using modern tools	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		2										2	2
CO4					2							2	2
@	**3**	**2**			**2**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25HS301 PROJECT AND FINANCE MANAGEMENT
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO PROJECT MANAGEMENT: Project: Trends in project management, project management versus general management, agile project management, the three goals of a project, life cycle of projects, project selection methods, project portfolio process, case study – friendly assisted living facility. **(9)**

ROLE OF PROJECT MANAGER AND ORGANISATION: Project manager's roles and responsibilities, selection of a project manager, project management as a profession, fitting projects into the parent organisation, the project team and agile team roles, case study – the company with traditional functional organizational structure setting up teams for the new initiatives. **(9)**

PROJECT ACTIVITIES: The planning process, work-breakdown structure and other aids, risk management, methods of budgeting, cost estimation, scheduling the project with PERT and CPM networks, allocating resources, resource loading and leveling, Goldratt's Critical Chain, application – using ProjectLibre for project management, case study – success of Chandrayan-3. **(9)**

INTRODUCTION TO FINANCE MANAGEMENT: Overview - finance and related disciplines, scope and objectives of financial management, time value of money, and risk and return and calculations with spreadsheet, analysis using cash flow statement and other statements. **(9)**

PERSONAL FINANCE: Compounding, debt, equity and financial markets and investments- debt and bonds. Equity, mutual funds, hedge funds, real estate, and commodities, Personal financial plan to enhance wealth and job marketability, components of a financial plan, tools for planning – financial statements, applying time value concept of money and tax planning. **(9)**

Total L: 45 periods

TEXTBOOKS

1. Jack R. Meredith and Scott M. Shafer, '*Project Management in Practice'*, Wiley, 2021.
2. Khan M. Y. and Jain P. K., '*Basic Financial Management'*, Tata McGraw Hill, 2012.
3. Michael Fisher, '*Saving and Investing'*, Author House, 2005.
4. Jeff Madura, '*Personal Finance'*, Pearson, 2020.

REFERENCES:

1. National Finance Olympiad, 'Personal Finance Handbook', Pockvue Solutions, 2024.
2. Glen Arnold, '*Investing*', Financial Times Guides, 2020.
3. Rachel Siegel and Carol Yacht, '*Personal Finance'*, Open Textbook Library, Saylor Foundation, 2009.
4. Google, '*Google Project Management: Professional Certificate',* Google Project Management: Professional Certificate, Coursera.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Distinguish project management from general management and interpret the phases of project life cycle.	**K2**
CO2	Understand the roles and responsibilities of project manager and how projects are integrated into different types of organizational structures.	**K2**
CO3	Identify various budgeting and cost estimation techniques suited to different project scenarios and the use project scheduling methods.	**K2**
CO4	Apply theoretical knowledge and practical tools to support sound financial decision-making in real-world scenarios.	**K3**
CO5	Differentiate between various financial instruments and application of financial planning to enhance personal wealth.	**K3**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								2		2			
CO2								3		3			
CO3								2		2			
CO4						2	2			2			
CO5							1			1			
@						**2**	**2**	**3**		**3**			

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC311 ANALOG ELECTRONICS LABORATORY
(Common to ECE and EE-VLSI)

0 0 2 1

LIST OF EXPERIMENTS

1. Full Wave Rectifiers with and without filters.
2. Series voltage regulators.
3. BJT amplifiers.
4. MOSFET amplifiers.
5. RC phase shift and Colpitt's oscillators.
6. Class B and Class AB amplifiers.
7. Astable and Monostable Multivibrators.
8. Schmitt Trigger.
9. Current mirrors and Differential amplifiers
10. MOS CS amplifier with resistive load and current source load
11. Feedback Amplifiers
12. RC Integrator and Differentiator Circuits.

AUGMENTED EXPERIMENTS*

1. Design of a regulated power supply.
2. Design of an audio power amplifier.
3. Design of an Automatic gain control circuit using a differential amplifier.
4. Application using multivibrator circuits.

Total P: 30 periods

REFERENCES:

1.ECE Department Laboratory Manual, 2025
2. David A Bell, '*Electronic Devices and Circuits'*, Prentice Hall of India, New Delhi, 2008.

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Conduct experiments and verify the characteristics of various electronic devices	**K2**
CO2	Design various electronic circuits for the given specification and verify their characteristics for analog applications.	**K3**
CO3	Simulate various analog electronic circuits using SPICE	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	3
CO2		3						3				3	3
CO3			1		1			1				1	1
@	**3**	**3**	**1**		**1**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC312 DIGITAL ELECTRONICS LABORATORY
(Common to ECE and EE-VLSI)

0 0 2 1

LIST OF EXPERIMENTS
1. Half adder and Full adder
2. Code Conversion: BCD to Gray and Seven segment conversion
3. Multiplexers/Demultiplexers
4. Encoders/Decoders
5. Flip-flops
6. Shift Registers
7. Ring Counter and Johnson Counter
8. Asynchronous Counters
9. Adder / Subtractor Circuits and BCD adder using verilog
10. Magnitude Comparator and ALU using verilog
11. Synchronous Counters using verilog
12. Sequence Detector using verilog

AUGMENTED EXPERIMENTS*
1. Design of Hamming code generator for 8-bit data
2. Design of Digital Clock
3. Develop Verilog code for 4-bit Universal Shift Register
4. Develop Verilog code for Arithmetic Logic Unit

Total P: 30 periods

REFERENCES:
1. ECE Department Laboratory Manual, 2025

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Conduct suitable experiments to demonstrate functionality of the digital logic circuits.	**K2**
CO2	Apply digital design principles and choose/use basic building blocks of digital circuits for the given application.	**K3**
CO3	Design a digital circuit for the given application, implement in Verilog and verify the functionality.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3							3				3	3
CO3			2		2			2				2	2
@	**3**		**2**		**2**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EEC02 FOUNDATIONS OF PROBLEM SOLVING
(Common to ECE and EE-VLSI)

0 0 2 1

1. Speed Mathematics (SAW, Oz, Mirror methods)
2. Speed Mathematics (High5, Minion, Butterfly methods)
3. Speed Mathematics (Inception, Goldeneye methods)
4. Thinking with Numbers
5. Problem Solving with Visual information
6. Words Puzzles
7. Resume Writing Essentials

Total P: 30 periods

REFERENCES:
1. R.S. Agarwal, '*Quantitative Aptitude for Competitive Examination*', S Chand Publishing, New Delhi, 2017.

SEMESTER IV

25MA404 PROBABILITY AND RANDOM PROCESSES
(Common to ECE, ICE, MECH and EE-VLSI)

3 1 0 4

RANDOM VARIABLES: Probability: Review of basic concepts, discrete random variables: probability mass function, cumulative distribution function, binomial, Poisson and geometric random variables, expected values. Continuous random variables: cumulative distribution function, probability density function, uniform, exponential and Gaussian random variables, expected values. **(11+3)**

MULTIPLE RANDOM VARIABLES: Joint cumulative distribution function, joint probability mass function, marginal probability mass function, joint probability density function, marginal probability density function, independent random variables, expected values, covariance, correlation and independence. **(10+3)**

SUMS OF RANDOM VARIABLES AND ESTIMATION: Expectations of sums, moment generating functions, mgf of sums of independent random variables, central limit theorem, laws of large numbers. Estimation of a random variable: linear estimation of X given Y, MAP and ML estimation. **(8+3)**

RANDOM PROCESSES: Definition, classifications of random processes, Poisson process, Brownian motion process, expected value and correlation, stationary processes, strict sense and wide sense stationary processes, cross covariance, cross correlation. **(8+3)**

POWER SPECTRAL DENSITY AND LINEAR SYSTEMS: Linear filtering of a continuous-time random process, linear filtering of a random sequence, power spectral density of a continuous-time process, Wiener-Khintchine theorem (statement), power spectral density of a random sequence. **(8+3)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. Roy D Yates and David J Goodman, '*Probability and Stochastic Processes'*, Wiley India, New Delhi, 2021.
2. Athanasios P and Unnikrishna P S, '*Probability, Random Variables and Stochastic Processes'*, Tata McGraw Hill, New Delhi, 2017.

REFERENCES:

1. Saeed Ghahramani, '*Fundamentals of Probability with Stochastic Processes'*, CRC Press, USA, 2018.
2. Douglas C Montgomery and George C Runger, '*Applied Statistics and Probability for Engineers'*, Wiley India, New Delhi, 2018.
3. Oliver C Ibe, '*Fundamentals of Applied Probability and Random Processes'*, Elsevier Academic Press, USA, 2005.
4. Scott Miller and Donald Childers, '*Probability and Random Processes: With applications to Signal Processing and Communications'*, Academic Press, USA, 2012.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the concepts related to Random variables, Random processes and Power spectral density.	K2
CO2	Apply the techniques of Random variables, Random processes and Power spectral density. to solve engineering problems.	K3
CO3	Analyze the solutions of engineering problems using Random variables, Random processes and Power spectral density.	K4
CO4	Use modern tools to solve engineering problems with the help of Random variables, Random processes and Power spectral density.	-

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4					2								
@	3	2			2								

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC401 LINEAR INTEGRATED CIRCUITS
(Common to ECE and EE-VLSI)

3 0 0 3

OPERATIONAL AMPLIFIERS: Block diagram - Ideal Operational Amplifier Characteristics - DC and AC characteristics - frequency response - Stability.

(9)

APPLICATION OF OPERATIONAL AMPLIFIERS: Linear applications- DC & AC amplifiers- summing differential amplifier-instrumentation amplifier-Log and antilog amplifiers-V to I and I to V Converters-Integrator-Differentiator-Active filters. Nonlinear applications - Op-Amp circuits using diodes-Comparators-Schmitt Trigger- Oscillators-Waveform Generators-Sample and hold circuits.

(9)

TIMER AND PHASE LOCKED LOOP: 555 Timer - modes of operation and applications- Voltage Controlled Oscillator - Phase Locked Loop and applications.

(9)

A-D AND D-A CONVERTERS: Digital to Analog converters: Binary weighted and R-2R Ladder types - Analog to digital converters: Flash, Counter, Successive approximation and Dual slope - DAC / ADC performance characteristics and comparison.

(9)

VOLTAGE REGULATORS: Fixed voltage regulators - adjustable voltage regulators - IC Voltage regulators - Buck & Boost regulators - Switching regulators.

(9)

Total L: 45 periods

TEXTBOOKS:

1. D. Roy Choudhury and Shail Bala Jain, *'Linear Integrated Circuits'*, New Age International Publishers, NewDelhi, 6th Edition, 2022.
2. James.M.Fiore , '*OP- AMPS and Linear Integrated Circuits-concepts and applications'*, Cenage learning India, New Delhi, 3rd Edition , 2019.

REFERENCES:

1. Ramakant A. Gayakwad, '*Op-Amps and Linear Integrated Circuits'*, Pearson Noida, 4th Edition, 2016.
2. Michael Jacob J, *'Analog Integrated Circuits and Applications'*, Prentice Hall of India, New Delhi, 1st Edition 2019.
3. Robert F Coughlin and Fedrick F Driscoll, '*Operational amplifiers and linear Integrated Circuits'*, Pearson, Noida, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the characteristics and applications of OPAMP	**K2**
CO2	Apply the basic concepts of OPAMP to various applications of Linear Integrated Circuits	**K3**
CO3	Analyse the operation of various Linear Integrated Circuit applications	**K4**
CO4	Design OPAMP Circuits for real-time applications	**K6**
CO5	Carry out a mini project as a team to implement the given real-world application	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			1									1	1
CO5						2		2			2	2	2
@	**3**	**2**	**1**			**2**		**2**			**2**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC402 SIGNALS AND SYSTEMS
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION & LTI SYSTEMS: Continuous Time (CT) and Discrete Time (DT) signals: Operations - Basic signals - Classification - Properties of CT & DT systems – Analysis of LTI systems - Convolution Sum - Convolution Integral – Properties.
(9)

FOURIER SERIES ANALYSIS FOR CT & DT SIGNALS AND SYSTEMS: Representation of CT periodic signals by Continuous Time Fourier Series (CTFS) - Convergence - Properties - Representation of DT periodic signals by Discrete Time Fourier Series (DTFS) – Properties.
(9)

FOURIER TRANSFORM ANALYSIS FOR CT & DT SIGNALS AND SYSTEMS: Representation of CT aperiodic and periodic signals by Continuous Time Fourier Transform (CTFT) - Convergence - Properties - Frequency response of CT systems - Representation of DT aperiodic and periodic signals by Discrete Time Fourier Transform (DTFT) – Convergence - Properties - Frequency response of DT systems. **(9)**

SAMPLING: Representation of CT signals by samples - Impulse train sampling - Effect of under sampling - Reconstruction of CT signal from samples using interpolation - Zero-order hold Sampling.
(9)

Z TRANSFORM ANALYSIS OF DT SIGNALS AND SYSTEMS: z- transform - Properties - Inverse z-transform - Partial fraction and Cauchy Residue methods - Analysis of LTI systems using z transform - Solution of difference equations - Stability and causality in z-plane.
(9)

Total L: 45 periods

TEXT BOOKS:

1. Alan V Oppenheim, Alan S Willsky and Hamid Nawab S, '*Signals and Systems'*, Pearson, 2nd Edition, 2021.
2. V Krishnaveni and A Rajeswari, 'Signals and Systems', Wiley India, 1st Edition, 2019.

REFERENCES:

1. Simon Haykin and Barry Van Veen, '*Signals and Systems'*, Wiley India, 2nd Edition, 2018.
2. HP Hsu and R Ranjan, '*Signals and Systems'*, Schaums's Outlines, Tata McGraw Hill, 2nd Edition, 2010.
3. Samir S. Soliman and Mandyam Dhati Srinath, *'Continuous and Discrete Signals and Systems'*, Prentice Hall International, Second Edition, 2011.
4. Luis F. Chaparro, '*Signals and Systems Using MATLAB'*, Academic Press, An Imprint of Elsevier, 1st Edition, 2011.
5. MIT open courseware https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the fundamentals of signals and systems	**K2**
CO2	Apply the mathematical concepts and transform techniques to characterize signals and to solve the continuous and discrete LTI systems	**K3**
CO3	Analyze various methods to categorize the LTI systems and identify solutions for mathematical representations of systems	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EC404 DATA STRUCTURES AND ALGORITHMS
(Common to ECE and EE-VLSI)

3 2 0 5

INTRODUCTION: Data types – Abstract data types – Types of Data structures- Algorithms- properties – Design and development of algorithm-Recursive Algorithms- Analysis of Algorithms-Best case, Average case, Worst case – Asymptotic Notations.

(9+6)

LINEAR DATA STRUCTURES: Arrays-operations – Memory Representation- Row Major and Column Major – Multi Dimensional Arrays – Sparse Matrix, Dense Matrix. Stack: Array implementation – operations- Applications – Checking of well-formedness Parenthesis Infix to Postfix –Conversions.

(9+6)

QUEUES: Queue Operations-Circular Queue - Priority Queues - Array Implementation of Queue.Linked List:. Types-Singly Linked List – Circularly Linked List – Doubly Linked List–List operations-linked stack-linked queue. **(9+6)**

NONLINEAR DATA STRUCTURES: Trees-Terminologies - Binary trees – Representations – Operations – Traversals- Inorder, Preorder and Postorder- Binary Search Trees – Insertion and deletion. Graph: Terminologies -Breadth First Search algorithm- Depth First Search Algorithm.

(9+6)

SORTING AND SEARCHING: Bubble Sort – Insertion Sort – Radix Sort- Quick sort- Algorithms and Time Complexity. Linear Search – Binary Search – Hashing: Hash functions – Separate Chaining – Open Addressing – Linear Probing.

(9+6)

Total L: 45 + T: 30 = 75

TEXT BOOKS:

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, *'Introduction to Algorithms'*, The MIT Press, 2022.
2. Mark Allen Weiss, *'Data Structures and Algorithm Analysis in C++'*, Pearson Education, 2012.

REFERENCES:

1. Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran. 'Fundamentals of Computer Algorithms' Second Universities Press, 2011.
2. Sahni Sartaj. '*Data Structures, Algorithms and Applications in C++*', Silicon Press, 2009.
3. Aaron M Tanenbaum,Moshe J Augenstein and YedidyahLangsam. '*Data structures using C and C++*', PHI Learning, 2009.
4. G A V Vijayalakshmi Pai. '*Data Structures and Algorithms Concepts, Techniques and Allocations'*, New Delhi: McGraw Hill Education (India) Private Limited, 2015.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of Data structures and its applications	**K2**
CO2	Apply the concepts of Data structures for any real world/technical application	**K3**
CO3	Analyse linear/non-linear data structure algorithms for problem solving	**K4**
CO4	Develop and demonstrate real time applications in data structures as a team	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		2			2								
CO4			1		1	1			1	1	1		
@	**3**	**2**	**1**		**3**	**1**			**1**	**1**	**1**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV401 CMOS VLSI DESIGN

3 1 0 4

INTRODUCTION TO DIGITAL IC DESIGN: Historical Perspective, Moore's Law, Scaling Challenges, MOS Transistors, CMOS Logic, CMOS Fabrication and Layout, Stick diagrams, Design Partitioning, Abstractions, Digital IC Design Flow, CMOS inverter – DC Transfer Characteristics, Noise Margin, Power dissipation. **(9+3)**

VERILOG HDL: HDL and EDA tools overview, Importance of HDL, Structural specification of Hardware using Verilog, Writing test bench. Design and implementation logic circuits with Verilog: Combinational logic circuits- Multiplexers, Decoders, Encoders, Code Converters, Design of adders, Multipliers, Booths and Modified Booths multiplier Barrell shifters, Arithmetic comparison circuits, Logarithmic shifter. sequential logic circuits with Verilog- Latches and flip-flops, counter, FSM Design: Moore vs Mealy. **(9+3)**

CMOS CIRCUIT DESIGN: Combinational logic circuits - Static CMOS logic- Complementary CMOS, Ratioed logic, Pass- Transistor, Transmission gate - Dynamic CMOS logic – Performance, Noise considerations, Logical efforts- Elmore delay model, domino logic, npCMOS logic - Sequential logic circuits - static and dynamic flip-flops, Synchronous Design, Self-Timed Circuit Design. **(9+3)**

FPGA & ASICS: Goals and techniques, basic FPGA design flow- RTL to Bitstream, FPGA architectures– Configurable logic blocks-configurable I/O blocks, Programming Technologies: Antifuse, SRAM, EPROM, EEPROM, Introduction to ASIC design flow RTL to GDSII. **(9+3)**

ARCHITECTING SPEED AND TIMING ISSUES: High Throughput - Low Latency - Timing - Add Register Layers, Parallel Structures, Flatten Logic Structures, Register Balancing, reorder Paths. CLOCKING AND METASTABILITY: Set up time, hold time, setup time-hold time violations, critical path-calculation of maximum clock frequency– metastability - synchronizers- design examples. **(9+3)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. Neil H. E. Weste, and David Money Harris, '*CMOS VLSI Design: A Circuits and Systems Perspective*', Pearson, 2017.
2. Jan M. Rabaey and Anantha Chandrakasan, '*Digital Integrated Circuits: A Design Perspective*', Prentice Hall of India, 2016.
3. Stephen Brown and Zvonko Vranesic, '*Digital Logic with Verilog Design*', McGraw Hill, 2003.
4. Michael D. Ciletti, '*Advanced Digital Design with the Verilog HDL*', Pearson, 2nd Edition, 2011.
5. Steve Kilts, '*Advanced FPGA Design: Architecture, Implementation, and Optimization*', John Wiley & Sons, 1st Edition, 2007.

REFERENCES:

1. Zainalabedin Navabi,' *Verilog Digital System Design*', McGraw-Hill Education, 2nd Edition, 2005.
2. Ming-Bo Lin, '*Digital System Designs and Practices: Using Verilog HDL and FPGAs*', Wiley, 1st Edition, 2008.
3. Samir Palnitkar, '*Verilog HDL: A Guide to Digital Design and Synthesis*', SunSoft Press, 2003.
4. Douglas A. Pucknell and Kamran Eshraghian, '*Basic VLSI Design*', Prentice Hall of India, 3rd Edition, 2011.
5. Amar Mukherjee, '*Introduction to nMOS and CMOS VLSI System Design*', Prentice Hall, 1986.
6. Sung-Mo Kang and Yusuf Leblebici, '*CMOS Digital Integrated Circuits: Analysis and Design*', McGraw Hill Education, 4th Edition, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of Metal Oxide Semiconductor transistors, IC design techniques, FPGA architectures and testing strategies.	**K2**
CO2	Apply the knowledge of CMOS technology and Digital System Design in the context of VLSI circuits and subsystems.	**K3**
CO3	Analyse CMOS circuits and subsystems and obtain the desired performance metrics	**K4**
CO4	Design CMOS based combinational and sequential circuits for a given specification	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			1		1							1	1
@	**3**	**2**	**1**		**1**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EC411 LINEAR INTEGRATED CIRCUITS LABORATORY
(Common to ECE and EE-VLSI)

0 0 2 1

LIST OF EXPERIMENTS

1. Design and testing of Inverting, Non-Inverting, Differential amplifiers, Integrator and Differentiator
2. Design and testing of Rectifiers using precision diodes
3. Design and testing of Comparators and Schmitt Trigger using op-amp
4. Design and testing of Phase shift and Wien bridge oscillators using op-amp
5. Frequency response analysis of Second order High pass and wide Band pass filters
6. Design and testing of Astable and monostable multivibrators using Timer.
7. Design and testing of Digital to Analog Converters and Analog to Digital converters
8. Design and testing of Low dropout voltage regulators
9. Design and testing of Instrumentation amplifier
10. Design and testing of Log and Antilog amplifiers
11. Design and testing of Universal Filters
12. Design and testing of Voltage Controlled Oscillator

AUGMENTED EXPERIMENTS*

1. Design of a function generator to generate sine/square/Triangular waveforms.
2. Design a circuit to reduce the power supply noise.
3. Design of a frequency synthesizer using PLL.
4. Application using 555 timer circuits.

Total P: 30 periods

REFERENCES:

1. ECE Department Laboratory Manual, 2025, *PSG iTech*
2. D. Roy Choudhury and Shail Bala Jain, *'Linear Integrated Circuits'*, New Age International Publishers, New Delhi, 6^{th} Edition, 2022.
3. Ramakant A. Gayakwad, 'Op-Amps and Linear Integrated Circuits', Pearson, Noida, 4th Edition, 2016.

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Conduct experiments and verify the characteristics of various electronic op-Amp devices	**K3**
CO2	Design various electronic op-Amp circuits for the given specification and verify their characteristics.	**K6**
CO3	Simulate various Op-Amp based and timer electronic circuits using SPICE	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3							3				3	3
CO2			2					2				2	2
CO3		2			2			2				2	2
@	**3**	**2**	**2**		**2**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EV411 FPGA PROGRAMMING LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Introduction to Verilog Modeling Styles and their Synthesis Implications: Case study: Implementation of a 4-bit 2-to-1 multiplexer using Behavioral, Dataflow and Structural modelling
2. Design a module to convert Binary Coded Decimal (BCD) to Gray Code and then display the Gray Code value on a 7-segment display.
3. Design PWM based LED brightness control
4. Design UART communication module
5. Design a Digital wall Clock and display the time.
6. SPI or I2C interfacing with Temperature sensor and display
7. Design a debounce circuit and realtime counter
8. Design and implement a Parking lot occupancy counter.
9. FPGA System design using IP Integrator

AUGMENTED EXPERIMENTS*

1. Design and Implementation of Parametrized N-bit Adder
2. Design and Implementation of a traffic light controller using both Mealy and Moore machines.
3. Design, simulate, and synthesize a 4×4 matrix multiplication using C/C++ in Vitis HLS, and generate the corresponding RTL (Verilog) for FPGA implementation.

Total P: 30 periods

REFERENCES:

1. ECE Department, ‘Laboratory Manual’, 2025, PSG iTech.

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Apply Verilog and SystemVerilog modeling techniques to design, simulate, and synthesize digital systems on modern FPGA platforms.	**K3**
CO2	Analyze trade-offs between resource utilization, power consumption, and timing performance in FPGA-based system implementations.	**K4**
CO3	Create a functional embedded application by integrating sensor input, logic, and display using FPGA resources.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3			3				3	3
CO2		3						3				3	3
CO3			2		2			2				2	2
@	**3**	**3**	**2**		**3**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVE01 MINI PROJECT - I

0 0 2 1

OBJECTIVES

- Identification of a real time problem in thrust areas.
- Developing a mathematical model for solving the above problem.
- Finalization of system requirements and specification.
- Simulation / Implementation of different solutions for the problem based on literature survey and future trends in providing alternate solutions.
- Consolidated report preparation of the above.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply engineering knowledge to identify, analyze, design, and implement a real-time problem using appropriate tools and techniques, while considering societal, environmental, ethical aspects, working effectively in teams, communicating results clearly, and engaging in lifelong learning.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EEC03 PROBLEM SOLVING
(Common to ECE and EE-VLSI)

0 0 2 1

1. Algorithmic Thinking, Branching & Repetition Problems
2. Logical Reasoning - Data Arrangements & Relations
3. Solving problems based on Coding & decoding, Series, Analogy, Odd man out and Visual reasoning
4. Problems based on Ages, Logical Connectives, Syllogisms, Data Interpretation & Data Sufficiency
5. Solving problems on Clocks Calendars, Direction Sense & Cubes
6. Problems based on Number system, Percentages, Simple & Compound Interest
7. Resume Update

Total P: 30 periods

REFERENCES:

1. R.S. Agarwal, '*Quantitative Aptitude for Competitive Examination'*, S Chand Publishing, New Delhi, 2017.

SEMESTER V

25EC503 CONTROL SYSTEMS
(Common to ECE and EE-VLSI)

3 1 0 4

INTRODUCTION: Modeling of Electrical and Mechanical systems - Translational and Rotational systems – Block diagram –Signal flow graph - Mason's gain formula. **(9+2)**

TIME AND FREQUENCY DOMAIN ANALYSIS: Standard Test signals – Time response of second order systems - Performance specifications on system time response - Types of systems - Steady state error - Generalized error series - Introduction to PID Controllers – Performance specifications on system Frequency response – Correlation between time and frequency response. **(10+3)**

STABILITY ANALYSIS: Concepts of Stability - Routh Stability Criterion - Root locus technique. **(6+2)**

FREQUENCY RESPONSE PLOTS AND SYSTEM STABILITY: Polar plot - Nyquist stability Criterion - Bode plot - Compensator design using Bode Plot. **(10+4)**

STATE VARIABLE ANALYSIS: Introduction –State space representation of continuous time systems using Physical and Phase Variables – Solution of state equations–Concepts of Controllability and Observability. **(10 +4)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. Nagrath I J, and Gopal, M, ‘*Control Systems Engineering*’, New Age International P Ltd, New Delhi, 7th Edition, 2022.
2. Norman S Nise, ‘*Nise's Control Systems Engineering*’, Wiley, New Delhi, 5th Edition, 2022.

REFERENCES:

1. Katsuhiko Ogata, ‘*Modern Control Engineering’*, Pearson, New Delhi., 5th Edition, 2021.
2. Kuo B C, ‘*Automatic Control Systems*’, McGraw Hill Education (I) P Ltd, Chennai, 10th Edition 2018.
3. Katsuhiko Ogata, ‘*Discrete Time Control Systems*’, Pearson Education Asia, New Delhi, 2nd Edition 2016.
4. Smarajit Ghosh, ‘*Control Systems Theory and Applications’*, Pearson Education Asia, Chennai, 2nd Edition, 2022.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the basic concepts related to Control Systems	**K2**
CO2	Apply the knowledge of control system fundamentals to form mathematical model and obtain transfer function/state space representation of a systems	**K3**
CO3	Analyze the stability of LTI systems in time and frequency domain using different stability analysis concepts	**K4**
CO4	Demonstrate the concepts of linear control systems using modern tools as an individual/team.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		2										2	2
CO4					1			1				1	1
@	**3**	**2**			**1**			**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV501 COMPUTER ORGANIZATION

3 0 0 3

INTRODUCTION: Generations of computer system - Elements of computer - CPU organization - Instruction formats - Addressing modes - Instruction types - CISC and RISC architectures.

(9)

DATA PATH DESIGN: Fixed point arithmetic - adder / subtractor - Signed magnitude multiplication algorithm - Robertson multiplication algorithm - Booth's and modified Booth's multiplication algorithm - non-restoring division algorithm - restoring division algorithm - floating point arithmetic - addition, subtraction, multiplication and division - ALU - Verilog implementation of datapath components

(9)

CONTROL LOGIC DESIGN: Control organization - Hardwired Control - one flip flop per state - sequence register and decoder - PLA control - Micro programmed control - performance enhancement techniques - parallel processing - arithmetic pipeline, instruction pipeline - Amdhal's law - Measuring CPU performance – Verilog implementation of control logic components.

(9)

MEMORY ORGANIZATION: Basic Concepts - Memory Hierarchy - Main Memory - Auxiliary Memory – Associative Memory - Cache and Virtual Memory - SDRAM, DDRAM, QDRAM - Flash memories.

(9)

INPUT / OUTPUT AND SYSTEM ORGANIZATION: Input / Output Interface - Modes of data transfer - I/O Processor - Interrupts -Communication methods - Buses -Bus control - Bus interfacing - Bus arbitration -Multicore architectures - Introduction to RISC V.

(9)

Total L: 45 periods

TEXT BOOKS:

1. Morris Mano M, '*Digital Logic and computer design*', Pearson Education, New Delhi, 2016.
2. Hayes J P, '*Computer architecture and Organization*', McGraw Hill, New Delhi, 2012.

REFERENCES:

1. Stallings W, '*Computer Organization and Architecture: Designing for performance'*, Pearson Education, New Delhi, 10th Edition, 2016.
2. Patterson D and Hennessy J, '*Computer Organization and Design RISC-V Edition: The Hardware Software Interface*', Morgan Kaufmann Publishers, 2nd Edition, 2021.
3. Joseph Cavanagh, '*Computer Arithmetic and Verilog HDL Fundamentals*', CRC Press, 2020.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic structure and functions of the building blocks of a digital computer.	**K2**
CO2	Apply the principles of data path and control unit design to perform arithmetic and logic operations and develop Verilog code.	**K3**
CO3	Analyse the impact of various factors on CPU performance and the different memory mapping techniques	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV502 VLSI DESIGN FOR TESTABILITY

3 0 0 3

INTRODUCTION TO VLSI TESTING: Importance of testing in VLSI design and manufacturing - Defect and fault modeling: stuck-at, bridging, delay, and crosstalk faults - Test economics and yield analysis - Overview of VLSI design flow and its impact on testability. **(9)**

FAULT SIMULATION AND TEST PATTERN GENERATION: Fault simulation techniques: serial, parallel, deductive, and concurrent - Automatic Test Pattern Generation (ATPG) algorithms: D-algorithm, PODEM, FAN - Test generation for combinational and sequential circuits - Testability measures and fault coverage analysis. **(9)**

DESIGN FOR TESTABILITY (DFT) TECHNIQUES: Scan design methodologies: full scan, partial scan, and scan path design - Built-In Self-Test (BIST) architectures: logic BIST, memory BIST - Boundary scan and IEEE 1149.1 (JTAG) standard - Test compression techniques and test access mechanisms. **(9)**

ADVANCED VLSI TESTING: Delay fault testing and path delay fault models - Analog and mixed-signal testing methodologies - System-on-Chip (SoC) and Network on Chip (NoC) testing challenges and solutions - Fault diagnosis and debugging strategies. **(9)**

TESTABLE MEMORY DESIGN: RAM Fault models - Testing algorithms for RAMs – Pattern sensitive faults – BIST Techniques for RAM chips – Test generation and BIST for Embedded RAMs. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, '*Digital Systems Testing and Testable Design'*, Wiley-IEEE Press, 1990.
2. P.K. Lala, '*Digital Circuit Testing and Testability'*, Academic Press, 1997.

REFERENCES:

1. Michael Lee Bushnell and Vishwani Agrawal, '*Essentials of Electronic Testing for Digital, memory & mixed-signal VLSI Circuits*', Kluwer Academics, 2002.
3. Laung-Terng Wang, Cheng-Wen Wu and Xiaoqing Wen, '*VLSI Test Principles and Architectures: Design for Testability*', Morgan Kaufmann, 2006, ISBN:9780080474793, 0080474799.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the need for testing in VLSI design and describe various defect, fault modelling techniques and scan design methodologies.	**K2**
CO2	Apply fault simulation techniques and generate test patterns using ATPG algorithms.	**K3**
CO3	Analyze VLSI circuits with testability features, testing algorithms for RAMs, issues including delay faults and mixed-signal circuits.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EV503 ANALOG IC DESIGN

3 0 0 3

SINGLE STAGE AND DIFFERENTIAL AMPLIFIERS: Single Stage Amplifiers: Common-Source stage, Source Follower, Common-Gate Stage, Cascode Stage, Differential Amplifiers: Single-Ended and Differential Operation, Basic Differential Pair, Common-Mode Response, Differential Pair with MOS Loads. **(9)**

HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS: Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, Noise: statistical characteristics of noise, Types of Noise, Representation of Noise in Circuits, Noise in Single Stage and Differential Amplifiers. **(9)**

FEEDBACK AND OPERATIONAL AMPLIFIERS: Feedback: Properties and types of negative feedback circuits, Feedback Topologies, Effect of loading in feedback networks, Op-Amp: Operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection **(9)**

STABILITY AND FREQUENCY COMPENSATION: Multipole Systems, Phase Margin, Frequency Compensation, Compensation of Two Stage Op Amps, Slewing In Two Stage Op Amps, Other Compensation Techniques. **(9)**

SWITCHED CAPACITOR CIRCUITS AND OSCILLATORS: Switched-Capacitor Circuits: General Considerations, Sampling Switches, Switched-Capacitor Amplifiers, Switched-Capacitor Integrator, Oscillators: General Considerations, Ring Oscillators, LC Oscillators, Voltage-Controlled Oscillators (VCOs), Mathematical model of VCOs **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Behzad Razavi, '*Design of Analog Cmos Integrated Circuits*', Tata Mcgraw Hill, 2001.

REFERENCES:

1. Willey M.C. Sansen, *Analog Design Essentials*', Springer, 2006.
2. R.Jacob Baker, '*CMOS Circuit Design, Layout and Simulation*', Wiley India, IEEE Press, 2nd Edition, reprint 2009.
3. Grebene, '*Bipolar and Mos Analog Integrated Circuit Design*', John Wiley and Sons, Inc.,2003.
4. Phillip Allen and Douglas Holmberg, '*CMOS Analog Circuit Design*', Oxford University Press, 2nd Edition, 2004.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Understand the fundamental concepts and design principles of Analog circuits	**K2**
CO2	Apply Analog circuit design principles to create and optimize amplifiers, feedback systems, and oscillators in real-world applications	**K3**
CO3	Analyze Analog circuit designs to evaluate their performance and identify areas for improvement and optimization	**K4**
CO4	Design Analog circuits by applying core principles to meet specific performance and functional requirements in practical applications	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		2										2	2
CO4			1		1			1				1	1
@	**3**	**2**	**1**		**1**			**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV504 SILICON SYSTEMS DESIGN

3 1 0 4

SYSTEM-LEVEL SYSTEM ON CHIP (SoC) ARCHITECTURE AND DESIGN PRINCIPLES: Motivation & applications of SoCs, Components of a typical SoC, generic SoC template, Hardware/Software co-design trade-offs, SoC design flow overview (RTL to GDSII), Processor architecture: RISC vs. CISC, VLIW, Superscalar, Instruction Set Architecture (ISA) fundamentals, Processor types: soft, firm, and custom processors, Processor selection and design decisions in embedded SoCs, Introduction to Network-on-Chip(NoC):topology, architecture. **(9+3)**

INTEGRATION OF IPs AND SOC DESIGN CHALLENGES: Types of IPs: Digital, analog, memory, interface IPs, SoC-level IP integration methodologies, Interconnect protocols (AMBA, AXI, AHB, APB), Integration challenges: power domains, clock domains, reset strategies, Mixed-signal design considerations. **(9+3)**

HARDWARE-SOFTWARE CODESIGN AND MODELING TECHNIQUES: Nature and boundaries of hardware and software in embedded systems, Energy efficiency: design constraints and motivations, Hardware-software partitioning and co-design space exploration, Abstraction levels in system modeling (behavioral to structural), Concurrency, parallelism, and task-level hardware/software mapping, Dataflow modeling for SoC systems, HW/SW trade-offs and system simulation **(9+3)**

PHYSICAL DESIGN, VERIFICATION AND IMPLEMENTATION: Logic synthesis and optimization strategies, Timing constraints (SDC), Static Timing Analysis (STA), Floor planning and placement, Clock tree synthesis (CTS) and skew optimization, Routing techniques and congestion analysis, Physical design challenges: IR drop, antenna effects, electromigration, Physical verification: DRC, LVS, parasitic extraction, Tape-out process, GDSII generation, Handling Multiple GDSII files, Introduction to 2.5D and 3D Packaging. **(9+3)**

SOC IMPLEMENTATION, PROTOTYPING, AND TESTING: Case Study: MicroBlaze soft-core processor, Real-time operating systems (RTOS) integration, Peripheral interfacing and memory mapping, FPGA-based SoC prototyping using Xilinx SoC development kits, SoC Testing: core-level, system-level, and application-level strategies. **(9+3)**

Total L: 45+T:15=60 periods

TEXT BOOKS:

1. Michael J.Flynn and Wayne Luk, ‘*Computer system Design: System-on-Chip*’, Wiley-India, 2012.
2. Sudeep Pasricha and Nikil Dutt, *‘On Chip Communication Architectures: System on Chip Interconnect*’, Morghan Kaufmann Publishers, 2008.
3. Chakravarthi, Veena, ‘*A Practical Approach to VLSI System on Chip (SoC) Design*’, Springer Nature, 2019.
4. Wayne Wolf, ‘*Modern VLSI Design: System-on-Chip Design*’, Pearson Education, 3rd Edition, 2002.

REFERENCES:

1. Patrick Schaumont, ‘*A Practical Introduction to Hardware/Software Co-design*’, Springer, 2nd Edition, 2012.
2. Lin and Youn-Long Steve, ‘*Essential issues in SOC design: designing complex systems-on-chip*’, Springer, 2006.
3. William Hohl, ‘*ARM Assembly Language: Fundamentals and Techniques*’, CRC Press, 2nd Edition, 2014.
4. Farzad Nekoogar, ‘*From ASICs to SOCs: A Practical Approach’*, Prentice Hall Professional, 2003.
5. Michael Keating and Synopsys, ‘*The Simple Art of SoC Design*’, Springer Science & Business Media, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Understand the principles, architecture, and design methodologies involved in developing integrated systems at the chip level.	**K2**
CO2	Apply VLSI design tools and design methods to build, test, and integrate system and chip-level hardware solutions."	**K3**
CO3	Analyze complex system design challenges by evaluating architectural choices, implementation constraints, and trade-offs to guide efficient design decisions.	**K4**
CO4	Carry out a mini project as a team to implement a SoC for the given real-world application	

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		2										2	2
CO4			1		1	1		1		1	1	1	1
@	**3**	**2**	**1**		**1**	**1**		**1**		**1**	**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EV511 ANALOG IC DESIGN LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Design and Simulation of Common-Source Amplifier
2. Design and Simulation of Common gate Amplifier
3. Design and Simulation of Source Follower
4. Design and Simulation of Cascode Amplifier
5. Design and Simulation of Differential Amplifier
6. Design and simulation of Single Stage Op-Amp
7. Design and Simulation of Two-Stage Op-Amp
8. Design and Simulation of Feedback Amplifiers
9. Design and Simulation of 3 and 5 stage Ring Oscillators
10. Design and Simulation of VCO

AUGMENTED EXPERIMENTS*

1. DRC, LVS check and GDSII generation for Common-Source Amplifier
2. DRC, LVS check and GDSII generation for Single Stage Op-Amp

Total P: 30 periods

REFERENCES:

1. Behzad Razavi, '*Design of Analog Cmos Integrated Circuits*', Tata Mcgraw Hill, 2001.
2. R.Jacob Baker, '*CMOS Circuit Design, Layout and Simulation*', Wiley India, IEEE Press, 2nd Edition, reprint 2009.
3. Grebene, '*Bipolar and Mos Analog Integrated Circuit Design*', John Wiley & Sons, Inc.,2003.
4. Laboratory Manual Prepared by ECE Department, 2025.

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Conduct experiments and verify the characteristics of various configuration of CMOS devices	**K3**
CO2	Design various CMOS-Amplifier circuits for the given specification and verify their characteristics.	**K4**
CO3	Simulate various CMOS- Amplifier circuits using Modern Tools	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3			3				3	3
CO2		3			3			3				3	3
CO3					2			2				2	2
@	**3**	**3**			**3**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV512 VLSI DESIGN FOR TESTABILITY LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Introduction to VLSI circuit Testing and Fault Simulation of Combinational Circuits
2. Scan Chain Insertion for Sequential Circuits
3. Automatic Test Pattern Generation (ATPG)
4. Design and Simulation of Built-In Self-Test (BIST)
5. Boundary Scan Test (IEEE 1149.1 – JTAG) Implementation
6. Delay Fault Testing
7. Test Pattern Compression using Linear Feedback Shift Registers
8. Fault Diagnosis and Location in Digital Circuits
9. Testable Design of a 4-bit ALU
10. Memory testing.

Total P: 30 periods

REFERENCES:

1. Laboratory Manual Prepared by ECE Department, 2025.
2. Cadence Manual

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Conduct experiments and test combinational and sequential VLSI circuits using various testing methods	**K3**
CO2	Analyze the test pattern and fault coverage details of the given VLSI circuit	**K4**
CO3	Design test methodologies and simulate various Device under Test (DUTs) using Modern Tools	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3			3				3	3
CO2		3			3			3				3	3
CO3			1		1			1				2	2
@	**3**	**3**			**3**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVE02 INTENSHIP - I

0 0 0 1

OBJECTIVES

- To expose students to industrial practices and work culture
- To apply classroom concepts in real-time scenarios
- To enhance technical, communication, and teamwork skills
- To understand professional ethics and responsibilities
- To work under the guidance of an industry mentor
- To Understand organizational structure and workflow
- To contribute Involvement in assigned tasks/projects
- Maintaining a daily logbook or diary
- To Consolidated report preparation of the above.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply engineering knowledge to identify, analyze, design, and implement a real-time problem using appropriate tools and techniques, while considering societal, environmental, ethical aspects, working effectively in teams, communicating results clearly, and engaging in lifelong learning.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVE03 COMMUNITY PROJECT

0 0 0 1

OBJECTIVES

- To identify real-time problems and needs within the community
- To develop awareness about social, environmental, and economic issues
- To apply technical and engineering knowledge for community welfare
- To encourage teamwork, leadership, and communication skills
- To conduct field visits, surveys, and interaction with local stakeholders
- To design and implement feasible and sustainable solutions
- To promote ethical values and social responsibility

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply engineering knowledge to identify and solve real-time community problems, develop sustainable solutions, work effectively in teams, communicate with stakeholders, and demonstrate social, environmental, and ethical responsibility while documenting and presenting the work.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EEC04 APTITUDE SKILLS

0 0 2 1

1. Reading comprehension
2. Sentence correction, Sentence completion and Para-jumbles
3. Vocabulary, Articles, Prepositions and Interrogatives
4. Critical reasoning
5. Ratio and Proportion, Profit and loss, Partnerships and averages
6. Permutation, Combination and Probability
7. Time, Speed and Distance
8. Resume progress check

REFERENCES:

1. R.S. Aggarwal, '*Quantitative Aptitude for Competitive Examination*', S Chand Publishing, New Delhi, 2017.
2. P.C.Wren and H.Martin, '*High school English grammar & composition'*, S Chand Publishing, New Delhi, 2017.
3. Norman Lewis, '*Word Power Made Easy'*, Goyal Publisher, New Delhi, 2011.

SEMESTER VI

25EV601 NANOSCALE ELECTRONICS

3 0 0 3

NANO EVOLUTION: Scientific evolution - Feynman's quantum electrodynamics – Taniguchi's nanotechnology – Drexler's engines of creation – Definition of a nanosystem – Dimensionality and size dependent phenomena - Nanostructures – Naturally occurring nanomaterials - Nanoscale properties - Magnetic Moment in clusters/Nanoparticles – Coercivity – Thermal activation and superparamagnetic effects, Excitonic binding and recombination Energies, Capacitance in a nanoparticle, Optical properties - Surface Plasmon Resonance, Nanotechnology Initiatives – challenges and future prospects of nanoscience. **(9)**

QUANTUM CONCEPTS: Inadequacies of Classical Mechanics – Duality nature of electromagnetic radiation – De Broglie hypothesis for matter waves – Heisenberg's uncertainty principle – Schrödinger's wave equation - Energy levels of a particle, Density of states (DOS) - DOS of 3D, 2D, 1D and 0D materials - Quantum confinement - Penetration of a barrier, Tunnel effect - Ballistic transport - Coulomb blockade. **(9)**

TRANSPORT IN THE NANOSCALE: Size effect on electronic properties – phonons in nanostructures - size effect on electron – phonon coupling, evolution of band structures and Fermi surface - fraction of surface atoms – surface energy and surface stress, size-induced metal-insulator-transition (SIMIT)- electron transport and kinetics in zero, one- and two-dimensional nanostructures - nanocrystalline materials, effect of grain size and grain boundaries. **(9)**

DESIGN OF ELECTRONIC DEVICES: Short Channel MOS Transistor – Split Gate Transistor - Resonant Tunneling Diode (RTD), Three Terminal Resonant Tunneling Devices, Single Electron Transistors, Nano MOSFET, Carbon Nanotube Field Effect Transistors, Nano ferroelectrics - Ferroelectric random-access memory - Fe-RAM circuit design. **(9)**

NANO ELECTRONICS & NANOCOMPUTER ARCHITECTURES: Introduction to Nanocomputers, Nanocomputer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Pradeep T, '*Nano: The Essentials Understanding Nanoscience and Nanotechnology*', Mc-Graw Hill, New Delhi, 2007.
2. Masaru Kuno, '*Introductory Nanoscience: Physical and Chemical Concepts*', Garland Science, New York, 2012.
3. Aruldhas G, '*Quantum Mechanics*', PHI Learning Pvt. Ltd., New Delhi. 2013.
4. Gabor L Hornyak, Harry F Tibbals, Joydeep Dutta and John J Moore, '*Introduction to Nanoscience and Nanotechnology*', CRC Press, Boca Raton, 2009.

REFERENCES:

1. Mathews P M and Venkatesan K, '*A Text book of Quantum Mechanics*', Tata McGraw Hill, New Delhi, 2010.
2. Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury, '*Concepts of Modern Physics*', McGraw Hill, New Delhi, 2017.
3. Shunri Oda and David Ferry, '*Silicon Nanoelectronics*', CRC Press, Boca Raton, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the fundamental concepts, technical challenges, and the state of- the-art technology development and applications of Nanoelectronics and Quantum.	**K2**
CO2	Apply Nanoscale electronic principles and design the Quantum device for real-time applications.	**K3**
CO3	Analyze the properties of Nanoscale electronic and Quantum devices.	**K4**
CO4	Discover potential use cases of Nanoscale electronic and Quantum devices using modern tools	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		2										2	2
CO4			1		1			1				1	1
@	**3**	**2**	**1**		**1**			**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV602 VLSI PHYSICAL DESIGN

3 0 0 3

INTRODUCTION TO VLSI DESIGN AUTOMATION: Algorithmic Graph Theory for Physical Design, Computational Complexity in Layout Optimization, Advanced ROBDD Applications, Open-Source VLSI CAD Tools (e.g., OpenROAD, Magic). **(9)**

ADVANCED PARTITIONING AND PLACEMENT: Circuit- Partitioning, Classification of Partitioning algorithms, Simulated Annealing and Evolution, Performance driven Partitioning, classification of placement algorithms, Partitioning based placement algorithm, Machine Learning for Placement Optimization. **(9)**

FLOORPLANNING AND PIN ASSIGNMENT: Classification of Floorplanning algorithms, Floor planning model, cost functions, slicing and Non-Slicing Floorplans, Graph Representations of floorplans, Classifications of Pin Assignment algorithm, Integrated approach of Floorplanning and Pin assignment **(9)**

ROUTING AND PERFORMANCE OPTIMIZATION: Global routing and classification of global routing algorithms, Maze routing algorithm, Approaches to channel Routing, Basic left-edge algorithm, Dogleg algorithm, Yoshimura and Kuh algorithm, Switch-box **(9)**

TIMING, POWER, AND COMPACTION: Static Timing Analysis (STA) for Physical Design, False Path Analysis, IR Drop Analysis, Decoupling Capacitor Placement, Hierarchical Compaction, FPGA-Specific Physical Design. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Sherwani, N, '*Algorithms for VLSI Physicsl Design Automation*', Springer, 3rd Edition, 2007.
2. Gerez S.H., '*Algorithms for VLSI Design Automation*', John Wiley, 2008.

REFERENCES:

1. Sarrafzadeh, M. and Wong, C. K., '*An Introduction to VLSI Physical Design*', McGraw Hill, 2015.
2. Trimberger, S. M., '*An Introduction to CAD for VLSI',* Kluwer, 1987.
3. Sait, S. M. and Habib Youssef, '*VLSI Physical Design Automation – Theory and Practice*', World Scientific, 2004.
4. Andrew B. Kahng, Jens Lienig, Igor L. Markov and Jin Hu, '*VLSI Physical Design: From Graph Partitioning to Timing Closure*', Springer, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental principles and theories underlying VLSI physical design automation	**K2**
CO2	Apply appropriate algorithmic, mathematical, and computational techniques to address challenges in VLSI physical design automation.	**K3**
CO3	Analyze design constraints and performance trade-offs involved in physical design processes to support efficient circuit implementation.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV603 VLSI VERIFICATION METHODOLOGIES

3 0 0 3

SV FUNDAMENTALS: Creating a Class and understanding its declaration, using constructor to dynamically change data members, writing data to data member using function, reading data from the function, Components of SV Testbench, Understanding Transaction, Randomization in SV, Constraints, Fork Join, Fork Join _Any, Fork Join, None, Event and Mailbox. **(9)**

SV TESTBENCH COMPONENTS: Generator, Driver, Interface, Monitor, Scoreboard, Environment, Complete Testbench for a combinational circuit, sequential circuit and Memory Circuits, Assertions (immediate and concurrent), properties and sequences **(9)**

UVM FUNDAMENTALS: Polymorphism, Factory usages, UVM_Object Class, UVM_Component, Create and new methods, Object_utils, Configuration method to change Verbosity level. **(9)**

ADVANCED UVM COMPONENTS AND TLM TECHNIQUES: Creating UVM Sequence Item, Constraints, reusability, UVM Phases, end_of_elaboration phase, uvm_common_phase, Producer Consume Model, TLM blocking port, Transaction data in TLM Blocking port, global_stop_request, Independent Multiple TLM Blocking Port, TLM_FIFO, TLM Analysis Port. **(9)**

UVM TESTBENCH ARCHITECTURE AND COMPONENT INTEGRATION: Interface, Monitor and Scoreboard, uvm_config_db, sequencer, Complete UVM Testbench for 4-bit Adder and 8-bit RAM. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Chris Spear and Greg Tumbush, '*SystemVerilog for Verification: A Guide to Learning the Testbench Language Features'*, Springer, 3rd Edition, 2012.
2. UVM Class Reference, Accellera Systems Initiative.

REFERENCES:

1. Michael D. Ciletti, '*Advanced Digital Design with the Verilog HDL*', Pearson, 2nd Edition, 2010.
2. Samir Palnitkar, *'Verilog HDL: A Guide to Digital Design and Synthesis*', Prentice Hall, 2nd Edition, 2003.
3. Janick Bergeron, '*Writing Testbenches using SystemVerilog*', Springer, 2nd Edition, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand SystemVerilog and UVM for developing Verification components and Testbenches for Digital Circuits	**K2**
CO2	Apply SystemVerilog and UVM methodologies to design and implement verification components, testbenches, and transaction-level models for verifying digital circuits.	**K3**
CO3	Analyze and evaluate the effectiveness of SystemVerilog and UVM testbenches and components in verifying the functionality and performance of digital circuits.	**K4**
CO4	Create efficient and reusable SystemVerilog and UVM-based testbenches and verification components for complex digital circuit designs.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			1		1			1				1	1
@	**3**	**2**	**1**		**1**			**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV611 VLSI FABRICATION AND CHARACTERIZATION LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Thin Film Coating and Thickness Measurement
2. Pattern Transfer using simple lithography
3. Resistivity measurement on semiconductor samples
4. I-V Characterization of PN-junction diode
5. I-V Characterization of MOSFET
6. Quasi-static C-V Characterization of MOS capacitors
7. Photoconductivity measurements on solar cell

AUGMENTED EXPERIMENTS*

1. Simulation of Ion Implantation using TCAD
2. Simulation of Wet etching and dry etching using TCAD
3. Simulation of Thermal Oxidation using TCAD/COMSOL
4. Simulation and Analysis of MEMS Cantilever Beam using COMSOL
5. Microfluidics device fabrication using replica mold/soft lithography

Total P: 30 periods

REFERENCES:

1. Laboratory Manual Prepared by ECE Department, 2025.

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Conduct Hands-on experiments and verify the characteristics of various semiconductor devices	**K3**
CO2	Analyze various process methodologies for the given IC specification and verify their characteristics.	**K4**
CO3	Simulate various semiconductor process and devices using TCAD/ Modern Tools	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				5			3				3	3
CO2		3			3			3				3	3
CO3			1		1			1				1	1
@	**3**	**3**	**1**		**3**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EV612 VLSI VERIFICATION LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Verification of Priority Encoder using SystemVerilog
2. Verification of 4-bit Adder using SystemVerilog
3. Verification of Flip-flops using SystemVerilog
4. Verification of Shift registers using SystemVerilog
5. Verification of sequence detector (FSM) using SystemVerilog
6. Verification of Memory Circuits using SystemVerilog
7. Design a UVM testbench for Full Adder

AUGMENTED EXPERIMENTS*

1. Design a UVM testbench for 4-bit Multiplier
2. Design a UVM testbench for JK Flip-flop
3. Design a UVM testbench for synchronous counters
4. Design a UVM testbench to verify FSM
5. Design a UVM testbench to verify Memory Circuits

Total P: 30 Periods

REFERENCES:

1. Chris Spear and Greg Tumbush, '*SystemVerilog for Verification: A Guide to Learning the Testbench Language Features*', Springer, 3rd Edition, 2012.
2. UVM Class Reference, Accellera Systems Initiative.
3. Samir Palnitkar, '*Verilog HDL: A Guide to Digital Design and Synthesis'*, Prentice Hall, 2nd Edition, 2003.
4. Janick Bergeron, '*Writing Testbenches using SystemVerilog*', Springer, 2nd Edition, 2006.
5. Laboratory Manual Prepared by ECE Department, 2025.

* Augmented experiments will be evaluated at the end of the semester.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply the concepts of SystemVerilog and UVM to verify digital circuits	**K3**
CO2	Analyze verification environments using SystemVerilog (SV) and UVM, and apply optimization techniques for efficient verification	**K4**
CO3	Develop SystemVerilog (SV) and UVM-based testbenches to verify and validate digital circuits for real-time problem statements	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3			3				3	3
CO2		3			3			3				3	3
CO3			1		1			1				1	1
@	**3**	**3**	**1**		**3**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVE04 MINI PROJECT - II

0 0 2 1

OBJECTIVES

- Identification of a real time problem in thrust areas.
- Developing a mathematical model for solving the above problem.
- Finalization of system requirements and specification.
- Simulation / Implementation of different solutions for the problem based on literature survey Future trends in providing alternate solutions.
- Consolidated report preparation of the above.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply engineering knowledge to identify, analyze, design, and implement a real-time problem using appropriate tools and techniques, while considering societal, environmental, ethical aspects, working effectively in teams, communicating results clearly, and engaging in lifelong learning.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EEC05 ENHANCING PROBLEM SOLVING ABILTIY WITH CODE
(Common to ECE and EE-VLSI)

0 0 2 1

LIST OF EXPERIMENTS

1. Compilation, Namespace, Header file, Data types, Variables, Declaration, Scope of variables
2. Input / Output, Type Conversion, Operators
3. For, While, Do-while, break, continue.
4. Decision Making
5. Problem solving Pattern Programming
6. Arrays
7. Call by value & Call by reference, with and without arguments
8. Functions, Recursion & Strings
9. Structures & Union
10. Command Line Argument
11. Structure using Pointers
12. Handling Stress
13. Handling Peer pressure
14. Resume progress check

Total P: 30 Periods

REFERENCES:

1. GayleLaakmann McDowell, '*Cracking the Coding Interview: 150 Programming Questions and Solutions*'. S Chand Publishing, New Delhi, 5th Edition, 2015.
2. John Mongan, Noah Kindler and Eric Giguère, '*Programming Interviews Exposed: Secrets to Landing Your Next Job*'. Wrox, New Delhi, 5th Edition, 2018.

SEMESTER VII

25EV701 MICROELECTRONIC DEVICES AND MODELING

3 0 0 3

SEMICONDUCTOR ELECTRONICS: Physics of Semiconductor Materials, Band Model of Solids Thermal-Equilibrium Statistics, Carriers in Semiconductors, Drift Velocity, Mobility and Scattering, Drift & Diffusion Current, Device: Hall-Effect. **(9)**

METAL-SEMICONDUCTOR CONTACTS AND P-N JUNCTIONS: Metal-Semiconductor junctions, Current-Voltage Characteristics, Surface Effects. The PN junction, Step Junction, Linearly Graded Junction, Heterojunctions, Reverse-Biased p-n junctions and break down mechanism. Generation and Recombination. **(9)**

MOSFET: PHYSICAL EFFECTS AND MODELS: MOS Capacitor, Oxide and Interface Charge: Origin and Experimental Determination Charge- Coupled Devices, non-volatile memory. Basic MOSFET behaviour, MOSFET scaling and short channel model. Devices: Complementary MOSFETs (CMOS), electric fields and velocity-saturation, basic leakage currents, channel length modulation, body bias effect, threshold adjustment, sub-threshold conduction. **(9)**

DEVICE MODELING: Limitation of long channel analysis, short-channel effects: velocity saturation, device degradation, channel length modulation, body bias effect, threshold adjustment, mobility degradation, hot carrier effects, MOSFET scaling goals, gate coupling, velocity overshoot, high field effects in scaled MOSFETs, substrate current and effects in scaled MOSFETS,.Moore law, Technology nodes and ITRS, Physical & Technological Challenges to scaling, Nonconventional MOSFET – (FDSOI, SOI, Multi-gate MOSFETs). **(9)**

NUMERICAL SIMULATION: Numerical simulation, basic concepts of simulations, grids, device simulation and challenges.Importance of semiconductor device simulators - Key elements of physical device simulation, historical development of the physical device modeling. Introduction to the TCAD Simulation Tool, Examples of TCAD Simulations –MOSFETs and SOI. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. S. M. Sze and M.K. Lee, '*Semiconductor devices- Physics and Technology*', John Wiley & Sons, 3rd Edition, 2012.
2. Richard S. Muller and Theodore I.Kamins , '*Device Electronics for Integrated circuits*', John Wiley & Sons, 3rd Edition, 2002.

REFERENCES:

1. S. M. Sze and Kwok K. Ng, *'Physics of Semiconductor Devices'*, John Wiley & Sons, 3rd Edition, 2002.
2. Ben G. Streetman and Sanjay Banerjee, *'Solid State Electronic Device'*, Prentice Hall, 6th Edition 2005.
3. Robert F. Pierret, *'Semiconductor Device Fundamentals'*, Addison-Wesley Publishing, 1996.
4. Donald A. Neamen, *'Semiconductor Physics and Devices'*, McGraw-Hill, 3rd Edition, 2003.
5. Jasprit Singh, *'Semiconductor Devices – Basic Principles'*, John Wiley and Sons Inc., 2001.
6. Vagica Vasileska and Stephen M. Goodnick, *'Computational Electronics: Semiclassical and Quantum Device Modeling and Simulation"*, CRC Press, 2010.
7. Shunri Oda and David K. Ferry, *'Silicon Nanoelectronics'*, CRC Press, 2012.
8. Y. Tsividis and C. McAndrew, *'Operation and Modeling of the MOS Transistor'*, Oxford University Press, USA, 3rd Edition, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Describe the physics of semiconductor materials and carrier transport mechanisms and model of physical behavior of MOSFETs.	**K2**
CO2	Apply numerical simulation techniques using TCAD tools for modeling semiconductor devices and interpret the simulation outcomes.	**K3**
CO3	Analyze the electrical characteristics and behavior of metal-semiconductor contacts and p-n junctions, and short-channel effects and advanced modeling techniques for modern MOSFETs.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2			2							2	2
@	**3**	**2**			**2**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EV711 MICROELECTRONIC DEVICES MODELING LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Introduction to Technology computer aided design (TCAD) tools; inputs and outputs of device and process simulations.
2. Simulation of transfer characteristics of MOSFET capacitor.
3. Simulation of transfer and drain characteristics of bulk MOSFET
4. Extraction of threshold voltage, transconductance, device ON and OFF current, and subthreshold slope of MOSFET
5. Simulation of short channel effects such as threshold voltage roll-off and DIBL effects of small-dimension MOSFET
6. Simulation of transfer and drain characteristics of SOI MOSFET
7. Device simulation: observing the terminal characteristics and distributions of carriers, current, field, potential and energy band diagrams within the device.
8. Process simulation: observation of device structure and doping profile

Total P: 30 Periods

REFERENCES:

1. C K Maiti, '*Introducing Technology Computer-Aided Design (TCAD): Fundamentals, Simulations, and Applications*', Jenny Stanford Publishing; 1st Edition, 2017.
2. Wu, Yung-Chun, Jhan and Yi-Ruei, '*3D TCAD Simulation for CMOS Nanoeletronic Devices*', Springer, 2017.
3. C K Sarkar, '*Technology Computer Aided Design: Simulation for VLSI MOSFET'*, CRC Press, 1st Edition, 2013.
4. J.P. Colinge, '*FinFETs and Other Multi-Gate Transistors'*, Springer, 2008.
5. Laboratory Manual prepared by ECE Department 2025.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply TCAD tools to simulate and compare characteristics of bulk, SOI, and Double Gate MOSFETs.	**K2**
CO2	Analyze simulation data to extract key parameters and evaluate device performance.	**K3**
CO3	Simulate and evaluate short-channel effects and their implications on nano-scale device reliability.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1					3			3				3	3
CO2	3							3				3	3
CO3		1			1			1				1	1
@	**3**	**1**			**3**			**3**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVE05 PROJECT WORK - I

OBJECTIVES

0 0 4 2

- Identification of a real time problem in thrust areas.
- Developing a mathematical model for solving the above problem.
- Finalization of system requirements and specification.
- Simulation / Implementation of different solutions for the problem based on literature survey Future trends in providing alternate solutions.
- Consolidated report preparation of the above.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply engineering knowledge to identify, analyze, design, and implement a real-time problem using appropriate tools and techniques, while considering societal, environmental, ethical aspects, working effectively in teams, communicating results clearly, and engaging in lifelong learning.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVE06 INTENSHIP -II

0 0 0 1

OBJECTIVES

- To expose students to industrial practices and work culture
- To apply classroom concepts in real-time scenarios
- To enhance technical, communication, and teamwork skills
- To understand professional ethics and responsibilities
- To work under the guidance of an industry mentor
- To Understand organizational structure and workflow
- To contribute Involvement in assigned tasks/projects
- Maintaining a daily logbook or diary
- To Consolidated report preparation of the above.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply engineering knowledge to identify, analyze, design, and implement a real-time problem using appropriate tools and techniques, while considering societal, environmental, ethical aspects, working effectively in teams, communicating results clearly, and engaging in lifelong learning.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

SEMESTER VIII

25EVE07 PROJECT WORK -II

0 0 8 4

OBJECTIVES

- Identification of a real time problem in thrust areas.
- Developing a mathematical model for solving the above problem.
- Finalization of system requirements and specification.
- Simulation / Implementation of different solutions for the problem based on literature survey Future trends in providing alternate solutions.
- Consolidated report preparation of the above.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply engineering knowledge to identify, analyze, design, and implement a real-time problem using appropriate tools and techniques, while considering societal, environmental, ethical aspects, working effectively in teams, communicating results clearly, and engaging in lifelong learning.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
@	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

PROFESSIONAL ELECTIVES

VERTICAL 1: VLSI DEIGN TO TAPE-OUT

25ECP01 MIXED SIGNAL IC DESIGN
(Common to ECE and EE-VLSI)

3 0 0 3

SAMPLING AND ALIASING: Sampling: Impulse Sampling, Decimation, The Sample and Hold (S/H), The Track and Hold (T/H), Interpolation, Circuits: Implementing the S/H, The S/H with Gain, The Discrete Analog Integrator (DAI). **(9)**

INTEGRATOR BASED CMOS FILTERS: Integrator Building Blocks: Low Pass Filters, Active-RC Integrators, MOSFET-C Integrators, gm-C (Transconductance-C) Integrators, Discrete-Time Integrators. Filtering Topologies: The Bilinear Transfer Function, The Biquadratic Transfer Function. **(9)**

DIGITAL FILTERS: SPICE Models for DACs and ADCs: The Ideal DAC and ADC, Number Representation, Sinc-Shaped Digital Filters: The Counter, Lowpass Sinc Filters, Bandpass and High pass Sinc Filters, Interpolation and Decimation using Sinc Filters, Filtering Topologies: The Bilinear Transfer Function, The Biquadratic Transfer Function. **(9)**

DATA CONVERTER ARCHITECTURES: DAC Architectures: Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures: Flash, Two-step flash ADC, Pipeline ADC, Integrating ADC‘s, Successive Approximation ADC. **(9)**

IMPLEMENTING DATA CONVERTERS: R-2R Topologies for DAC: The Current-Mode R-2R DAC, The Voltage-Mode R-2R DAC, Topologies Without an Op-Amp, Op-Amps in Data Converters: Op-Amp Gain, Op-Amp Unity Gain Frequency, Op-Amp Offset, Implementing ADCs: The Cyclic ADC, The Pipeline ADC. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. R.Jacob Baker, ‘*CMOS Mixed Signal Circuit Design*’, Wiley India, IEEE Press, reprint 2008.
2. R.Jacob Baker, ‘*CMOS Circuit Design, Layout and Simulation*’, Wiley India, IEEE Press, 2nd Edition, reprint 2009.

REFERENCES:

1. Behzad Razavi, ‘*Design of Analog CMOS Integrated Circuits*’, McGraw Hill, 2nd Edition, reprint 2001.
2. Behzad Razavi, ‘*Principles of Data Conversion System Design*’, IEEE Press, 1995.
3. Rudy Van de Plassche, ‘*CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters*’, Kluwer Acedamic Publishers, Boston, 2003.
4. David A Johns and Ken Martin, ‘*Analog IC design*’, Wiley, 2008.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom’s Level
CO1	Understand the fundamental principles and design techniques of mixed-signal circuits used in analog and digital signal processing	**K2**
CO2	Apply the principles of mixed-signal circuit design to develop and implement circuits for communication and signal processing applications	**K3**
CO3	Analyze the performance of mixed-signal circuits to evaluate their functionality in communication and signal processing applications	**K4**
CO4	Present a case study that demonstrates the application and performance evaluation of mixed-signal circuits in real-world signal processing scenario.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		1										1	1
CO4					1			1	1			1	1
@	**3**	**1**			**1**			**1**	**1**			**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP02 CAD FOR VLSI
(Common to ECE and EE-VLSI)

3 0 0 3

ALGORITHM & SYNTHESIS: VLSI Design cycle - Role of CAD tools in the VLSI Design process -data structures and algorithms: Complexity of algorithms, General purpose methods for combinatorial optimization, logic synthesis – two level synthesis, Binary decision diagrams, and ROBDD principles. **(9)**

PARTITIONING AND PLACEMENT ALGORITHMS: Partitioning - KL, FM algorithms, Placement – Simulation based algorithms- Simulated Annealing, Force Directed Algorithm, Partitioning based algorithms- Breuer's Algorithm, Terminal propagation Algorithm, Cluster Growth Algorithm. **(9)**

FLOOR PLANNING AUTOMATION: Floor planning – slicing floor plan, Constraint Based Floor Planning, Integer Program Based Floor planning – Pin Assignment. **(9)**

ROUTING ALGORITHMS: Grid routing – Maze Routing Algorithms, Global routing - Shortest Path Based Algorithms, Steiner tree-based Algorithms, detailed routing – Left Edge algorithm, Dog-Leg Algorithm, Greedy Channel Routing, Switch Box Routing algorithms- over the cell routing, Clock Routing. **(9)**

LAYOUT SYNTHESIS AND OPTIMIZATION: Layout generation and Optimization of standard cell layout, gate matrix layout and PLA, Layout Compaction – one dimensional and two-dimensional compaction. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Sherwani N A, '*Algorithms for VLSI Physical Design Automation*', Kluwer, 2007.
2. Sait S M and Youssef H, '*VLSI Physical Design Automation*', World Scientific, 2004.

REFERENCES:

1. Sarrafzadeh, M. and Wong, C. K., '*An Introduction to VLSI Physical Design*', McGraw Hill, 2015.
2. Trimberger, S. M., '*An Introduction to CAD for VLSI*', Kluwer, 1987.
3. Sait, S. M. and Habib Youssef, '*VLSI Physical Design Automation – Theory and Practice*', World Scientific, 2004.
4. Andrew B. Kahng, Jens Lienig, Igor L. Markov and Jin Hu, '*VLSI Physical Design: From Graph Partitioning to Timing Closure*', Springer,2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the role of CAD tools, and key algorithmic concepts including logic synthesis, optimization methods, and data structures like BDD and ROBDD.	**K2**
CO2	Apply partitioning, placement, floor planning, and routing algorithms to automate and optimize the VLSI physical design process.	**K3**
CO3	Analyze various partitioning, placement, floorplanning, and routing algorithms to enhance overall efficiency.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP03 LOW POWER IC DESIGN
(Common to ECE and EE-VLSI)

3 0 0 3

PRINCIPLES OF LOW POWER IC DESIGN: Need for Low power VLSI chips - Sources of Power Dissipation, Dynamic Power Dissipation- Switching and Short Circuit Power Dissipation, Static power Dissipation, Glitching power Dissipation, Short channel Effects, Low power Adder and Low power Multipliers. **(10)**

POWER REDUCTION AT THE CIRCUIT LEVEL: Adjustable Device Threshold Voltage, Adiabatic Computation, CMOS Floating Node - Transistor and Gate Sizing – Equivalent Pin Ordering – Network Restructuring and Reorganization – Special Latches and Flip Flops – Low Power Digital Cell Library. **(10)**

POWER REDUCTION AT THE LOGIC LEVEL: Gate Reorganization – Signal Gating – Logic Encoding – State Machine Encoding – Precomputation Logic, Switching Activity Reduction- Pass Transistor Logic Synthesis. **(7)**

POWER REDUCTION AT THE ARCHITECTURE AND SYSTEM LEVEL: Pipelining and Parallel Architecture with Voltage Reduction – Flow Graph Transformation – Power Reduction in Clock Networks - Low Power Bus-Software power estimation and optimization techniques- Power and Performance management **(9)**

POWER ANALYSIS: Simulation power Analysis - Gate-Level Analysis - Architecture level Analysis – Data Correlation Analysis – Monte Carlo Simulation - Probabilistic Power Analysis Techniques.

(9)

Total L: 45 periods

TEXT BOOKS:

1. Gary K Yeap, '*Practical Low Power Digital VLSI Design*', Kluwer academic publishers, 2012.
2. Kaushik Roy and Sharat C. Prasad, '*Low Power CMOS VLSI circuit Design*', John Wiley & Sons, 2009.
3. Sung-Mo Kang and Yusuf Leblebici, '*CMOS Digital Integrated Circuits – Analysis and Design*', TMH, 2011.
1. 4.Kiat-Seng Yeo and Kaushik Roy, '*Low-Voltage, Low-Power VLSI Subsystems*', TMH Professional Engineering, 2004.

REFERENCES:

1. Kuo J B and Lou J H, '*Low Voltage CMOS VLSI Circuits*', John Wiley & Sons, 2001.
2. AP Chandrakasan and RW Brodersen, '*Low Power Digital CMOS Design*', Kluwer Academic Publishers, 1995.
3. Abdelatif Belaouar and Mohamed l Elmasry, '*Low-Power Digital VLSI Design: Circuits and Systems*', Kluwer Academic Press, 1995.
4. Sasan Iman and Massoud Pedram, '*Logic Synthesis for Low Power VLSI Designs*', Kluwer Academic publishers, 1998.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of low power design approaches	**K2**
CO2	Apply the low power techniques to design power efficient arithmetic blocks and memories	**K3**
CO3	Analyse and compare various design architectures based on design metrics	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		2			2							2	2
@	**3**	**2**			**2**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25ECP04 VLSI SIGNAL PROCESSING
(Common to ECE and EE-VLSI)

3 0 0 3

FUNDAMENTALS OF DSP AND VLSI ARCHITECTURES : Review of Discrete-Time Signal Processing - DSP system representations: Data flow graph, Signal flow graph - Introduction to VLSI design flow - Effect of hardware implementation of DSP algorithms -Performance metrics. **(9)**

PIPELINING AND PARALLEL PROCESSING: Pipelining and parallel processing techniques - Iteration bound and critical path - Retiming and unfolding - Folding transformation -Scheduling and resource allocation. **(9)**

SYSTOLIC ARCHITECTURE DESIGN AND OPTIMIZATION: Basics of systolic architectures - Case studies: convolution, matrix multiplication - Mapping DSP algorithms to systolic arrays - Design space exploration and trade-offs. **(9)**

BIT-LEVEL ARITHMETIC ARCHITECTURES: Bit-level architectures for arithmetic operations - Design of fast adders, multipliers, MAC units - Redundant number systems - Distributed arithmetic - Implementation using fixed-point arithmetic. **(9)**

SIGNAL PROCESSING APPLICATIONS: Numerical strength reduction techniques - Low-power design techniques for DSP - Use of FPGAs and ASICs for DSP - DFT, FFT, DCT, FIR filter banks - Complete hardware realization of a DSP block. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Keshab K. Parhi, '*VLSI Digital Signal Processing – Design and implementation*', Wiley – Inter science, 1999.
2. Steven W. Smith, '*Digital Signal processing- A Practical Guide for Engineers and Scientists*', Elsevier, 2003.

REFERENCES:

1. Michael John Sebastian Smith, '*Application-Specific Integrated Circuits*', Wesley Professional, 2002.
2. Lars Wanhammer, '*DSP Integrated Circuits*', Academic Press, 1999.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain discrete-time signal processing concepts, represent DSP systems using data flow and signal flow graphs, describe various design techniques and performance metrics for DSP hardware implementation.	**K2**
CO2	Apply design techniques to optimize DSP algorithms.	**K3**
CO3	Analyze various architectures for signal processing applications.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**2**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EVP01 MEMORY DESIGN AND TESTING

3 0 0 3

RANDOM ACCESS MEMORY TECHNOLOGIES: Static Random-Access Memories (SRAMs): SRAM Cell Structures-MOS SRAM Architecture-MOS SRAM Cell and Peripheral Circuit Operation-Bipolar SRAM Technologies-Silicon on Insulator (SOl) Technology-Advanced SRAM Architectures and Technologies-Application Specific SRAMs. **(9)**

DYNAMIC RANDOM-ACCESS MEMORIES (DRAMS): DRAM Technology Development-CMOS DRAMs-DRAMs Cell Theory and Advanced Cell Strucutures -BiCMOS DRAMs-Soft Error Failures in DRAMs-Advanced DRAM Designs and Architecture-Application Specific DRAMs. **(9)**

NONVOLATILE MEMORIES: Masked Read-Only Memories (ROMs)-High Density ROMs-Programmable Read-Only Memories (PROMs)-Bipolar PROMs-CMOS PROMs-Erasable (UV) -Programmable Road-Only Memories (EPROMs)-Floating-Gate EPROM Cell-One-Time Programmable (OTP) EPROMS-Electrically Erasable PROMs (EEPROMs)-EEPROM Technology and Arcitecture-Nonvolatile SRAM-Flash Memories (EPROMs or EEPROM)-Advanced Flash Memory Architecture. **(9)**

MEMORY FAULT MODELING: Testing, And Memory Design for Testability and Fault Tolerance RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing-Application Specific Memory Testing. Semiconductor Memory Reliability and Radiation Effects. **(9)**

ADVANCED MEMORY TECHNOLOGIES & HIGH-DENSITY MEMORY PACKAGING TECHNOLOGIES: Ferroelectric Random-Access Memories (FRAMs)-Gallium Arsenide (GaAs) FRAMs-Analog Memories-Magneto resistive Random-Access Memories (MRAMs)-Experimental Memory Devices. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D)-Memory MCM Testing and Reliability Issues-Memory Cards-High Density Memory Packaging Future Directions. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Ashok K.Sharma, ‘*Semiconductor Memories Technology, Testing and Reliability*’, Prentice-Hall of India Private Limited, New Delhi, 1997.
2. Luecke Mize Care, ‘*Semiconductor Memory design & application*’, Mc-Graw Hill.2011

REFERENCES:

1. Belty Prince, ‘*Semiconductor Memory Design Handbook*’, Springer, 2nd Edition, 2007.
2. Parag K. Lala, ‘*An Introduction to Logic Circuit Testing*’, Morgan & Claypool Publishers, 2009.
3. Viswani D.Agarval and Michael L.Bushnell, ‘*Essentials of Electronic Testing for Digital Memory & Mixed Signal VLSI Circuit*’, Kluwer Academic Publications, 1999.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Describe the architecture, operation, and applications of SRAM and DRAM technologies and memory fault modeling techniques.	**K2**
CO2	Apply memory fault modeling techniques to identify, diagnose, and test memory faults in various memory structures.	**K3**
CO3	Analyze the design principles, working mechanisms, and challenges of non-volatile advanced and emerging memory technologies.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	2											2	2
CO3		1										1	1
@	**2**	**1**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

Third ACM

25EVP02 AI OPTIMIZATION OF VLSI CIRCUIT DESIGN

3 0 0 3

INTRODUCTION: Introduction to Machine Learning and AI, VLSI and Hardware Implementation Using Machine Learning Methods, A Preliminary Taxonomy for Machine Learning in VLSI CAD, Applications of Machine Learning in VLSI Design. **(9)**

MACHINE LEARNING FOR DEVICE MODELLING: Machine Learning for Compact Lithographic Process Models, Machine Learning for Mask Synthesis, Machine Learning in Physical Verification, Mask Synthesis, and Physical Design, Machine Learning Algorithms for Semiconductor Device Modeling, Deep Learning Techniques for Side-Channel Analysis. **(9)**

MACHINE LEARNING FOR CIRCUIT DESIGN: Fast Statistical Analysis Using Machine Learning, Learning from Limited Data in VLSI CAD, SynTunSys: A Synthesis Parameter Autotuning System for Optimizing High-Performance Processors, Multicore Power and Thermal Proxies Using Least-Angle Regression, Machine Learning for Analog Layout, ML for System-Level Modeling. **(9)**

MACHINE LEARNING FOR VLSI PROCESS: ML for Design QoR Prediction, Deep Learning for Routability, Deep Learning for Power and Switching Activity Estimation, Deep Learning for Analyzing Power Delivery Networks and Thermal Networks, Machine Learning for Logic Synthesis, RL for Placement and Partitioning, Deep Learning Framework for Placement, Machine Learning for Analog Circuit Sizing. **(9)**

MACHINE LEARNING FOR VLSI TESTING: Machine Learning Approaches for IC Manufacturing Yield Enhancement, Machine Learning for VLSI Chip Testing and Semiconductor Manufacturing Process Monitoring and Improvement, Machine Learning-Based Aging Analysis, Machine Learning for Testing of VLSI Circuit, Online Test Derived from Binary Neural Network for Critical Autonomous Automotive Hardware, Application-Driven Fault Identification in NoC Design. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Ibrahim (Abe) M. Elfadel, Duane S. Boning and Xin Li, '*Machine Learning in VLSI Computer-Aided Design*', Springer 2019.
2. Sandeep Saini, Kusum Lata and G.R. Sinha, '*VLSI and Hardware Implementations using Modern Machine Learning Methods*", CRC Press, 2020.
3. Haoxing Ren and Jiang Hu, '*Machine Learning Applications in Electronic Design Automation*", Springer, 2022.

REFERENCES:

1. Oliver Theobald, '*Machine Learning for Absolute Beginners*', Springer, 2018.
2. Rohit Sharma, '*Machine Intelligence in Design Automation*', Paripath, 2023.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the applications of machine learning and AI techniques in VLSI design and manufacturing.	**K2**
CO2	Apply machine learning methods for modeling, simulation, and optimization in VLSI process and circuit design.	**K3**
CO3	Analyze the performance of AI/ML algorithms in VLSI CAD, process control, and testing environments.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	2											2	2
CO3		1										1	1
@	**2**	**1**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVP03 RF IC DESIGN

3 0 0 3

BASIC CONCEPTS OF RF IC DESIGN: Design Bottle necks of RF IC design Non-linearity and Time invariance Sensitivity and dynamic range, Passive impedance transformation, RF radio receiver front end nonidealities and design parameters: Effects of nonlinearity, 1 dB compression point, Derivation of required noise figure at receiver front end, Required IIP3 at receiver front end, Partitioning of required NF at receiver front end and IIP3 into individual NF and IIP3. **(9)**

NOISE: Noise sources in MOSFETs, Modeling of thermal noise and flicker noise, noise analog integrated circuits. **(9)**

TRANSCEIVER ARCHITECTURES: General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests. **(9)**

LOW NOISE AMPLIFIER: Introduction, General Philosophy, Matching Networks, Comparison of Narrowband and wideband LNA. Wideband LNA Design: DC Bias, Gain ad Frequency Response, Noise Figure. Narrowband LNA: Principles, core amplifier design, noise figure, power dissipation. **(9)**

MIXERS, OSCILLATORS AND FREQUENCY SYNTHESIZERS: Active mixer, modeling mixers, unbalanced mixer circuits, single balanced mixer circuit, Gilbert mixer, conversion gain. PLL based frequency synthesizer: Concepts of PLL, phase detector, charge pump, Frequency Divider, VCO, LC oscillators, Ring oscillator, Phase noise. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Bosco Leung, '*VLSI for wireless communication*', Prentice Hall, 2014.
2. Behad Razavi, '*RF Microelectronics*', Prentice Hall, 2011

REFERENCES:

1. Robert Caverly, '*CMOS RF IC Design Principles*', Artech House Publishers, 2007.
2. Li, Richard C, *'RF circuit design*', John Wiley & Sons, 2008.
3. Thangarasu and Bharatha Kumar, '*CMOS RF and mm-Wave Transceivers and Synthesizers*'. CRC Press, 2025.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Interpret the functionality RF transceivers and RF IC.	**K2**
CO2	Construct elements of RF transceivers for wireless applications	**K3**
CO3	Analyze the performance of elements in RF transceivers	**K4**
CO4	Design and simulate RF ICs circuits using simulation tool like ADS as a team	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		1										1	1
CO4					2			2				2	2
@	**3**	**1**			**2**			**2**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVP04 BEYOND CMOS

3 0 0 3

BEYOND SI-BASED CMOS DEVICES: Needs for Beyond Si-Based CMOS Devices, Opportunities, and Challenges, limitations of conventional CMOS for power and high-voltage applications, introduction to Power MOSFETs, device structure and operating principles, comparison of Power MOSFETs with logic CMOS devices, challenges in Power MOSFETs (scaling limits, ON-resistance, switching losses, thermal issues, reliability), Nanowire-Based Si-CMOS Devices, Carbon Nanotube FETS: An Alternative for Beyond Si Devices, Graphene-Based Devices for Beyond CMOS Applications, and Heterogeneous Integration of 2D Materials with Silicon Complementary Metal Oxide Semiconductor (Si-CMOS) Devices, 3D integration. **(9)**

NEGATIVE CAPACITANCE FIELD-EFFECT TRANSISTOR AND Z2FET: Introduction to NCFET, Understanding NC-FETs from scratch, Fundamental challenges of NC-FET, Design and optimization of NC-FET; Introduction to Z2FET, Z2FET steady-state analysis, analytical and compact model, experimental evidence, Z2FET as 1T-DRAM, Z2FET structure optimization, Z2FET as ESD, logic switch and photodetector. **(9)**

MEMRISTOR DEVICES AND MEMRISTOR-BASED CIRCUITS: Introduction, Types of memristors, Device structure and working of a memristor, Memristor device modelling, Characteristics of the memristor, Memristors in analog nanoelectronics, Memristors in digital nanoelectronics, Future directions of research. **(9)**

ADVANCES IN NANOELECTRONICS: SETS, OTFTS, SPINTRONICS: Introduction to Single electron devices (SET), SET as a switch and sensor. Application of density functional theory (DFT) for emerging materials and interconnects, Organic thin-film transistors, working principle of OTFT and parameters. Advanced Spintronics Memories, Magnetic Layered Interfaces for TST-MRAM, Future Trends in Spintronics Memory. **(9)**

QUANTUM COMPUTING: Introduction to Superposition, Qubit, Creating Superposition: The Beam Splitter, Stern-Gerlach, Quantum Cryptography, Quantum Gates, Entanglement, Quantum Teleportation, Quantum Algorithms. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Singh, S., Sharma, S. K., & Nandan, D, *'Beyond Si-Based CMOS Devices: Materials to Architecture*', . Springer, 2024. https://doi.org/10.1007/978-981-97-4623-1 [Unit 1]
2. Cresti, A, '*Beyond-CMOS: State of the Art and Trends*', Springer, 2020. https://doi.org/10.1007/978-3-030-37536-4 [Unit 2]
3. Ashok Srivastava and Saraju Mohanty, '*Advanced Technologies for Next Generation Integrated Circuits*', IET MATERIALS, CIRCUITS AND DEVICES SERIES,2020 [Unit 3 &4]

REFERENCES:

1. Dhiman R, '*Nanoelectronics for Next-Generation Integrated Circuits*', CRC Press, 2022, https://doi.org/10.1201/9781003155751VitalSource+3Taylor & Francis+3VitalSource+3 [Unit 4]
2. Hughes, C., Isaacson, J., Perry, A., Sun, R. F., and Turner, J, '*Quantum computing for the quantum curious'* Springer, 2nd Edition, 2021, https://doi.org/10.1007/978-3-030-61601-4 [Unit 5]

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the structure, operating principle and key concepts of nano electronic devices	**K2**
CO2	Apply knowledge of devices with advanced materials for practical nano electronic design and implementation	**K3**
CO3	Analyze the performance and operating behavior of emerging nano electronic devices using appropriate simulation tools and interpret the results.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		1			1							1	1
@	**3**	**1**			**1**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

VERTICAL 2: SIGNAL PROCESSING AND TECHNOLOGIES

25ECP11 ADVANCED DIGITAL SIGNAL PROCESSING
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION: DT signals and DT systems - DTFT - Random variables and random process – Autocorrelation function - Power spectral density. **(5)**

MULTIRATE SIGNAL PROCESSING: Down sampling - Up sampling - Noble identities - cascading sampling rate convertors - Decimation with transversal filters - interpolation with transversal filters - decimation with polyphase filters – interpolation with polyphase filters - decimation and interpolation with rational sampling factors - multistage implementation of sampling rate convertors. **(10)**

POWER SPECTRUM ESTIMATION: Nonparametric methods - Periodogram - Modified Periodogram - Bartlett - Welch & Blackman Tukey methods - Performance comparison - Parametric methods - Auto Regressive spectrum estimation - Relationship between autocorrelation and model parameters - Moving Average and Auto Regressive Moving Average spectrum estimation. **(10)**

ADAPTIVE FILTERS: Introduction to Wiener Filter - Adaptive Filter Applications - System identification - Inverse modeling - Prediction - Interference Cancellation - Adaptive linear combiner - Performance function - Gradient and Minimum Mean Square error - Gradient search by steepest descent method - LMS algorithm - Convergence of LMS algorithm – Learning curve - Introduction to RLS algorithm. **(10)**

WAVELET TRANSFORMS: Need for Time Frequency Analysis - Short time Fourier transform - short comings of STFT – Need for Wavelets - Continuous time Wavelet Transform - Multi Resolution Analysis - Haar and Daubechies wavelet functions - Introduction to Discrete Wavelet Transform. **(10)**

Total L: 45 periods

TEXT BOOKS:

1. Monson H.Hayes, '*Statistical Digital Signal Processing and Modeling*', John Wiley and Sons, 2015.
2. Ifeachor E C and Jervis B. W, '*Digital Signal Processing: A Practical Approach*', Prentice Hall, 2015.

REFERENCES:

1. K.P.Soman, K.I.Ramach and N.G.Resmi , '*Insight into Wavelets from Theory to Practice*', PHI, 3rd Edition, 2015.
2. Jaideva C Goswami and Andrew K Chan, '*Fundamentals of Wavelets – Theory, Algorithms and Applications*', John Wiley and Sons, 2015.
3. Vaidyanathan P P, *Multirate Systems and Filter banks*', Prentice Hall, 2008.
4. Bernard Widrow and Samuel D Stearns, '*Adaptive Signal Processing*', Prentice Hall, 2008.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of multirate signal processing and its applications to discrete random signals.	**K2**
CO2	Apply power spectral density applications to discrete random signals and systems.	**K3**
CO3	Analyze the types of wavelets transform, adaptive filtering algorithms / problems in signal processing applications.	**K4**
CO4	Implement / Develop code using suitable tool for Signal Processing applications such as multirate, adaptive filtering, and power spectrum estimation techniques.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		1										1	1
CO4			1		1							1	1
@	3	1	1		1							3	3

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP12 DIGITAL IMAGE PROCESSING
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels – Neighbors and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Remote Sensing. Colour Image Processing: Colour Fundamentals, Colour Models. **(8)**

IMAGE ENHANCEMENT: Spatial Domain: Some Basic Gray Level Transformations, Histogram equalization and specification, Enhancement using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. Frequency Domain: Preliminary Concepts, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening using Frequency Domain Filters. **(8)**

IMAGE SEGMENTATION AND MORPHOLOGY: Introduction, Detection of isolated points, Line detection, Edge detection (Sobel, Prewitt, Canny), Edge linking, Region-based segmentation – Region growing, Split and merge technique, Local processing, regional processing, Hough transform, Segmentation using Threshold. Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing. **(10)**

IMAGE COMPRESSION: Need for data compression- Lossless vs lossy compression – Image compression techniques: Huffman, Run Length Encoding, Arithmetic coding, JPEG standard, MPEG - Applications of image compression. **(9)**

IMAGE RESTORATION: Degradation model; Noise models, Restoration in the Presence of Noise Only using Spatial Filtering: Mean filters - Order statistics - Adaptive filters - Periodic Noise Reduction by Frequency Domain Filtering: Band reject filters - Band pass filters - Notch filters, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. **(10)**

Total L: 45 periods

TEXT BOOKS:

1. Rafael C Gonzalez and Richard E Woods, '*Digital Image Processing*', Pearson, India, 4th Edition 2018.
2. Anil K Jain, '*Fundamentals of Digital Image Processing*', Prentice Hall of India Pvt Ltd, New Delhi, 1995.

REFERENCES:

1. Milan Sonka, '*Image Processing, Analysis and Machine Vision*', Thomson Press India Ltd, 4th Edition, 2014.
2. Anil K. Jain, '*Fundamentals of Digital Image Processing*', Prentice Hall of India, 2nd Edition, 1989.
3. S. Sridhar, '*Digital Image Processing*', Oxford University Press, 2nd Edition, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of digital image processing, including digitization, sampling, quantization, and 2D-transforms.	**K2**
CO2	Apply image enhancement techniques in spatial and frequency domains for improved image quality.	**K3**
CO3	Analyze the effectiveness of image processing methods, including feature extraction, compression, and color models.	**K4**
CO4	Develop and implement MATLAB-based image processing algorithms for restoration, segmentation, compression, and recognition, with performance analysis as an individual/team.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		2										2	2
CO4			1		1	1	1	1				1	1
@	**3**	**2**	**1**		**1**	**1**	**1**	**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP13 SPEECH PROCESSING
(Common to ECE and EE-VLSI)

3 0 0 3

FUNDAMENTALS OF SPEECH: The Human speech production mechanism, Speech perception – human auditory system, Phonetics – articulatory phonetics, acoustic phonetics, and auditory phonetics, Source - Filter model - Lossless Tube Models, effect of losses in vocal tract, effect of radiation at lips, Digital Model of speech signals. **(9)**

SPEECH SIGNAL ANALYSIS IN TIME DOMAIN: Speech signal analysis, Time domain parameters of speech signal, Methods for extracting the parameters- short time Energy, Short -time Average Magnitude, Short Time Zero Crossing Rate (ZCR), The short Time Autocorrelation Function, Silence Discrimination using ZCR and energy, Pitch Period Estimation using Autocorrelation Function. **(9)**

SPEECH SIGNAL ANALYSIS IN FREQUENCY DOMAIN: Short Time Fourier analysis, Filter bank analysis, Homomorphic speech analysis - Homomorphic Systems for Convolution, The Complex Spectrum of Speech, The Homomorphic Vocoder, Formant and Pitch Estimation, Linear Predictive analysis of speech - Introduction, Basic Principles of Linear Predictive analysis of speech, Autocorrelation method, Covariance method. **(9)**

SPEECH FEATURES: Significance of speech features in speech-based applications, Speech Features – Cepstral Coefficients, Mel Frequency Cepstral Coefficients (MFCCs), Perceptual Linear Prediction (PLP), Log Frequency Power Coefficients (LFPCs), Filter bank and Zero Crossing Analysis, Analysis–by-Synthesis, Pitch Extraction. **(9)**

SPEECH ENHANCEMENT AND APPLICATION: Speech enhancement techniques: Single Microphone Approach: spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter. Applications of Speech Processing: Text-to-Speech system, Speaker recognition systems, hearing aid design and recognition systems **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Lawrence Rabiner and B.H. Juang, '*Fundamentals of Speech Recognition*', Prentice-hall, 2nd Edition, 1993.
2. Ben Gold, Nelson Morgan and Dan Ellis, '*Speech and Audio Signal Processing: Processing and Perception of Speech and Music*', Wiley, 2016.

REFERENCES:

1. Owens FJ, '*Signal Processing of Speech*', Macmillan, 2015.
2. H. Anton, I. Bivens and S. Davis, '*Calculus*', John Wiley and Sons, USA, 2016.
3. John R Deller Jr, John H L Hansen and John G Proakis, '*Discrete Time Processing of Speech Signal*', IEEE press, 2015.
4. Rabiner L R and Schaffer R W, '*Digital Processing of Speech Signals*', Pearson Education - India, 2015.
5. Thomas F Quatieri, *'Discrete-Time Speech Signal Processing – Principles and Practice*', Pearson Education, 2001.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the mechanism of human speech production and models of speech signals	**K2**
CO2	Apply Time and frequency domain models for speech signals	**K3**
CO3	Analyze the different features of speech signals	**K4**
CO4	Design and implement speech processing systems using appropriate tools and technologies	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	2											2	2
CO3		1										1	1
CO4			1		1							1	1
@	**2**	**1**	**1**		**1**							**2**	**2**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP14 SOFTWARE DEFINED RADIO
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO: Evolution of Software Defined Radio and Cognitive radio – goals – benefits – definitions – architectures - enabling technologies - radio frequency spectrum and regulations. **(9)**

SOFTWARE DEFINED RADIO ARCHITECTURE: Cognition cycle – orient – plan - decide and act phases – organization of CR - SDR as a platform for Cognitive Radio – Hardware and Software Architectures - Overview of IEEE 802.22 standard for broadband wireless access in TV bands **(9)**

SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS: Introduction – Primary user detection techniques – energy detection - feature detection - matched filtering - cooperative detection and other approaches - Fundamental Tradeoffs in spectrum sensing - Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing - Fundamental Limits of Cognitive Radio. **(9)**

MAC AND NETWORK LAYER DESIGN FOR SOFTWARE DEFINED RADIO: MAC for cognitive radios: Polling – ALOHA - slotted ALOHA – CSMA -CSMA / CA - Network layer design: routing in cognitive radios - flow control and error control techniques **(9)**

HARDWARE AND SOFTWARE FOR SDR: DSP Processors, FPGA, ASICs. Trade-offs, GNU Radio-USRP. Case Studies: SPEAK easy, JRTS, SDR-3000. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Alexander M. Wyglinski, Maziar Nekovee and Thomas Hou, '*Cognitive Radio Communications and Networks – Principles and Practice'*. Academic Press, Elsevier, 2010.
2. Huseyin Arslan, '*Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems'*. Springer, 2014.

REFERENCES:

1. Bruce A. Fette, '*Cognitive Radio Technology'*. Elsevier Science, 2nd Edition, 2009.
2. Kwang Cheng Chen and Ramjee Prasad, '*Cognitive Radio Networks*'. John Wiley and Sons, 2009.
3. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan B. Mandayam and H. Vincent Poor, '*Principles of Cognitive Radio'*. Cambridge University Press, 2013.
4. Ahmed Khattab, Dmitri Perkins and Magdy Bayoumi, '*Cognitive Radio Networks – From Theory to Practice*'. Springer Series: Analog Circuits and Signal Processing, 2014.
5. Geetam Singh Tomar, Ashish Bagwari and Jyotshana Kanti, '*Introduction to Cognitive Radio Networks and Applications*'. CRC Press, Taylor & Francis Group, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the principles and evolution of Software-Defined Radio and Cognitive Radio systems	**K2**
CO2	Apply spectrum sensing techniques and dynamic spectrum access mechanisms to compare the performance	**K3**
CO3	Analyze the OSI layer protocols suitable for SDR environments	**K4**
CO4	Evaluate the concepts through case studies	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4				2							2	2	2
@	**3**	**2**		**2**							**2**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP15 WAVELETS AND ITS APPLICATIONS
(Common to ECE and EE-VLSI)

3 0 0 3

FOURIER ANALYSIS: Fourier basis & Fourier Transform – failure of Fourier Transform – Need for Time-Frequency Analysis – Heisenberg 's Uncertainty principle – Short time Fourier transform (STFT)- short comings of STFT- Need for Wavelets. **(9)**

CWT AND MRA: Wavelet basis – Continuous time Wavelet Transform (CWT) – need for scaling function – Multi- Resolution Analysis (MRA) – important wavelets: Haar, Mexican hat, Meyer, Shannon, Daubachies. **(9)**

INTRODUCTION TO MULTIRATE SYSTEMS: Decimation and Interpolation in Time domain - Decimation and Interpolation in Frequency domain – Multi rate systems for a rational factor. **(9)**

FILTER BANKS AND DWT: Two channel filter bank – Perfect Reconstruction (PR) condition – relationship between filter banks and wavelet basis – DWT – Filter banks for Daubachies wavelet function. **(9)**

ADVANCED TOPICS AND APPLICATIONS: Introduction to Multiwavelets, Multidimensional wavelets – wavelet packet transform, wavelet frame transform- Feature extraction using wavelet coefficients, Image compression, Wavelet based denoising. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Jaideva C Goswami and Andrew K Chan, *'Fundamentals of Wavelets – Theory, Algorithms and Applications*', John Wiley & Sons, Singapore, 2011.
2. Soman K P and Ramachandran K I, '*Insight into wavelets from Theory to practice*', Prentice Hall, New Delhi, 2010.

REFERENCES:

1. Sidney Burrus C, *'Introduction to Wavelets and Wavelets Transforms*', Prentice Hall, New Delhi, 2002.
2. Stephane G Mallat, '*A Wavelet Tour of Signal Processing*', Academic Press, India, 2009.
3. Raghuveer M Rao and Ajit S Bopardikar, '*Wavelet Transforms: Introduction to Theory & Applications*', New Delhi, 2003.
4. Mani Mehra, '*Wavelets Theory and Its Applications: A First Course*', Springer, 1st Edition, 2018.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of Fourier analysis, multirate systems and multi resolution analysis.	**K2**
CO2	Apply the types of continuous and discrete wavelet transform to discrete time signals.	**K3**
CO3	Analyze filter banks and wavelet functions in signal processing applications.	**K4**
CO4	Implement / Develop code using suitable tool for wavelet transform applications in advanced topics.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												1	1
CO2	3											3	3
CO3		1										1	1
CO4			1		1						1	1	1
@	**3**	**1**	**1**		**1**						**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP16 BIOMEDICAL SIGNAL PROCESSING
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO BIOMEDICAL SIGNALS: Nature and types of Biomedical Signals- action potential, electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG), electrogastrogram (EGG), electrooculogram (EOG), electroretinogram (ERG); Objectives of Biomedical Signal Analysis. **(9)**

FILTERING TECHNIQUES FOR BIOMEDICAL SIGNALS: Types of digital filters, The z-plane and pole-zero plots, The rubber membrane concept; FIR filters- Smoothing filters, derivative filters, Notch filters, Window design; IIR filters, Integer filters, Adaptive filters, Signal averaging. **(9)**

THE CARDIOVASCULAR SYSTEM AND ECG SIGNAL PROCESSING: Electrical activity of heart, ECG leads and recording system, Heart rhythms, Heartbeat morphologies, Noise and artifacts in ECG; ECG Signal Processing- baseline wander removal, powerline interference removal, QRS detection- differentiation and template matching techniques, Pan-Tompkin's algorithm; P and T wave detection. **(9)**

THE NERVOUS SYSTEM AND EEG SIGNAL PROCESSING: The nervous system, EEG rhythms and waveforms, EEG recording techniques, EEG applications- epilepsy, sleep disorders, brain-computer interface (BCI); EEG Signal Processing- artifacts in EEG, artifact cancellation using reference signals, The auto-regressive (AR) and autoregressive moving average (ARMA) models. **(9)**

ADVANCED BIOMEDICAL SIGNAL PROCESSING TECHNIQUES: Multi-resolution analysis (MRA) and Wavelets, Pattern classification- Supervised and Unsupervised classification, Neural networks, Support vector machines. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Lesli Cromwell, F J Weibell and Erich Pfeiffer, '*Biomedical Instrumentation and Measurements*, PHI, 1980.
2. Willis J Tompkins, '*Biomedical Digital Signal Processing*', PHI, 1993.
3. Reddy, D.C, '*Biomedical signal processing: principles and techniques*', McGraw-Hill, 2005.

REFERENCES:

1. Rangaraj M. Rangayyan , '*Biomedical Signal Analysis*', John Wiley & Sons, 1st Edition, 2002.
2. Leif Sornmo and Pablo Laguna, '*Bioelectrical Signal Processing in Cardiac and Neurological Applications*', Elsevier, Academic Press, 2005.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand human physiological system and generation and acquisition of various biomedical signals.	**K2**
CO2	Apply basic and advanced digital filtering and signal processing techniques for biomedical signals	**K3**
CO3	Analyze the efficient signal processing techniques for cardiovascular and nervous system	**K4**
CO4	Implement advanced signal processing and pattern classification techniques for biomedical signals	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	2											2	2
CO3		2										2	2
CO4			1		1			1				1	1
@	**2**	**2**	**1**		**1**			**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP17 5G AND BEYOND
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO 5G COMMUNICATION: 5G potential and applications, Usage scenarios, enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications, Spectrum for 5G, spectrum access/sharing, millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity, 5G STANDARDS. **(9)**

5G NETWORK: New Radio (NR), Standalone and non-standalone mode, non-orthogonal multiple access (NOMA), massive MIMO, beam formation, PHY API Specification, flexible frame structure, Service Data Adaptation Protocol (SDAP), centralized RAN, open RAN, multi-access edge computing (MEC); Introduction to software defined networking (SDN), network function virtualization (NFV), network slicing; restful API for service-based interface, private networks. **(9)**

MOBILITY AND HANDOFF MANAGEMENT IN 5G: Network deployment types, Interference management in 5G, Mobility management in 5G, Dynamic network reconfiguration in 5G. **(9)**

mmWAVE MIMO WIRELESS SYSTEMS: Introduction and motivation, millimeter wave propagation and channel models, Analog, Digital and Hybrid Processing, Sparse channel estimation. **(9)**

FULL-DUPLEX FUTURE WIRELESS SYSTEM: Introduction and motivation, Self interference cancellation, active/passive cancellation, FD massive MIMO system multi-hop massive MIMO communication: Introduction and motivation, Transmission model for amplify-and-forward and decode-and-forward protocols, multi-pair multi-hop communication, Capacity and asymptotic analysis. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Erik Dahlman, Stefan Parkvall and Johan Sköld, '*5G NR: The Next Generation Wireless Access Technology*', Academic Press, Elseiver, 2018.
2. Sassan Ahmadi, '*5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards*', Academic Press, 2019.

REFERENCES:

1. Özlem Tugfe Demir, Emil Björnson and Luca Sanguinetti, '*Foundations of User-Centric Cell-Free Massive MIMO*', Now publishers, 2021.
2. Sassan Ahmadi, '*5G NRArchitecture, Technology, Implementation, and Operation of 3GPP New Radio Standards*", Academic Press, 2019.
3. Xingqin Lin and Namyoon Lee, '*5G and Beyond: Fundamentals and Standards*', Springer, 2021.

COURSE OUTCOMES:

At the end of this course students will be able to:		**Bloom's Level**
CO1	Demonstrate knowledge of standards and architectures of 5G and beyond networks	K2
CO2	Apply the principles of 5G and beyond technologies to design and optimize wireless communication systems for enhanced performance and efficiency	K3
CO3	Analyze the capacity of different channels and identify methods to improve the capacity of wireless systems	K4
CO4	Identify and present applications of 5G and B5G network as a team	-

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		1										1	1
CO4									1		1	1	1
@	**3**	**1**							**1**		**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP18 MOBILE COMMUNICATION
(Common to ECE and EE-VLSI)

3 0 0 3

WIRELESS FUNDAMENTALS: Overview of cellular evolution to 4G and beyond - Cellular basics - Cellular terminology, link budget - Frequency reuse- Co-channel interference, handoff, Erlang capacity- Computer Simulation of Digital communications link. **(9)**

RADIO PROPAGATION: Small scale effects- Multipath, different types of fading, delay spread - BER performance in fading - Radio Propagation - large scale effects - Propagation and Path loss models-shadowing, diffraction loss-Diversity -Types of diversity. **(9)**

CAPACITY OF WIRELESS CHANNELS: Introduction to Channel Capacity - AWGN Channel Capacity - Fading Channels, CSIR, CSIT, water-filling, introduction to MIMO systems - Capacity of MIMO channels. **(9)**

MULTIPLE ACCESS METHODS: Types- CDMA Systems Principles of CDMA cellular systems-Principles of OFDM based broadband wireless systems -4G LTE basics - OFDM, and OFDMA - Generalised framework for Filtered OFDM and FBMC. **(9)**

INTRODUCTION OF 5G: Limitations of 4G LTE - The need for 5G- 5G Architecture- 5G Radio Technologies- Spectrum for 5G- Challenges and Limitations- Future of 5G & beyond. **(9)**

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Total L: 45 periods

TEXT BOOKS:

1. Goldsmith, '*Wireless Communications*', Wiley, 2005
2. T. S. Rappaport, '*Wireless Communications - Principles and Practice*', Pearson, 2nd Edition, 2010, ISBN 9788131731864.
3. Ali Behrouzfar, Jose F. Monserrat and Patrick Marsch, '*5G Mobile and Wireless Communications Technology*', Cambridge University press, 2016.

REFERENCES:

1. Goldsmith, '*Wireless Communications*', Cambridge University Press, 2005.
2. D. Tse and P. Viswanath, '*Fundamentals of Wireless Communications*', Cambridge University Press, 2005.\
3. Andreas F. Molisch, '*Modern Wireless Communications*', Indian Edition, Pearson, 2011, ISBN 9788131704431.
4. J.G. Proakis, '*Digital Communications*', McGraw Hill, New York, 1989.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Demonstrate knowledge of cellular evolution, cellular basics, frequency reuse, co-channel interference, handoff, Erlang capacity and modern wireless systems.	**K2**
CO2	Apply radio propagation concepts to assess the effects on mobile communication systems	**K3**
CO3	Analyze capacity of different channels and identify methods to improve the capacity of wireless systems.	**K4**
CO4	Demonstrate an understanding of the societal, technological and economic impacts of Mobile and Wireless communication systems.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		1										1	1
CO4						1	1		1			1	1
@	**3**	**1**				**1**	**1**		**1**			**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

VERTICAL 3: IOT AND EMBEDDED SYSTEM

25ECP21 REAL TIME OPERATING SYSTEMS
(Common to ECE and EE-VLSI)

3 0 0 3

BASIC OF OPERATING SYSTEMS: Computer System Overview - Basic Elements, Instruction Execution, Interrupts, Multiprocessor and Multicore Organization. Operating system overview-objectives and functions, Evolution of Operating System. Operating System Structure and Operations- System Calls, System Programs, OS Generation and System Boot. Parallel, Distributed & Real – Time Operating Systems, UNIX based commands **(9)**

PROCESS SCHEDULING: Process Concept, Process Scheduling, Scheduling algorithms: FCFS, SJF, Priority, Round Robin.Periodic Tasks Scheduling: Cyclic Schedulers, EDF, RMA, and DMA - Aperiodic Task Scheduling: Jackson's Algorithm, Horn's Algorithm. **(9)**

INTER - PROCESS COMMUNICATION: Process Synchronization — The critical-section problem, Synchronization hardware, Mutex locks, Semaphores, Classic problems of synchronization, Critical regions, Monitors; Deadlock — System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock, Priority Inversion. **(9)**

STORAGE MANAGEMENT: Main Memory — Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging, 32- and 64-bit architecture Examples; Virtual Memory — Background, Demand Paging, Page Replacement, Allocation, Thrashing; Allocating Kernel Memory, OS Examples. **(9)**

FILE SYSTEMS AND I/O SYSTEMS: Mass Storage system — Overview of Mass Storage Structure, Disk Structure, Disk Scheduling and Management, swap space management; File-System Interface — File concept, Access methods, Directory Structure, Directory organization, File system mounting, File Sharing and Protection; File System Implementation- File System Structure, Directory implementation, Allocation Methods, Free Space Management, Efficiency and Performance, Recovery; I/O Systems — I/O Hardware, Application I/O interface, Kernel I/O subsystem, Streams, Performance. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, '*Operating System Concepts*', John Wiley and Sons Inc., 9th Edition, 2018.
2. Andrew S Tanenbaum, '*Modern Operating Systems*', Pearson, 4th Edition, New Delhi, 2016.

REFERENCES:

1. Ramaz Elmasri, A. Gil Carrick and David Levine, *Operating Systems – A Spiral Approach*', Tata McGraw Hill Edition, 2010.
2. 2.William Stallings, '*Operating Systems: Internals and Design Principles*, Prentice Hall, 7th Edition, 2018.
3. Achyut S. Godbole and Atul Kahate, '*Operating Systems*', McGraw Hill Education, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic structure, functions, and evolution of operating systems	**K2**
CO2	Apply process scheduling, synchronization, memory and I/O management techniques using appropriate algorithms for handling periodic, aperiodic tasks, inter-process communication and memory.	**K3**
CO3	Analyze process and memory management strategies to evaluate system performance and optimize resource allocation	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
	3	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP22 IOT BASED SYSTEM DESIGN
(Common to ECE and EE-VLSI)

3 0 0 3

IMPLEMENTING IOT WITH ARDUINO: Introduction to Arduino Platforms, Arduino Uno architecture, IDE setup, importing Arduino boards in Arduino IDE tool, Installation of Arduino libraries, Basics of Embedded C Programming, Interfacing of Sensors and Actuators with Arduino Uno. **(9)**

IMPLEMENTING IOT WITH RASPBERRY Pi (RPi): Basic functionality of RPi board, RPi GPIO pins, Reading the datasheet of RPi setting up the board by installing OS, first boot and basic configuration of Rpi, Basic Linux Commands, Accessing RPi remotely using networking tools, Interfacing of Sensors and Actuators with RPi. **(9)**

NODE-RED TOOL ON Rpi: Prerequisite for Node-RED, Installing and upgrading Node-RED, Running Node-RED app locally and as a service on network, auto-start on boot, opening the editor, installation of various libraries for Node-RED, Creation and deployment of flows, Case studies on debug window, HTTP server, chart, gauge, slider, dashboard form etc. **(9)**

SECURITY & SECURITY ARCHITECTURE: Introduction, Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications, Security Requirements in IoT, Insufficient Authentication/Authorisation, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT. **(9)**

CASE STUDY ON IOT SYSTEM: Case study for weather monitoring system – modules & package of python, python packages of interest for IoT- JSON, XML, HTTP & URLLib, SMTPLib. Exemplary device – Rasberry pi, Linux on Raspberry pi. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Simon Monk , '*Programming the Raspberry Pi: Getting Started with Python*', Tata McGraw Hill Publication, 3rd Edition, 2021
2. Pethuru Raj and Anupama C. Raman, *'The Internet of Things: Enabling Technologies, Platforms, and Use Cases*', CRC Press, 2017.
3. Shancang Li, Li Da Xu and Shanshan Zhao ,*'Securing the Internet of Things*', Elsevier, 2017, ISBN: 978-0-12-804458-2.

REFERENCES:

1. Simon Monk , '*Programming Arduino: Getting started with sketches'*, Tata McGraw Hill Publication, 2nd Edition, ISBN: 978-1259641633.
2. Derex Molly , '*Exploring Raspberry Pi: Interfacing to the real world with Embedded Linux'*, Wiley Publication, 1st Edition, 2016, ISBN: 978-1119188681.
3. Richard Blum, '*Arduino Programming in 24 hours'*, Sams Teach Yourself Publishing, 1st Edition, 2014, ISBN: 978-0672337123.
4. Aditya Gupta, '*The IoT Hacker's Handbook: A Practical Guide to Hacking the Internet of Things'*, Apress publisher, 2019, ISBN: 1484242998.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the key requirements for implementing IoT with Arduino Uno and Raspberry Pi development boards.	**K2**
CO2	Apply Node-RED tool and python code for designing the IoT applications in Raspberry Pi.	**K3**
CO3	Analyze the IoT security issues and concerns to create awareness.	**K4**
CO4	Develop IoT systems with using Arduino Uno and Raspberry Pi for real-time applications.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			1		1	1		1				1	1
@	**3**	**2**	**1**		**1**	**1**		**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP23 ARTIFICIAL IOT
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO IOT: Introduction to IoT - IoT applications- sensor systems - IoT sensing techniques - IoT networking - IoT Data analytics - IoT platforms and systems - Raspberry Pi - Arduino Programming. **(9)**

INTRODUCTION TO AI: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation. **(9)**

INTRODUCTION TO AIOT: Introduction to AIoT - AIoT concepts and issues-Technologies behind AIoT AIoT application segments - Distributed intelligence at the edge of IoT systems (edge computing; blockchain, etc.) - Robotics for AIoT. **(9)**

AIOT COMPONENTS: Technical architecture of AIoT - Smart sensors and devices – Wearables - Smart object and human sensing - Challenges of AI in networks for IoT - AI for IoT data analytics and automation. **(9)**

APPLICATIONS: Intelligent manufacturing - Smart health - Smart infrastructure and construction - Smart Appliances in home and Industry – Smart Vehicle - Intelligent Agriculture. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Eugene Chang , '*The Future of Artificial Intelligence, the Internet of Things, and Blockchain: From AI to AIoT to AIoTB'*, Publisher: Amazon (KDP), 2019.
2. Amita Kapoor, '*Hands-On Artificial Intelligence for IoT: Expert machine learning and deep learning techniques for developing smarter IoT systems'*, Publisher: Packt Publishing Ltd. 2018.

REFERENCES:

1. Francis DaCosta, '*Rethinking the Internet of Things: A Scalable Approach to Connecting Everything'*, Publisher: Apress, 2013.
2. Vlasios Tsiatsis Stamatis Karnouskos Jan Holler David Boyle Catherine Mulligan '*Internet of Things'*, Publisher: Elsevier. 2nd Edition. 2018.
3. Kai Hwang and Min Chen, '*Big-Data Analytics for Cloud, IoT and Cognitive Computing'*, Publisher: Wiley. 2017.
4. Fadi AI-Turjman, '*AIoT Innovation'*, Publisher: Springer. 2020.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts, technical challenges, and the state of- the-art technology development and applications of AI, IoT, AIoT.	**K2**
CO2	Deploy the AI models, algorithms and techniques for IoT operation efficiency, cost reduction, event detection, and predictive maintenance in practice.	**K3**
CO3	Analyze the protocols and platforms for sensing, networking and data analytics in IoT systems.	**K4**
CO4	Identify potential AI-oriented usage scenarios in IoT and apply AIoT methods and techniques to solve various challenging IoT problems.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			1		1	1		1				1	1
@	**3**	**2**	**1**		**1**	**1**		**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP24 INDUSTRIAL INTERNET OF THNINGS AND INDUSTRY 4.0
(Common to ECE and EE-VLSI)

3 0 0 3

OVERIVEW OF INDUSTRY 4.0 & IIOT: Industrial Revolution: Phases of Development-Evolution of Industry 4.0-Environmental impacts of Industrial Revolution-Industrial Internet-Applications of Industrial Internet and Industry 4.0. IIoT: Prerequisites of IIoT- Basics of Cyber Physical Systems (CPS)-CPS and IIoT-Applications of IIoT. **(9)**

TECHNOLOGICAL ASPECTS OF INDUSTRY 4.0 AND IIOT: Cloud Computing and IIoT-Industrial Cloud Platform Providers-Requirements of Industry 4.0 and its solution. Fog Computing for IIoT- Applications of fog and their solutions. Big Data and advanced analytics-Smart factories: Characteristics fo Smart Factory-Technologies used in Smart Factories. **(9)**

INDUSTRIAL DATA TRANSMISSION: Field Bus – Profibus – HART – Interbus – Butbus –CCLink – Modbus – Batibus – Digital STROM – CAN – DeviceNet – LonWorks - Wireless HART - LoRa and LoRa WAN - NB-IoT - IEEE 802.11AH. **(9)**

IIOT ANALYTICS, PLANT SAFETY & SECURITY: Necessity-Categorization of Analytics-Usefulness of IIoT Analytics-Challenges of Analytics in Industries-Mapping of Analytics with the IIRA Architecture-Deployment of Analytics-Application of analytics across value chain. IIoT applications for undertaking safety measures in Plant-Plant.Software Security – Network Security - Mobile Device Security. **(9)**

CASE STUDY: Operational Management Tool for Factory IoT- Configuration and Dashboard Visualization-Monitoring the operational status of the whole factory: Equipment Monitoring-Group Alarm and Signal Monitoring-Operational Results-Group Results and Production Results. Connecting Legacy equipments: OPC UA Configuration, data back-up – SRAM Data Utility- Machine Data Archive Management-Web API. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Sudip Misra, Chandana Roy and Anandarup Mukherjee, '*Introduction to Industrial Internet of Things and Industry 4.0*', CRC Press, Taylor &Francis Group, 2021.
2. Arshdeep Bahga and Vijay Madisetti, '*Internet of Things A Hands-on Approach'*, Universities Press (India), 2015.

REFERENCES:

1. Adrian McEwen and Hakim Cassimally, '*Designing the Internet of Things'*, John Wiley & Sons, 2014
2. Francis Dacosta, '*Rethinking the Internet of Things'*, A press Open, 2013.
3. Gater, A and Ryu, S.H, '*Process Analytics Concepts and Techniques for Querying and Analyzing Process Data*' Springer International Publishing Switzerland, 2016.
4. MT Link-i Reference Manual from FANUC.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basics of Industrial IOT, evolution of Industry 4.0, and Cyber-Physical Systems.	**K2**
CO2	Apply core concepts and enabling /computing technologies for Industry 4.0 in the context of smart factories and IIoT-based solutions	**K3**
CO3	Analyze various industrial data transmission protocols/IIoT communication protocols and determine their suitability for specific IIoT applications	**K4**
CO4	Design an operational monitoring and management system and Implement dashboard visualization to monitor factory operations that provides support for product optimization	**K6**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		1										1	1
CO4			2		2	2	2	2	2		2	2	2
	3	**1**	**2**		**2**	**2**	**2**	**2**	**2**		**2**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP25 FPGA BASED SYSTEM DESIGN
(Common to ECE and EE-VLSI)

3 0 0 3

FPGA DESIGN FLOW AND ARCHITECTURES: Digital IC design flow -The role of FPGAs in digital design–Goals and techniques–Hierarchical design – CAD Tools. FPGA architectures – Configurable logic blocks – configurable / Oblocks–Programmable interconnect – clock circuitry – Xilinx FPGA architecture–Programming Technologies: Antifuse, SRAM, EPROM, EEPROM. **(9)**

VERILOG HDL: HDL overview – Modules and ports – compiler directives – data types - operands and operators- gate level modeling – data flow modeling – behavioral modeling – structural modeling – primitives – Tasks and functions –Writing test bench. **(9)**

ARCHITECTING SPEED AND TIMING ISSUES: High Throughput - Low Latency - Timing - Add Register Layers, Parallel Structures, Flatten Logic Structures, Register Balancing, reorder Paths. CLOCKING AND METASTABILITY: Setup time hold time–setup time hold time violations – critical path – calculation of maximum clock frequency – Meta stability - synchronizers-design examples. **(9)**

ARCHITECTING AREA AND POWER: Architecting Area - Rolling Up the Pipeline - Control-Based Logic Reuse – Resource Sharing - Impact of Reset on Area - Resources Without Reset, Resources Without Set, Resources Without Asynchronous Reset, Resetting RAM, Utilizing Set/Reset Flip-Flop Pins. Architecting Power -Clock Control, Clock Skew, Managing Skew, Input Control, Reducing the Voltage Supply, Dual-Edge Triggered Flip-Flops, Modifying Terminations. **(9)**

EMBEDDED SYSTEM DESIGN WITH FPGA: Processors-Interfaces- Zynq System-on-chip Development-IP based Design Hardware-Software Co-design for Zynq – Software Development Tools - Real-time Applications. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Michael D. Ciletti, '*Advanced Digital Design with the Verilog HDL'* Second Edition, Pearson, 2011.
2. Steve Kilts, '*Advanced FPGA Design Architecture, Implementation, and Optimization'*, John Wiley & Sons, Inc., Hoboken, New-Jersey, 1st Edition, 2007.

REFERENCES:

1. Crockett H. Louise, Ross A. Elliot and Martin A. Enderwitz, '*The Zynq Book Embedded Processing with the ARM Cortex-A9 on the Xilinx Zynq-7000 Programmable SoC'*, Strathclyde Academic Media, 1st Edition, 2014.
2. Charlet H. Roth, Lizy Kurian John and Byeong Kil Lee , '*Digital Systems Design using Verilog'*, Cengage Learning, 2016.
3. Zainalabedin Navabi, '*Verilog Digital System Design'*, Second Edition, McGraw-Hill Education, 2005.
4. Ming-BoLin,*'Digital System Designs and Practices: Using Verilog HDL and FPGAs'*, Wiley, 1st Edition, 2008.
5. Raj, A. Arockia Bazil,*'FPGA-Based Embedded System Developer's Guide'*, Taylor & Francis, CRC Press, 2018
6. Clive Maxfield, *'FPGAs world class designs'*, Newnes 2009.
7. Sass and Schmidt, '*Embedded system design with Platform FPGAs'*, Morgan Kaufmann, 2010

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain FPGA design flow, Verilog constructs and modeling styles, and embedded system design principles.	**K2**
CO2	Design and implement functional digital subsystems and embedded applications using Verilog HDL and FPGA tools like Vivado and Zynq Soc.	**K3**
CO3	Analyze FPGA-based designs for design tradeoffs, performance, area, power, and timing, considering clocking, and hardware/software integration.	**K4**
CO4	Design and demonstrate a mini-project that applies FPGA-based system design concepts to solve an embedded application problem.	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		2										2	2
CO4			1		1			1			1	1	1
@	**3**	**2**	**1**		**1**			**1**			**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP26 ROBOTICS
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO ROBOTICS: Introduction to Robotics and Automation, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots. **(9)**

ROBOT ANATOMY AND MOTION ANALYSIS: Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix. **(9)**

ROBOT DRIVES AND END EFFECTORS: Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control. **(9)**

PATH PLANNING: Definition-Joint space technique, Use of P-degree polynomial-Cubic, polynomial-Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning. **(9)**

ROBOTICS APPLICATIONS: Material Handling: pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Robots, Autonomous robots, and Swarm robots. **(9)**

Total L:45 Periods

TEXT BOOKS:

1. S.R. Deb, '*Robotics Technology and flexible automation'*, Tata McGraw-Hill Education, 2009.
2. Mikell P. Groove , *'Industrial Robots - Technology, Programming and Applications'*, McGraw Hill, Special Edition, (2012).
3. Ganesh S Hegde, '*A textbook on Industrial Robotics'*, University science press, 3rd Edition, 2017.

REFERENCES:

1. Richard D Klafter, Thomas A Chmielewski and Michael Negin, '*Robotics Engineering – An Integrated Approach*', Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C and Lee C.S.G, '*Robotics: : Control, Sensing, Vision and Intelligence'*, McGraw Hill, 1987.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the significance, social impact and future prospects of robotics and automation in various engineering applications	**K2**
CO2	Apply robotics concept to automate the monotonous and hazardous tasks and categorize various types of robots based on the design and applications in real world scenarios	**K3**
CO3	Examine the relationship between robot drive mechanisms, grippers, and control strategies in achieving precise automation.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP27 WEARABLE DEVICES
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS: Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor. **(9)**

SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES: Wearability issues -physical shape and placement of sensor, technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles. **(9)**

WIRELESS HEALTH SYSTEMS: Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques. **(9)**

SMART TEXTILE: Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study-smart fabric for monitoring biological parameters - ECG, respiration. **(9)**

APPLICATIONS OF WEARABLE SYSTEMS: Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Annalisa Bonfiglo and Danilo De Rossi, '*Wearable Monitoring Systems'*, Springer, 2011.
2. Zhang and Yuan-Ting, '*Wearable Medical Sensors and Systems'*, Springer, 2013.
3. Edward Sazonov and Micheal R Neuman, '*Wearable Sensors: Fundamentals, Implementation and Applications'*, Elsevier, 2014.
4. Mehmet R. Yuce and JamilY.Khan, '*Wireless Body Area Networks Technology, Implementation applications'*, Pan Stanford Publishing Pvt. Ltd, Singapore, 2012.

REFERENCES:

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkata subramanian, '*Body Area Networks Safety, Security, and Sustainability*', Cambridge University Press, 2013.
2. Guang-Zhong Yang, '*Body Sensor Networks'*, Springer, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the fundamental concepts of wearable systems and sensors	**K2**
CO2	Apply their understanding of signal processing techniques to address wearability issues and optimize energy consumption in wearable devices.	**K3**
CO3	Analyze the applications of wearable systems in various fields, such as medical diagnostics and sports medicine, identifying their potential benefits and challenges.	**K4**
CO4	Apply research, analysis, and synthesis skills using scholarly sources to develop and present a comprehensive understanding of wearable technology as part of a team	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4						1		1				1	1
@	**3**	**2**				**1**		**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP28 IOT PROCESSORS
(Common to ECE and EE-VLSI)

3 0 0 3

INTRODUCTION TO IOT AND PROCESSOR FUNDAMENTALS: Overview - Introduction to IoT: Definition, applications, challenges, and IoT ecosystems - Overview of IoT devices: Types of IoT devices - IoT Architecture: Edge vs. Cloud computing, and the role of processing units in IoT. **(9)**

MICROCONTROLLER ARCHITECTURES FOR IOT: ARM Cortex, PIC architectures and Usage - Power Management in IoT Processors - Real-time Operating Systems (RTOS) and Embedded Software for Microcontrollers. **(9)**

SPECIALIZED PROCESSORS FOR IOT: FPGA-Based IoT Solutions: Architecture and Design - Application-Specific Integrated Circuits (ASICs) for IoT - Low Power IoT Processors: Energy Efficiency Strategies - Comparing General-purpose vs. Specialized Processors in IoT Systems. **(9)**

IOT PROCESSOR INTEGRATION AND COMMUNICATION: Interfacing Processors with Sensors and Actuators - Communication Technologies: Wi-Fi, Bluetooth, Zigbee, and 5G - IoT Data Handling and Real-time Processing - Processor Scalability and Multi-Core Systems in IoT - Security Considerations for IoT Processors and Systems. **(9)**

IOT PROCESSORS AND FUTURE TRENDS: Edge Computing and Its Impact on IoT Processor Design - Artificial Intelligence (AI) Integration with IoT Processors - IoT Processor Development Tools and IDEs - The Role of IoT Processors in Smart Cities and Industry 4.0 - Future Trends in IoT Processors: Quantum Computing, Neuromorphic Chips. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti , '*Internet of Things: A Hands-On-Approach'*, Universities Press, 2014.
2. Jonathan W. Valvano, '*Embedded Systems: Introduction to the MSP432 Microcontroller'*, CreateSpace, 2015.

REFERENCES:

1. Joseph Yiu, '*The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors'*, Newnes (Elsevier), 2010.
2. Steven Smith, '*Digital Signal Processing: A Practical Guide for Engineers and Scientists'*, Newnes, 2013.
3. Qing Li and Caroline Yao, '*Real-Time Concepts for Embedded Systems'*, CMP Books, 2003.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the various architectures for IoT and specialized IoT Processors with IoT devices	**K2**
CO2	Apply knowledge of processor technologies to current and future IoT trends	**K3**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
@	**3**											**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

VERTICAL 4: EMERGING TECHNOLOGIES

25ECP08 VLSI ARCHITECTURES FOR AI APPLICATIONS
(Common to ECE and EE-VLSI)

3 0 0 3

DIGITAL IMPLEMENTATION OF NEURAL NETWORK: A VLSI Pipelined Neuroemulator, A Low Latency Digital Neural Network Architecture, MANTRA: A Multi-Model Neural-Network Computer, SPERT: A Neuro-Microprocessor, Design of Neural Self-Organization Chips for Semantic Applications, VLSI Implementation of a Digital Neural Network with Reward-Penalty Learning. **(9)**

NEURAL NETWORKS ON MULTIPROCESSOR SYSTEMS AND APPLICATIONS: VLSI-Implementation of Associative Memory Systems for Neural Information Processing, A Dataflow Approach for Neural Networks, A Custom Associative Chip Used as a Building Block for a Software Reconfigurable Multi-Network Simulator, Parallel Implementation of Neural Associative Memories on RISC Processors, A Cascadable VLSI Design for GENET, Knowledge Processing in Neural Architecture. **(9)**

VLSI MACHINES FOR ARTIFICIAL INTELLIGENCE: Hardware Support for Data Parallelism in Production Systems, SPACE: Symbolic Processing in Associative Computing Elements, PALM: A Logic Programming System on a Highly Parallel Architecture, A Distributed Parallel Associative Processor (DPAP) for the Execution of Logic Programs. **(9)**

ARTIFICIAL INTELLIGENCE AND HARDWARE ACCELERATORS: Artificial Intelligence Accelerators, AI Accelerators for Standalone Computer, AI Accelerators for Cloud and Server Applications, Overviewing AI-Dedicated Hardware for On-Device AI in Smartphones, Software Overview for On-Device AI and ML Benchmark in Smartphones, CNN Hardware Accelerator Architecture Design for Energy-Efficient AI. **(9)**

CASE STUDIES: NLP-Based AI-Powered Sanskrit Voice Bot, Obstacle Detection System, FPGA-Based Automatic Speech Emotion Recognition, Hardware Implementation of RNN Using FPGA. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. José G. Delgado-Frias and William R. Moore, '*VLSI for Neural Networks and Artificial Intelligence'*, Springer.
2. Ashutosh Mishra, Jaekwang Cha, Hyunbin Park and Shiho Kim, '*Artificial Intelligence and Hardware Accelerators*', Springer International Publishing.
3. Sheetal Umesh Bhandari and Anuradha D. Thakare, '*Artificial Intelligence Applications and Reconfigurable Architectures*', Wiley-Scrivener.

REFERENCES:

1. V. Sze, '*Designing Hardware for Machine Learning'*, IEEE Solid-State Circuits Magazine, vol. 9, no. 4, pp. 46-54, 2017.
2. N. R. Shanbhag, N. Verma, Y. Kim, A. D. Patil and L. R. Varshney, '*Shannon-Inspired Statistical Computing for the Nanoscale Era'*, Proceedings of the IEEE, vol. 107, no. 1, pp. 90-107, 2019.
3. V. Sze, Y. Chen, T. Yang and J. S. Emer, '*Efficient Processing of Deep Neural Networks: A Tutorial and Survey'*, Proceedings of the IEEE, vol.105, no. 12, pp. 2295-2329, 2017.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles of VLSI architectures for neural networks, AI accelerators, and their role in AI applications.	**K2**
CO2	Apply hardware acceleration techniques for VLSI-based neural networks and multiprocessor systems for AI tasks using modern tools and methodologies.	**K3**
CO3	Analyze the performance, energy efficiency, and scalability of AI hardware accelerators and assess real-world challenges in AI hardware implementation using various case studies	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP32 QUANTUM COMPUTING
(Common to ECE and EE-VLSI)

3 0 0 3

QUANTUM COMPUTING BASIC CONCEPTS: Complex Numbers - Linear Algebra - Matrices and Operators – Global Perspectives Postulates of Quantum Mechanics – Quantum Bits -Representations of Qubits – Super positions. **(9)**

QUANTUM GATES AND CIRCUITS: Universal logic gates - Basic single qubit gates - Multiple qubit gates – Circuit development - Quantum error correction. **(9)**

QUANTUM ALGORITHMS: Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm. **(9)**

QUANTUM INFORMATION THEORY: Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem – Classical information over noisy quantum channels. **(9)**

QUANTUM CRYPTOGRAPHY: Classical cryptography basic concepts - Private key cryptography - Shor's Factoring Algorithm - Quantum Key Distribution - BB84 - Ekart 91. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Parag K Lala, '*Quantum Computing, A Beginners Introduction'*, Mc Graw Hill Education, 1st Edition, 2020.
2. Michael A. Nielsen and Issac L. Chuang, '*Quantum Computation and Quantum Information'*, Cambridge University Press, 10th Edition, 2010.
3. Chris Bernhardt, *'Quantum Computing for Everyone'*, The MIT Press, 2020.

REFERENCES:

1. Scott Aaronson, '*Quantum Computing Since Democritus'*, Cambridge University Press, 2013.
2. N. David Mermin, '*Quantum Computer Science: An Introduction'*, Cambridge University Press, 2007.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basics of quantum computing concepts, quantum circuits, quantum algorithms and quantum applications	**K2**
CO2	Apply the quantum algorithms, quantum circuits to solve the real-life problems	**K3**
CO3	Analyze the quantum algorithms and quantum computation models	**K4**
CO4	Model the circuits using quantum computation environments and frameworks	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			1		1	1		1				1	1
@	**3**	**2**	**1**		**1**	**1**		**1**				**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP33 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
(Common to ECE and EE-VLSI)

3 0 0 3

PROBLEM SOLVING: Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems, Probabilistic reasoning – Bayesian networks, Knowledge Representation, Relationship between AI, ML, and DL. **(9)**

SUPERVISED LEARNING: Introduction to Machine learning, Types of Machine Learning, Linear Regression Models: Least squares, single & multiple variables, Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests, Regularization, Early Stopping, Cross Validation, Measures, ROC curve. **(9)**

ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING: Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization, Reinforcement Learning. **(9)**

NEURAL NETWORKS: Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks – vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, dropout. **(9)**

MACHINE LEARNING APPLICATIONS: Programming with Python – Case Studies: Signal Processing, Speech Recognition and Natural Language Processing, Image and Video Processing, Fault Detection and Diagnosis. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, '*Artificial Intelligence – A Modern Approach'*, Pearson Education, 4th Edition, 2021.
2. Ethem Alpaydin, '*Introduction to Machine Learning'*, MIT Press, 4th Edition, 2020.

REFERENCES:

1. Bishop Christopher, '*Neural Networks for Pattern Recognition'*, New York, NY: Oxford University Press, 1995.
2. Mitchell Tom, '*Machine learning'*, New York, NY: McGraw-Hill, 1997.
3. Raschka S., '*Python machine learning'*, Packt publishing Ltd., 2015.
4. Charu C. Aggarwal, *Data Classification Algorithms and Applications'*, CRC Press, 2014
5. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, *Foundations of Machine Learning'*, MIT Press, 2012.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the fundamentals of artificial intelligence and machine learning	**K2**
CO2	Apply the learning algorithms for the different applications	**K3**
CO3	Analyze the performance of various machine learning algorithms	**K4**
CO4	Design and implement machine learning models in Python for real-world datasets.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
CO4			2		2							2	2
@	**3**	**2**	**2**		**2**							**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25ECP37 CRYPTOGRAPHY AND NETWORK SECURITY
(Common to ECE and EE-VLSI)

3 0 0 3

CRYPTOGRAPHY - CONCEPTS AND TECHNIQUES: Security Concepts: Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security. Cryptography Concepts and Techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, stenography, key range and key size, possible types of attacks. **(9)**

SYMMETRIC AND ASYMMETRIC KEY CIPHERS: Block Cipher principles, DES, AES, Blowfish, RC5, IDEA, Block cipher operation, Stream ciphers, RC4. Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange, and Knapsack Algorithm. **(9)**

CRYPTOGRAPHIC HASH AND KEY MANAGEMENT: Message Authentication, Secure hash algorithm (SHA-512) Message Authentication Codes: Authentication requirements, HMAC, CMAC, ElGamal Digital signatures. Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure. **(9)**

ACCESS CONTROL AND SECURITY: Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access Control – IP Security – Internet Key Exchange (IKE). Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS standard, Secure Shell (SSH) application, Mobile Device Security, Wireless Security. E-Mail Security: Pretty Good Privacy, S/MIME. **(9)**

SECURITY PRACTICES: Intrusion Detection, Password Management, Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configurations. Blockchains, Cloud Security and IoT security. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. William Stallings, '*Cryptography and Network Security: Principles and Practice'*, Pearson, 6th Edition, 2014.
2. Atul Kahate, '*Cryptography and Network Security'*, Mc Graw Hill, 4th reprint, 2008.

REFERENCES:

1. M. Speciner, R. Perlman and C. Kaufma, '*Network Security: Private Communications in a Public World'*, Prentice Hall, 2002.
2. C K Shyamala, N Harini and Dr T R Padmanabhan, '*Cryptography and Network Security'*, Wiley India, 1st Edition, 2011.
3. Forouzan Mukhopadhyay , '*Cryptography and Network Security'*, Mc Graw Hill, 3rd Edition, 2007.
4. Mark Stamp, *'Information Security, Principles, and Practice'*, Wiley India, 2023.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of cryptography and network security, including encryption methods, security services, authentication protocols, and modern security technologies.	**K2**
CO2	Apply cryptographic techniques and key management schemes for secure communication using symmetric, asymmetric encryption, and hashing.	**K3**
CO3	Analyze network and web security mechanisms to identify appropriate authentication methods, access control strategies, and solutions for emerging technologies like IoT, cloud, and blockchain.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVP31 MEMS AND MICROSYSTEMS

3 0 0 3

INTRODUCTION: Overview of MEMS and Microsystems, Miniaturization, MEMS to NEMS, Multidisciplinary nature of microsystem design and manufacture, Applications of MEMS and microsystems in Automotive, Health care, Aerospace, Industrial Products, consumer products, Materials for MEMS and Microsystem: Substrates and Wafers, Silicon as a Substrate Material, Silicon Compounds, Polymers. **(8)**

SCALING AND MICROMANUFACTURING: Scaling laws in Miniaturization, Scaling in Geometry, Scaling-in Rigid Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid dynamics, Scaling in Heat transfer. Photolithography, Bulk Micromachining, Surface Micromachining, LIGA Process. **(8)**

MICROSENSORS AND MICROACTUATORS: Acoustic sensors, Biosensors, Chemical sensors, Optical Sensors, Pressure Sensors, Thermal Sensors, Actuation using Thermal Forces, Actuation using shape Memory Alloys, Actuation using Piezoelectric Crystals, Actuation using Electrostatic Forces, MEMS with Microactuators, Microaccelerometers, Microfluidics. **(10)**

MECHANICS AND ELECTRONICS FOR MICROSYSTEM DESIGN: Electronics: Semiconductor Diodes, MOSFET Amplifiers, Operational Amplifiers, Basic Op-AMP circuits, Charge measuring circuits. Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications. Internal force analysis, mechanical properties of silicon and related thin films, flexural beam bending analysis under simple loading conditions, torsional deflections, spring constant and resonant frequency. **(12)**

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MICROSYSTEM PACKAGING AND CASE STUDIES: Die -Level, Device-level, System-Level Packaging, Interfaces in Packaging, Packaging Technologies, MEMS Case studies: Piezoresistive Pressure Sensor, Capacitive Accelerometer, Microfluidics Mixers. **(7)**

Total L: 45 periods

TEXT BOOKS:

1. Tai-Ran Hsu, ‘*MEMS and Microsystems Design and Manufacture*’, TMH, 2002.
2. Stephen D. Senturia, ‘*Microsystem design*’, Springer (India), 2006.

REFERENCES:

1. Julian W Gardner, ‘*Microsensors: Principles and Applications*’, John Wiley & Sons, 1994.
2. Vinoy, Kalarickaparambil Joseph, ‘*Micro and smart devices and systems*’, Springer India, New Delhi, 2014.
3. Reza Ghodssi and Pinyen, ‘*MEMS Materials and Processes Handbook*’, Springer Science Business Media, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the fundamental principles of MEMS and NEMS, including their multidisciplinary nature and diverse applications across industries.	**K2**
CO2	Apply scaling laws and fabrication methods in microsensor and microactuator technologies for microsystem design	**K3**
CO3	Analyze different microsensors and microactuators, and their mechanical and electronic aspects using stress-strain, flexural, and semiconductor concepts	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVP32 RECONFIGURABLE ARCHITECTURES AND APPROXIMATE COMPUTING

3 0 0 3

INTRODUCTION TO RECONFIGURABLE SYSTEMS: Reconfigurable Computing Systems: Objectives, Expectations, Logistics, characterization of Reconfigurable Computing & Reconfigurable Hardware, Reconfigurable Software, General purpose computing – domain specific processors –Application Specific Processors – reconfigurable computing –fields of application – evolution of reconfigurable systems – simple Programmable Logic Devices – Complex Programmable Logic Devices – Field Programmable Gate Arrays – coarse grained reconfigurable devices. **(9)**

RECONFIGURATION MANAGEMENT: Reconfiguration – configuration architectures – managing the reconfiguration process – reducing configuration transfer time –configuration security. **(9)**

RECONFIGURABLE ARCHITECTURE: FPGA based parallel pattern matching – low power FPGA based architecture for microphone arrays in Wireless Sensor Networks –exploiting partial reconfiguration on a dynamic coarse grained reconfigurable architecture – parallel pipelined OFDM base band modulator with dynamic frequency scaling for 5G systems. **(9)**

INTRODUCTION TO APPROXIMATE COMPUTING: Approximate Arithmetic Circuits: Design and Applications, An Automated Logic-Level Framework for Approximate Modular Arithmetic Circuits, Approximate Multiplier Design for Energy Efficiency: From Circuit to Algorithm, Majority Logic-Based Approximate Multipliers for Error-Tolerant Applications, Test and Reliability of Approximate Hardware. **(9)**

APPROXIMATE COMPUTING ARCHITECTURES: Approximate Computing for Machine Learning Workloads: A Circuits and Systems Perspective, Approximate Computing for Efficient Neural Network Computation: A Survey, Efficient Approximate DNN Accelerators for Edge Devices: An Experimental Study, Approximate Computing in Image Compression and Denoising, Approximate Computation for Baseband Processing. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Christophe Bobda, *'Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications*', Springer 2007.
2. Scott Hauck and Andre Dehon, '*Reconfigurable Computing: TheTheory and Practice of FPGA Based Computation*', Elsevier, 2008.
2. Weiqiang Liu and Fabrizio Lombardi, '*Approximate Computing'*, Springer, 2022.

REFERENCES:

1. Nikoloas Voros, '*Applied Reconfigurable Computing: Architectures, Tools and Applications*' Springer, 2018.
2. Koen Bertels, João M.P. Cardoso and Stamatis Vassiliadis, '*Reconfigurable Computing: Architectures and Applications*', Springer, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the principles, evolution, and architectures of reconfigurable computing systems and approximate computing systems.	**K2**
CO2	Apply reconfiguration management techniques (e.g., configuration security, time optimization) to solve hardware-software co-design challenges.	**K3**
CO3	Analyze real-world applications of reconfigurable systems and the trade-offs in designing approximate arithmetic circuits and evaluate their efficiency.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVP33 OPTOELECTRONICS

3 0 0 3

FUNDAMENTALS OF OPTOELECTRONICS: Nature and properties of light - Light-matter interaction: absorption, spontaneous and stimulated emission - Photon energy, radiative and non-radiative transitions - Optical constants: refractive index, extinction coefficient - Optical waveguides and optical modes. **(9)**

SEMICONDUCTOR PHYSICS FOR OPTOELECTRONICS: Energy bands in semiconductors - Direct vs. indirect bandgap materials - Carrier transport: drift, diffusion, recombination - pn junction under bias - Quantum wells and heterojunctions. **(9)**

LIGHT SOURCES: LED principles, construction, and characteristics - Spontaneous vs. stimulated emission - Semiconductor lasers: Fabry–Perot, DFB, VCSEL - Threshold condition and laser rate equations -Quantum efficiency and modulation response. **(9)**

PHOTODETECTORS AND SOLAR CELLS: Photodiode operation (PIN, avalanche) - Responsivity, quantum efficiency, and noise - Phototransistors and photoconductors - Solar cells: IV characteristics, efficiency, and design parameters - Optical receiver circuits. **(9)**

ADVANCED TOPICS AND APPLICATIONS: Electro-optic and acousto-optic modulators - Optoelectronic integrated circuits (OEICs) - Optical interconnects and communication systems - Emerging materials: organic semiconductors, perovskites - Real-world applications: fiber-optic communication, sensors, imaging, and photovoltaics. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Safa O. Kasap, '*Optoelectronics and Photonics: Principles and Practices*', Pearson Education, 2nd Edition, 2013, ISBN: 978-0132151498.
2. Jasprit Singh, '*Optoelectronics: An Introduction to Materials and Devices*', McGraw-Hill, 2007.
3. Bahaa E. A. Saleh and Malvin Carl Teich, '*Fundamentals of Photonics*', Wiley, 2020. ISBN:9781119702115, 1119702119.

REFERENCES:

1. P. Bhattacharya, '*Semiconductor Optoelectronic Devices*', Pearson Education, 2nd Edition, 2006.
2. Amnon Yariv and Pochi Yeh, '*Photonics: Optical Electronics in Modern Communications*',nOxford University Press, 6th Edition , 2007.
3. Joachim Piprek, '*Handbook of Optoelectronic Device Modeling and Simulation*, CRC Press, 2017.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the physical principles of Optoelectronics	**K2**
CO2	Apply optoelectronic concepts to solve real-world problems	**K3**
CO3	Design an optoelectronic system to evaluate optoelectronic devices' performance parameters	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												3	3
CO2	3											3	3
CO3		2										2	2
@	**3**	**2**										**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVP34 IC PACKAGING, ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

INTRODUCTION TO IC PACKAGING TECHNOLOGIES: Overview of IC packaging and its significance, Evolution of integrated circuit packaging, Challenges and Solutions, Thermal issues in IC packaging and heat dissipation techniques, Introduction to packaging types: through-hole, surface-mount, ball grid array, System-in package, Fan-In, Fan-out Wafer/Panel-Level packaging. **(9)**

ELECTRICAL MODELING AND ADVANCED PACKAGING: Fundamental theory, Electrical analysis for advanced packaging, Signal distribution, Power allocation, Modeling, characterization, and design of throughsilicon via packages. 2D, 2.1D, and 2.3D IC integration,3D IC Integration and 3D IC Packaging, Hybrid Bonding, Low Loss Dielectric Materials. **(9)**

EMI/EMC CONCEPTS: Definition of EMI and EMC with examples, Classification of EMI/EMC - CE, RE, CS, RS, Units of Parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression, EMC standards, Frequency assignment - spectrum conversation. **(9)**

EMI MEASUREMENTS AND CONTROL METHODS: Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection technique open area site, shielded anechoic chamber, TEM cell. Shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, opto- isolator. **(9)**

EMC DESIGN AND INTERCONNECTION TECHNIQUES: Cable routing and connection, Component selection and mounting, PCB design- Trace routing, Impedance control, decoupling, Zoning and grounding. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Lau, John H. '*Advanced packaging*', Semiconductor Advanced Packaging. Singapore: Springer Singapore, 2021.
2. Zhang, Hengyun, '*Modeling, analysis, design, and tests for electronics packaging beyond Moore*'. Woodhead Publishing, 2019.
3. Prasad Kodali.V, '*Engineering Electromagnetic Compatibility*', S.Chand&Co, New Delhi, 2000.
4. Clayton R.Paul, '*Introduction to Electromagnetic compatibility*', Wiley & Sons, 1992.

REFERENCES:

1. King-Ning Tu, Chih Chen and Hung-Ming Chen, '*Electronic Packaging Science and Technology*', John Wiley and Sons Inc., 2022.
2. Clayton R.Paul, '*Principles of Electromagnetic Compatibility*', Artech House, 2nd Edition, 2006.
3. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 – 9.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts and standards of IC Packaging, EMC and principles of EMI measurement techniques and the operation of EMI measuring instruments.	**K2**
CO2	Apply IC Packaging and EMC design principles to design and implement effective EMI mitigation techniques in electronic systems.	**K3**
CO3	Analyze and select appropriate EMI control methods and fixes for specific scenarios.	**K4**
CO4	Identity and present EMI and EMC methods for real time applications as a team	

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3											3	3
CO3		3										3	3
CO4					1	1		1			1	1	1
@	**3**	**3**			**1**	**1**		**1**			**1**	**3**	**3**

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

PROFESSIONAL ELECTIVES (FOR MINOR DEGREE IN VLSI DESIGN)

25EVM01 DIGITAL SYSTEM DESIGN

3 1 0 4

NUMBER SYSTEM: Number Systems and Number-Base Conversion - Complements of Numbers (Diminished Radix Complement, Radix Complement) - Signed Binary Numbers - Arithmetic Operation with the Binary Numbers - fixed- and floating-point representation, Binary Codes (BCD, 2421Code, Gray Code, ASCII) **(10+4)**

BOOLEAN ALGEBRA: Boolean Algebra - Basic Theorems and Properties of Boolean Algebra - Simplification of Boolean Functions - Canonical and Standard Forms - Other Logic Operation. **(8+3)**

DESIGN OF COMBINATIONAL CIRCUITS: Introductory Digital Concepts - Digital Logic Gates - Karnaugh Map Method - Don't Care Conditions - The Tabulation Method - NAND and NOR Implementation - Design Procedure - Adder - Subtractor - Magnitude Comparator - Decoders - Encoders - Priority Encoder - Multiplexers - Demultiplexers - Three State Gates - Design Example. **(10+3)**

DESIGN OF SEQUENTIAL CIRCUITS: Introduction - Storage Elements: - Latch (S-R Latch, D-Latch) - Flip-Flops (S-R Flip Flop,D-Flip Flop, J-K Flip Flop, T-Flip Flop) - Master Slave Configuration of J-K Flip Flop - Shift Registers - Design of Asynchronous and Synchronous Counter. Mealy and Moore Models of Finite State Machines (FSM) - Synchronous Sequential Logic - State Reduction and Assignment - Design Procedure Algorithmic. **(11+3)**

MEMORY AND PROGRAMMABLE LOGIC: Introduction - Random Access Memory - Memory Decoding - Read Only Memory - Programmable Logic Array (PLA) - Programmable Array Logic (PAL) - Sequential Programmable Devices. **(6+2)**

Total L: 45+T: 15 = 60 periods

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, '*Digital Design: With an Introduction to the Verilog HDL, VHDL and System Verilog*', USA: Pearson Education, 6th Edition, 2018.
2. M. Morris Mano, '*Digital Logic and Computer Design'*, India: Pearson Education, 2017.
3. Thomas L. Floyd, '*Digital Fundamentals*', USA: Pearson Education, 2015.

REFERENCES:

1. Charles H. Roth,Jr, and Larry L. Kinney, '*Fundamentals of Logic Design*', Cengage Learning, 2014.
2. John F. Wakerly, '*Digital Design: Principles and Practices*', Pearson Education, 2018.
3. Roger L Tokheim, '*Digital Electronics: Principles and Applications*', McGraw-Hill Education, 2013.
4. Ronald Tocci, Neal S. Widmer, Gregory L. Moss, '*Digital Systems',* Pearson Education, 2016.
5. Donald D. Givone, '*Digital Principles and Design*', sMcGraw-Hill Education, 2003.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the core concepts of building blocks of Digital Electronic Circuits and Systems.	**K2**
CO2	Apply concepts and choose suitable logic blocks to realize digital logic functions.	**K3**
CO3	Analyze the combinational and sequential circuits to arrive at suitable conclusions	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		1											
@	**3**	**1**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM02 CMOS VLSI TECHNOLOGY

3 0 0 3

INVERTERS: Review of MOS transistor equations -Passive load inverter- CMOS inverter – Transfer Characteristics, Power dissipation- Depletion mode and enhancement mode pull ups – Pseudo nMOS Inverter - Sheet resistance - Area Capacitance - Inverter delay and Logical Effort. **(9)**

LOGIC DESIGN: Combinational logic circuits - Static CMOS logic- Complementary CMOS, Ratioed logic, Pass- Transistor, Transmission gate - Dynamic CMOS logic – Performance, Noise considerations, domino, npCMOS logic - Sequential logic circuits - static and dynamic flip-flops. **(10)**

SUBSYSTEM DESIGN: Design of adders-Static adder, Mirror adder, Carry Look Ahead adder, Binary adder – Multipliers-Array multiplier, Carry Save multiplier, Booths and Modified Booths multiplier - Barrel shifter, Logarithmic shifter. **(10)**

MEMORY DESIGN: 6T SRAM Cell, CAM memory,4x4 -OR ROM, NOR ROM, NAND ROM cell array,6-T SRAM cell,3-TDRAM cell, Memory peripheral circuitry-Address Decoders-Sense amplifiers-Power dissipation in memories. **(9)**

VLSI LAYOUT DESIGN AND FABRICATION TECHNIQUES: Layout styles – Full custom and Semi-custom approaches - Layout Design Rules – CMOS nwell process rules - Stick diagram - Layout examples – Fabrication techniques – Wafer processing - Oxidation - Patterning - Diffusion - Ion implantation - Deposition - CMOS processes: nWell, Twin tub, Silicon on Insulator. **(7)**

Total L: 45 periods

TEXT BOOKS:

1. Neil H E Weste and David Money Harris, '*CMOS VLSI Design: A Circuits and System Perspective'*, Pearson, 2017.
2. Jan M Rabaey and Anantha Chandrakasan, '*Digital Integrated Circuits- A Design Perspective*', Prentice Hall of India, 2016.

REFERENCES:

1. Caver Mead and Lynn Conway, '*Introduction to VLSI Systems*', Addison-Wesley, 2017.
2. Douglas A Pucknell and Kamran Eshranghian , '*Basic VLSI Design*', Prentice Hall of India, 3rd Edition, 2011.
3. Amar Mukherjee, '*Introduction to nMOS and CMOS VLSI System Design*', Prentice Hall, 1986.
4. Sung-Mo Kang and Yusuf Leblebici, '*CMOS Digital Integrated Circuits, Analysis and Design*', McGraw Hill Education, 4th Edition, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of Metal Oxide Semiconductor transistors, layout design and Fabrication Techniques in VLSI.	**K2**
CO2	Apply the knowledge of CMOS technology and Digital System Design in the context of VLSI circuits and subsystems.	**K3**
CO3	Analyse CMOS circuits and subsystems and obtain the desired performance metrics	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		1											
@	**3**	**1**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM03 HDL AND SYNTHESIS

3 0 0 3

FUNDAMENTALS OF DIGITAL DESIGN: Basic logic gates, combinational and sequential logic, overview of digital systems, RTL abstraction, and introduction to design flow: specification,HDL,synthesis, implementation. **(9)**

INTRODUCTION TO VERILOG HDL: Basic syntax, modeling styles: behavioral, dataflow, and structural. Writing modules and testbenches. Modeling combinational logic (adders, mux, encoders, decoders) and sequential logic (flip-flops, registers, counters). **(9)**

FINITE STATE MACHINES (FSMS): Mealy vs Moore, practical examples. Hierarchical design using Verilog. Modular decomposition and reusability. **(9)**

SYNTHESIS CONCEPTS AND CONSTRAINTS: RTL vs Gate-level vs Physical Design overview. Synthesis constraints: timing, area, power (conceptual). Combinational vs sequential synthesis. Importance of writing synthesizable Verilog. **(9)**

FPGA-BASED DESIGN FLOW: Overview of FPGA architectures (CLBs, LUTs, IOBs). RTL-to-bitstream flow using FPGA tools. Introduction to timing simulation, constraint files, and basic static timing. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Samir Palnitkar, '*Verilog HDL: A Guide to Digital Design and Synthesis*', SunSoft Press, 2nd Edition 2003.
2. Jan M. Rabaey and Anantha Chandrakasan, '*Digital Integrated Circuits: A Design Perspective*' , Prentice Hall of India, 2016.
3. Stephen Brown and Zvonko Vranesic, '*Digital Logic with Verilog Design*', McGraw Hill, 2003.

REFERENCES:

1. Zainalabedin Navabi, '*Verilog Digital System Design*' , McGraw-Hill Education, 2nd Edition, 2005.
2. Ming-Bo Lin, '*Digital System Designs and Practices: Using Verilog HDL and FPGAs*', Wiley, 1st Edition 2008.
3. Douglas A. Pucknell and Kamran Eshraghian,, '*Basic VLSI Design*', Prentice Hall of India, 3rd Edition, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the foundational principles of digital systems and describe the process of modeling hardware using HDL.	**K2**
CO2	Apply Verilog HDL to design, simulate, and verify combinational and sequential logic systems using modular and reusable coding techniques	**K3**
CO3	Analyze the synthesis process and FPGA implementation flow, and evaluate basic design trade-offs related to area, timing, and power	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM04 LOW POWER VLSI DESIGN

3 0 0 3

PRINCIPLES OF LOW POWER IC DESIGN: Need for Low power VLSI chips - Sources of Power Dissipation, Dynamic Power Dissipation- Switching and Short Circuit Power Dissipation, Static power Dissipation, Glitching power Dissipation, Short channel Effects, Low power Adder and Low power Multipliers. **(10)**

POWER REDUCTION AT THE CIRCUIT LEVEL: Adjustable Device Threshold Voltage, Adiabatic Computation, CMOS Floating Node - Transistor and Gate Sizing – Equivalent Pin Ordering – Network Restructuring and Reorganization – Special Latches and Flip Flops – Low Power Digital Cell Library (**10**)

POWER REDUCTION AT THE LOGIC LEVEL: Gate Reorganization – Signal Gating – Logic Encoding – State Machine Encoding – Precomputation Logic, Switching Activity Reduction- Pass Transistor Logic Synthesis. **(7)**

POWER REDUCTION AT THE ARCHITECTURE AND SYSTEM LEVEL: Pipelining and Parallel Architecture with Voltage Reduction – Flow Graph Transformation – Power Reduction in Clock Networks - Low Power Bus-Software power estimation and optimization techniques- Power and Performance management **(9)**

POWER ANALYSIS: Simulation power Analysis - Gate-Level Analysis - Architecture level Analysis – Data Correlation Analysis – Monte Carlo Simulation - Probabilistic Power Analysis Techniques. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Gary K Yeap, ‘*Practical Low Power Digital VLSI Design*’, Kluwer academic publishers, 2012.
2. Kaushik Roy and Sharat C. Prasad, ‘*Low Power CMOS VLSI circuit Design*’, John Wiley & Sons, 2009.
3. Sung-Mo Kang and Yusuf Leblebici, ‘*CMOS Digital Integrated Circuits – Analysis and Design*’, TMH, 2011.
4. Kiat-Seng Yeo and Kaushik Roy, ‘*Low-Voltage, Low-Power VLSI Subsystems*’, TMH Professional Engineering, 2004.

REFERENCES:

1. Kuo J B and Lou J H, ‘*Low Voltage CMOS VLSI Circuits*’, John Wiley & Sons, 2001.
2. AP Chandrakasan and RW Brodersen, ‘*Low Power Digital CMOS Design*’, Kluwer Academic Publishers, 1995.
3. Abdelatif Belaouar and Mohamed l. Elmasry, ‘*Low-Power Digital VLSI Design: Circuits and Systems*’, Kluwer Academic Press, 1995.
4. Sasan Iman and Massoud Pedram, ‘*Logic Synthesis for Low Power VLSI Designs*’ Kluwer Academic publishers, 1998.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the concepts of low power design approaches	**K2**
CO2	Apply the low power techniques to design power efficient arithmetic blocks and memories	**K3**
CO3	Analyse and compare various design architectures based on design metrics	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM05 VLSI DESIGN AUTOMATION

3 0 0 3

ALGORITHM & SYNTHESIS: VLSI Design cycle – Role of CAD tools in chip design – Basics of optimization in VLSI (area, power, performance trade-offs) – Introduction to logic gates and logic synthesis – Concept of Binary Decision Diagrams (BDD) – Intuition behind ROBDD (no algorithms) **(9)**

PARTITIONING AND PLACEMENT ALGORITHMS: Need for partitioning – Overview of KL algorithm (no steps, just the idea) – Placement – Placement goals (area minimization, wirelength) – Simulated Annealing **(9)**

FLOOR PLANNING AUTOMATION: Floor planning – Slicing floorplan (concept using visual blocks) – Pin Assignment (importance of connecting pins with less congestion). **(9)**

ROUTING ALGORITHMS: Why routing matters in chip design – Grid routing (visuals) – Maze routing (real-life maze analogy) – Left-edge algorithm (simple visual explanation) – Clock routing (what it is and why it's important). **(9)**

LAYOUT SYNTHESIS AND OPTIMIZATION:Overview of layout styles – Standard cell and PLA layout – Concept of layout compaction – One-dimensional compaction of standard cell layout, gate matrix layout and PLA, Layout Compaction – one dimensional and two-dimensional compaction. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Sherwani N A, *'Algorithms for VLSI Physical Design Automation*', Kluwer, 2007.
2. Sait S M and Youssef H, '*VLSI Physical Design Automation*', World Scientific, 2004.

REFERENCES:

1. Sarrafzadeh, M. and Wong, C. K, '*An Introduction to VLSI Physical Design*', McGraw Hill, 2015.
2. Trimberger, S. M, '*An Introduction to CAD for VLSI*', Kluwer, 1987.
3. Sait, S. M. and Youssef, Habib, *'VLSI Physical Design Automation – Theory and Practice',* World Scientific, 2004.
4. Andrew B. Kahng, Jens Lienig, Igor L. Markov, '*VLSI Physical Design: From Graph Partitioning to Timing Closure*', Springer, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the role of CAD tools, and key algorithmic concepts including logic synthesis, optimization methods, and data structures like BDD and ROBDD.	**K2**
CO2	Apply partitioning, placement, floor planning, and routing algorithms to automate and optimize the VLSI physical design process.	**K3**
CO3	Analyze various partitioning, placement, floorplanning, and routing algorithms to enhance overall efficiency.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM06 ASIC DESIGN

3 0 0 3

INTRODUCTION TO ASICs AND DESIGN FLOW: Types of ASICs: Full-custom, semi-custom, programmable (FPGAs, CPLDs) – Introduction to ASIC design flow – Industry relevance and applications of ASICs – Comparison with general-purpose processors. **(9)**

PROGRAMMABLE ASIC TECHNOLOGIES: Overview of FPGA vendors (Xilinx, Intel/Altera) – Introduction to SRAM-based and Flash-based FPGAs – Basic I/O functionality and configuration methods – Role of ASICs in embedded systems and smart devices. **(9**)

FPGA ARCHITECTURES AND TOOLS: High-level view of Spartan, Cyclone, Virtex, and Stratix families – Soft-core processors: MicroBlaze and Nios II (intro only) – Brief introduction to FPGA development tools (Vivado, Quartus). **(9)**

SYSTEM-LEVEL DESIGN CONCEPTS: Block-level design methodology – Introduction to logic synthesis (concept only, not RTL coding) – Floor planning and routing basics (conceptual) – Power and clock distribution overview. **(9**)

APPLICATIONS AND CASE STUDIES: ASICs in consumer electronics (e.g., digital cameras, smartphones) – ASICs in automotive and IoT systems – Signal processing applications (basic intro to FFT/DCT) – Industrial relevance: SDRAM, USB, HDMI controllers. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. M.J.S.Smith, '*Application - Specific Integrated Circuits*', Pearson, 2003.
2. Steve Kilts, '*Advanced FPGA Design*', Wiley IEEE-Press, 2007.
3. Roger Woods, John McAllister, Dr. Ying Yi and Gaye Lightbod, '*FPGA-based Implementation of Signal Processing System*', Wiley, 2008.
4. Mohammed Ismail and Terri Fiez, '*Analog VLSI Signal and Information Processing* ', Mc Graw Hill, 1994.

REFERENCES:

1. Douglas J. Smith, '*HDL Chip Design*', Madison, AL, USA: Doone Publications, 1996.
2. Jose E. France and Yannis Tsividis, '*Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing*', Prentice Hall, 1994.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the technologies and structures used in programmable ASICs and their I/O interfaces	**K2**
CO2	Apply logic synthesis and layout techniques to optimize ASIC designs for performance and power.	**K3**
CO3	Compare different programmable ASIC technologies and evaluate their applicability.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM07 MEMS DESIGN

3 0 0 3

INTRODUCTION: Overview of MEMS and NEMS, Miniaturization and its advantages, Transition from MEMS to NEMS, Multidisciplinary nature of microsystems, Applications in Automotive, Healthcare, Aerospace, Industrial and Consumer Products, Introduction to MEMS Materials: Silicon, Polymers, and Thin Films. **(8)**

SCALING & MICROMANUFACTURING: Basics of Scaling in Miniaturized Systems, Intuitive understanding of how systems behave differently at micro and nano scales. Overview of Microfabrication Techniques: Photolithography, Bulk and Surface Micromachining, LIGA process. **(8)**

MICROSENSORS AND MICROACTUATORS: Introduction to Microsensors – Pressure, Chemical, Optical, Thermal, and Biosensors; Introduction to Actuators – Thermal, Electrostatic, Piezoelectric, Real-world MEMS Devices – Accelerometers, Microfluidic Devices in Labs-on-Chips. **(10)**

ELECTRONICS FOR MICROSYSTEM DESIGN: Overview of basic electronics in MEMS – Role of sensors and signal conditioning, Operational amplifiers (block-level), Microdevice performance factors. **(12)**

MEMS CASE STUDIES: Case Studies: MEMS Pressure Sensor, MEMS Accelerometer, MEMS Microphone, Microfluidic Chip for Medical Testing. **(7)**

Total L: 45 periods

TEXT BOOKS:

1. Tai-Ran Hsu, '*MEMS and Microsystems Design and Manufacture*', TMH, 2002.
2. Stephen D. Senturia, '*Microsystem design*', Springer (India), 2006.

REFERENCES:

1. Julian W Gardner, '*Microsensors: Principles and Applications*', John Wiley & Sons, 1994.
2. Vinoy, Kalarickaparambil Joseph, '*Micro and smart devices and systems*', Springer India, New Delhi, 2014.
3. Reza Ghodssi and Pinyen, '*MEMS Materials and Processes Handbook*', Springer Science Business Media, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working principles and applications of common microsensors and microactuators in real-world systems	**K2**
CO2	Apply the basics of microfabrication processes and understand how scaling affects microsystem behavior	**K3**
CO3	Analyze the role of mechanics and basic electronics in the design and operation of MEMS devices.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVM08 VLSI VERIFICATION

3 0 0 3

SV FUNDAMENTALS: Creating a Class and understanding its declaration, using constructor to dynamically change data members, writing data to data member using function, Reading data from the function. **(9)**

SV TESTBENCH COMPONENTS: Components of SV Testbench, Understanding Transaction, Randomization in SV, Constraints, Fork Join, Fork Join _Any, Fork Join, None, Event and Mailbox.Generator, Driver, Interface, Monitor, Scoreboard, Environment, Complete Testbench for a combinational circuit and a sequential circuit. **(9)**

UVM FUNDAMENTALS: Polymorphism, Factory usages, UVM_Object Class, UVM_Component, Create and new methods, Object_utils, Configuration method to change Verbosity level. **(9)**

ADVANCED UVM COMPONENTS AND TLM TECHNIQUES: Creating UVM Sequence Item, Constraints, reusability, UVM Phases, end_of_elaboration phase, uvm_common_phase, Producer Consume Model, TLM blocking port, Transaction data in TLM Blocking port, global_stop_request, Independent Multiple TLM Blocking Port, TLM_FIFO, TLM Analysis Port. **(9)**

UVM TESTBENCH ARCHITECTURE AND COMPONNET INTEGRATION: Interface, Monitor and Scoreboard, uvm_config_db, sequencer, Complete UVM Testbench for 4-bit Adder. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Chris Spear and Greg Tumbush, '*SystemVerilog for Verification: A Guide to Learning the Testbench Language Features',* Springer, 3rd Edition, 2012
2. UVM Class Reference, Accellera Systems Initiative.

REFERENCES:

1. Michael D. Ciletti, *'Advanced Digital Design with the Verilog HDL*', Pearson, 2nd Edition, 2010.
2. Samir Palnitkar, '*Verilog HDL: A Guide to Digital Design and Synthesis*', Prentice Hall, 2nd Edition, 2003.
3. Janick Bergeron, '*Writing Testbenches using SystemVerilog*', Springer, 2nd Edition, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand SystemVerilog and UVM for developing Verification components and Testbenches for Digital Circuits	**K2**
CO2	Apply SystemVerilog and UVM methodologies to design and implement verification components, testbenches, and transaction-level models for verifying digital circuits.	**K3**
CO3	Analyze and evaluate the effectiveness of SystemVerilog and UVM testbenches and components in verifying the functionality and performance of digital circuits.	**K4**
CO4	Create efficient and reusable SystemVerilog and UVM-based testbenches and verification components for complex digital circuit designs.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4					1			1					
@	**3**	**2**			**1**			**1**					

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

OPEN ELECTIVES

25EVO01 NANO TECHNOLOGY AND ITS APPLICATIONS

3 0 0 3

INTRODUCTION: Definition and importance of nanoscale, Introduction to nanotechnology, generations of nanotechnology. **(9)**

PROPERTIES OF NANOMATERIALS: Dimensions of nanomaterials, Concept of Bohr radius, Idea about wave-corpuscular theory at sub-atomic level, exciton, surface area and volume ratio, quantum mechanical effects and Q-dots, Band theory of nano- materials. (9)

SYNTHESIS OF NANOMATERIALS: Growth techniques in nano-materials, Top down and Bottom up approaches, Lithographic processes and limitations, plasma arc discharge, sputtering, evaporation, Physical vapour deposition, Chemical vapour deposition, Pulsed laser deposition, Sol-Gel techniques advantages and disadvantages. **(9)**

CHARACTERIZATION TECHNIQUES: Characterization tools of nanomaterials, Microscopy methods: Scanning probe microscopy (SPM), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), comparison between SEM and TEM, Spectroscopic methods, UV and IR/Visible method. **(9)**

APPLICATIONS OF NANO MATERIALS: Nanoelectronics, medicine, batteries, food and agriculture, environmental protection textile and chemical industry, idea about nanomaterial - based products. Hazards of nonmaterial and precautions. **(9)**

Total L:45 Periods

TEXT BOOKS:
1. A K Bandyopadhya, '*A textbook of Nano materials*', New age international publishers, 2008.
2. H K Malik and A K Singh , '*Engineering Physics*', Mc Graw Hill Education, 2017.

REFERENCES:
1. M.R Srinivasan , '*Physics for engineers',* New age international publishers, 2017.
2. R. Murugeshan and Er. Kiruthiga Sivaprasath, '*Modern physics*', S Chand and company, 2020.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts, technical challenges, and the state of- the-art technology development and applications of Nanomaterials.	**K2**
CO2	Design the Nanoscale materials for real-time applications.	**K3**
CO3	Analyze the properties of Nanoscale materials with Characterization Techniques.	**K4**
CO4	Discover potential use cases of Nanomaterials in real-time applications.	**K6**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3		1											
CO4			1					1			1		
@	**2**	**1**	**1**					**1**			**1**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVO02 MEMS

3 0 0 3

INTRODUCTION: Overview of MEMS and NEMS, Multidisciplinary nature of microsystems, Applications in Automotive, Healthcare, Aerospace, Industrial and Consumer Products. **(8)**

SCALING: Basics of Scaling in Miniaturized Systems – Geometry, Forces, and Energy; Intuitive understanding of how systems behave differently at micro and nano scales. **(8)**

MICROFABRICATION, SENSORS AND ACTUATORS: Overview of Microfabrication Techniques: Photolithography, Bulk and Surface Micromachining, LIGA process.Introduction to Microsensors – Pressure, Chemical, Optical, Thermal, and Biosensors; Introduction to Actuators – Thermal, Electrostatic, Piezoelectric, Shape Memory Alloys. **(10)**

BASIC MECHANICS & ELECTRONICS FOR MEMS: Simplified concepts of stress, strain, elasticity, and mechanical behavior at microscale. Common MEMS structures – Beams, Cantilevers, Diaphragms. Overview of basic electronics in MEMS – Role of sensors and signal conditioning, Operational amplifiers (block-level), Microdevice performance factors. **(12)**

CASE STUDIES: MEMS Pressure Sensor, MEMS Accelerometer, MEMS Microphone, Microfluidic Chip for Medical Testing. **(7)**

Total L: 45 periods

TEXT BOOKS:

1. Tai-Ran Hsu, '*MEMS and Microsystems Design and Manufacture*', TMH, 2002.
2. Stephen D. Senturia, '*Microsystem design*', Springer (India), 2006.

REFERENCES:

1. Julian W Gardner, '*Microsensors: Principles and Applications*', John Wiley & Sons, 1994
2. K.J. Vinoy, *'Micro and smart devices and systems*', Springer India, New Delhi, 2014.
3. Reza Ghodssi and Pinyen, Lin '*MEMS Materials and Processes Handbook*', Springer Science Business Media, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of MEMS, microfabrication, sensors , actuators and basic mechanics.	**K2**
CO2	Apply the MEMS concepts in various sensors and actuators.	**K3**
CO3	To conduct case study on the use of MEMS concepts in real-time applications.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	2												
CO3					1			1			1		
@	**2**				**1**			**1**			**1**		

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVO03 DIGITAL DESIGN USING HDL

3 0 0 3

FUNDAMENTALS OF DIGITAL DESIGN: Basic logic gates, combinational and sequential logic, overview of digital systems, RTL abstraction, and introduction to design flow: specification,HDL,synthesis, implementation. **(9)**

INTRODUCTION TO VERILOG HDL: Basic syntax, modeling styles: behavioral, dataflow, and structural. Writing modules and testbenches. Modeling combinational logic (adders, mux, encoders, decoders) and sequential logic (flip-flops, registers, counters). **(9)**

FINITE STATE MACHINES (FSMS): Mealy vs Moore, practical examples. Hierarchical design using Verilog. Modular decomposition and reusability. **(9)**

SYNTHESIS CONCEPTS AND CONSTRAINTS: RTL vs Gate-level vs Physical Design overview. Synthesis constraints: timing, area, power (conceptual). Combinational vs sequential synthesis. Importance of writing synthesizable Verilog. **(9)**

FPGA-BASED DESIGN FLOW: Overview of FPGA architectures (CLBs, LUTs, IOBs). RTL-to-bitstream flow using FPGA tools. Introduction to timing simulation, constraint files, and basic static timing. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Samir Palnitkar, '*Verilog HDL: A Guide to Digital Design and Synthesis*', SunSoft Press, 2nd Edition 2003.
2. Jan M. Rabaey and Anantha Chandrakasan, '*Digital Integrated Circuits: A Design Perspective*', Prentice Hall of India, 2016.
3. Stephen Brown and Zvonko Vranesic, '*Digital Logic with Verilog Design*', McGraw Hill, 2003.

REFERENCES:

1. Zainalabedin Navabi, '*Verilog Digital System Design*', McGraw-Hill Education, 2nd Edition, 2005.
2. Ming-Bo Lin, '*Digital System Designs and Practices: Using Verilog HDL and FPGAs*', Wiley, 1st Edition 2008.
3. Douglas A. Pucknell and Kamran Eshraghian,, '*Basic VLSI Design*', Prentice Hall of India, 3rd Edition, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the foundational principles of digital systems and describe the process of modeling hardware using HDL.	**K2**
CO2	Apply Verilog HDL to design, simulate, and verify combinational and sequential logic systems using modular and reusable coding techniques	**K3**
CO3	Analyze the synthesis process and FPGA implementation flow, and evaluate basic design trade-offs related to area, timing, and power	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVO04 ASIC DESIGN

3 0 0 3

INTRODUCTION TO ASICs AND DESIGN FLOW: Types of ASICs: Full-custom, semi-custom, programmable (FPGAs, CPLDs) – Introduction to ASIC design flow – Industry relevance and applications of ASICs – Comparison with general-purpose processors. **(9)**

PROGRAMMABLE ASIC TECHNOLOGIES: Overview of FPGA vendors (Xilinx, Intel/Altera) – Introduction to SRAM-based and Flash-based FPGAs – Basic I/O functionality and configuration methods – Role of ASICs in embedded systems and smart devices. **(9)**

FPGA ARCHITECTURES AND TOOLS: High-level view of Spartan, Cyclone, Virtex, and Stratix families – Soft-core processors: MicroBlaze and Nios II (intro only) – Brief introduction to FPGA development tools (Vivado, Quartus). **(9)**

SYSTEM-LEVEL DESIGN CONCEPTS: Block-level design methodology – Introduction to logic synthesis (concept only, not RTL coding) – Floor planning and routing basics (conceptual) – Power and clock distribution overview. **(9)**

APPLICATIONS AND CASE STUDIES: ASICs in consumer electronics (e.g., digital cameras, smartphones) – ASICs in automotive and IoT systems – Signal processing applications (basic intro to FFT/DCT) – Industrial relevance: SDRAM, USB, HDMI controllers. **(9)**

Total L:45 Periods

TEXT BOOKS:

1. M.J.S.Smith, '*Application - Specific Integrated Circuits*', Pearson, 2003.
2. Steve Kilts, '*Advanced FPGA Design*', Wiley IEEE-Press, 2007.
3. Roger Woods, John McAllister, Ying Yi and Gaye Lightbod, '*FPGA-based Implementation of Signal Processing System*', Wiley, 2008.
4. Mohammed Ismail and Terri Fiez, '*Analog VLSI Signal and Information Processing*', Mc-Graw Hill, 1994.

REFERENCES:

1. Douglas J. Smith, HDL Chip Design, Madison, AL, USA: Doone Publications, 1996.
2. Jose E. France, Yannis Tsividis, "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the technologies and structures used in programmable ASICs and their I/O interfaces	**K2**
CO2	Apply logic synthesis and layout techniques to optimize ASIC designs for performance and power.	**K3**
CO3	Compare different programmable ASIC technologies and evaluate their applicability.	**K4**

COs-POs & PSOs MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

25EVO05 SEMICONDUCTOR FABRICATION AND CHARACTERIZATION

3 0 0 3

FUNDAMENTALS OF SEMICONDUCTORS: Introduction to semiconductors and applications, Crystal properties of semiconductors: crystal lattices and basic crystal growth concepts, Energy bands in solids, Intrinsic and Extrinsic semiconductors, Charge carriers and carrier concentration, Mobility and conductivity, Drift and diffusion (qualitative), Fermi level concept, Silicon and compound semiconductors (GaAs), Metals used in IC fabrication. **(9)**

FABRICATION TECHNIQUES –DEPOSITION: Introduction to microfabrication: Top-down and Bottom-up approaches, Wafer preparation and cleaning (overview), Silicon oxidation: Thermal oxidation, dry and wet oxidation (conceptual understanding), Thin film deposition: Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD), Polysilicon and dielectric deposition (overview). **(9)**

FABRICATION TECHNIQUES – PATTERNING AND REMOVAL: Doping techniques: Diffusion and Ion implantation (basic concepts), Annealing and defect removal (introduction), Photolithography: Photoresists, masks, exposure and pattern transfer, Etching: Wet and dry etching, Isotropic and anisotropic etching. **(9)**

MEMS, DEVICES AND CASE STUDIES: Introduction to MEMS, Bulk and surface micromachining (overview), LIGA process (introduction), Basic MOS capacitor and MOSFET fabrication process flow, Brief introduction to CMOS and FinFET technologies, Simple MEMS cantilever as a case study. **(9)**

CHARACTERIZATION TECHNIQUES: Electrical characterization: Two-point and four-point probe methods, I–V and C–V characterization (basic interpretation), Optical and surface characterization: Introduction to Ellipsometry, Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM), Importance of characterization in semiconductor devices. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. S.M. Sze, ‘*Physics of Semiconductor Devices’*. John Wiley and Sons, USA, 4th Edition, 2021.
2. Tai-Ran Hsu, ‘*MEMS & Microsystems Design and Manufacture*’, Tata McGraw-Hill Education, 2002.
3. Lau, John H. ‘*Advanced packaging*’, Semiconductor Advanced Packaging. Singapore: Springer Singapore, 2021.

REFERENCES:

1. Stephen D. Senturia, ‘*Microsystem design*’, Springer (India), 2006.
2. Douglas A. Pucknell and Kamran Eshraghian, ‘*Basic VLSI Design*’, Prentice Hall of India, 3rd Edition, 2011.
3. Amar Mukherjee, ‘*Introduction to nMOS and CMOS VLSI System Design*’, Prentice Hall, 1986.
4. Sung-Mo Kang and Yusuf Leblebici, ‘*CMOS Digital Integrated Circuits: Analysis and Design’*, McGraw Hill Education, 4th Edition, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the fundamental concepts of semiconductor physics, materials, microfabrication process and characterization techniques	**K2**
CO2	Apply the microfabrication process to develop basic Semiconductor devices.	**K3**
CO3	Analyze and test semiconductor materials and devices	**K4**

COs-POs & PSOs MAPPING:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
@	**3**	**2**											

1-Low, 2-Medium, 3-High, @-Overall Contribution to the Course

MANDATORY COURSES

25MC001 ENVIRONMENTAL SCIENCES
(Common to Civil, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

2 0 0 0

INTRODUCTION TO ENVIRONMENT: Environment - Definition, scope and importance. Types and composition of atmosphere – particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats – India as a mega-diversity nation, hotspots of biodiversity, endangered and endemic species of India, conservation of biodiversity. **(6)**

ENERGY RESOURCES: Introduction – National and International status- exploitation - sustainable strategies- Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources -tidal, geothermal, hydroelectric. **(6)**

ENVIRONMENTAL POLLUTION: Definition, Sources, causes, impacts and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, RF hazards, Role of an individual in prevention of pollution. Disaster Management: Floods, earthquake, cyclone and landslides – Case studies, consequences and rescue measures. **(6)**

WASTE MANAGEMENT: Waste water - Characteristics of domestic and industrial wastewater - COD and BOD, Various stages of treatment – primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management – Characteristics of municipal solid waste (MSW), biomedical, automobile and e-wastes and their management, landfills, incineration, pyrolysis, gasification and composting**.** **(6)**

SOCIAL ISSUES AND THE ENVIRONMENT: Environmentally Sustainable work practices- Rain water harvesting, Role of non-governmental organizations. Human ethics and rights- impact on environment and human health, role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act. **(6)**

Total L: 30 periods

TEXT BOOKS:

1. Gilbert M. Masters, '*Introduction to Environmental Engineering and Science*', Pearson Education, New Delhi, 2004.
2. Deswal S and Deswal A, '*A Basic Course in Environmental Studies*', Dhanpat Rai and Co, New Delhi, 2004.

REFERENCES:

1. Benny Joseph, '*Environmental Science and Engineering*', Tata McGraw - Hill, New Delhi, 2006.
2. Koteswara Rao M V R, '*Energy Resources: Conventional & Non – Conventional*', BSP Publications, New Delhi, 2006.
3. Botkin and Keller, '*Environmental Science*', Wiley India Private Limited, New Delhi, 2013.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of environment, energy sources and waste management	**K2**
CO2	Use different renewable energy resources and environment protection measures for sustainable development	**K3**
CO3	Conduct a case study and real-time environmental issues and present as a team	

COs-POs & PSOs MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	1												
CO3						2	2	2			2		
	1					**2**	**2**	**2**			**2**		

1-low, 2-medium, 3-high

25MC002 INDIAN CONSTITUTION
(Common to Civil, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

2 0 0 0

INTRODUCTION: Evolution of Indian Constitution; significance of constitution; Composition; Preamble and its Philosophy. **(4)**

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES: Fundamental Rights- Writs and Duties, Directive Principles of State Policy. **(5)**

UNION GOVERNMENT: Union Government, President and Vice President, Houses of the Parliament and their functions; Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. **(6)**

STATE GOVERNMENT AND FEDERALISM: Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. **(8)**

JUDICIARY: Supreme Court, High Court; District Court and Lower Courts - Functions and Powers – Judges – Qualifications and Powers - Judicial Review. **(7)**

Total L: 30 periods

TEXT BOOKS:

1. Subash C Kashyap, ‘*Our Political System*’, National Book Trust, 2011.
2. Praveenkumar Mellalli E, ‘*Constitution of India, Professional Ethics and Human Rights*’, Sage Publications India Pvt. Ltd., 2015.

REFERENCES:

1. Briji Kishore Sharma, ‘*Introduction to the Constitution of India*’, Prentice Hall of India, 2010.
2. Basu D D, ‘*Introduction to the Constitution of India*’, Prentice Hall of India, 2016.
3. Jain. M C, ‘*The Constitution of India*’, Law House, New Delhi, 2001.
4. Shukla V N, ‘*Constitution of India*’, Eastern Book Company Ltd., New Delhi, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the evolution, significance, and philosophy of the Indian Constitution, including its Preamble, composition, and core principles.	**K2**
CO2	Analyze the structure, powers, and functions of the Union and State Governments, including the roles of the President, Parliament, Governor, and Council of Ministers, as well as the legislative process, types of bills, and constitutional amendments.	**K3**
CO3	Conduct a case study on the Indian Constitution, demonstrating understanding of its evolution, fundamental rights and duties, structure of Union and State governments, federal system, and the role of the judiciary in governance.	

COs-POs & PSOs MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3								2	2		2		
	2							**2**	**2**		**2**		

1-low, 2-medium, 3-high

25MC003 INDUSTRIAL SAFETY
(Common to Civil, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

2 0 0 0

SAFETY TERMINOLOGIES: Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) -Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects-Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS. **(6)**

STANDARDS AND REGULATIONS: Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006. **(6)**

SAFETY ACTIVITIES: Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment. **(6)**

WORKPLACE HEALTH AND SAFETY: Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release. **(6)**

HAZARD IDENTIFICATION TECHNIQUES: Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment. **(6)**

Total L: 30 periods

TEXTBOOKS

1. Jain R. K. and Sunil S. Rao, '*Industrial Safety, Health and Environment Management Systems*'. Khanna Publisher, 4th Edition, 2000.
2. Deshmukh L. M., *'Industrial Safety Management: Hazard Identification and Risk Control'*. McGraw-Hill Education, 2007.

REFERENCES

1. John Ridley, John Channing, '*Safety at Work*'. Routledge, 7th Edition, 2008.
2. Dan Petersen, '*Techniques of Safety Management*: *A System Approach*'. Amer Society of Safety Engineers, 4th Edition, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to		Bloom's Level
CO1	Describe the safety protocols and standard operating procedures in industrial settings to ensure compliance with safety regulations and minimize hazards in the workplace.	**K2**
CO2	Implement and test emergency response plans tailored to the industrial environments, ensuring effective action during emergencies such as fires, chemical spills or equipment malfunctions.	**K3**
CO3	Review and present on risk assessments and hazards using industry-specific tools to identify potential safety risks and choose appropriate corrective actions to prevent accidents and injuries.	**-**

CO - PO & PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2					2	2						
CO3						1	1	1	1		1		1
	2					**2**	**2**	**1**	**1**		**1**		**1**

1 - low, 2- medium, 3 – high

Third ACM

25MC004 DISASTER RISK REDUCTION AND MANAGEMENT
(Common to CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

2 0 0 0

HAZRADS, VULNERABILITY AND DISASTER RISKS: Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced – Earthquake, Landslide, Flood, Drought, Fire, etc. – Technological disasters - Structural collapse, Industrial accidents, oil spills - Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Inter relations between Disasters and Sustainable development Goals. **(6)**

DISASTER RISK REDUCTION (DRR): Sendai Framework for Disaster Risk Reduction, Disaster cycle - Community Based DRR, Structural – Non-structural measures, Roles and responsibilities of - community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders - Early Warning System – Relevance of indigenous Knowledge, appropriate technology and Local resources. **(6)**

DISASTER MANAGEMENT: Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction - Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Institutional Processes and Framework at State and Central Level - (NDMA – SDMA – DDMA – NRDF - Civic Volunteers). **(6)**

TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT: Early warning systems - Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness) – Role of GIS and Information Technology in Disaster Management – Disaster Damage Assessment - Elements of Climate Resilient Development – Standard operation Procedure for disaster response – Financial planning for disaster Management. **(6)**

DISASTER MANAGEMENT: CASE STUDIES: Case studies in the context of disasters - Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding, Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding, Forest Fire, Man Made disasters. **(6)**

Total L: 30 periods

TEXTBOOKS

1. Thomas D. Schneid, and Larry Collins, '*Disaster Management and Preparedness*'. CRC Publications, 2016.
2. R. Singh, '*Disaster Management Guidelines: Earthquakes, Landslides, Avalanches and Tsunami'*. Horizon Press Publications, 2017.
3. J. P. Singhal, '*Disaster Management'*. Laxmi Publications, 2024.
4. T. Bhattacharya, '*Disaster Science and Management'*. McGraw Hill India Education Pvt. Ltd., 2012.

REFERENCES

1. Government of India, '*Disaster Management Act'*. New Delhi, 2005.
2. Government of India, '*National Disaster Management Policy'*. New Delhi, 2009.
3. R. Shaw, '*Community based Disaster risk reduction*'. Natural Hazard Science, Oxford Research Encyclopedias, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Summarize the concepts, tools, technologies and strategies for disaster risk reduction and management.	**K2**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1					1	1	1	1	1		1		
					1	**1**	**1**	**1**	**1**		**1**		

1-low, 2-medium, 3-high