PANIMALAR
ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai

CURRICULUM & SYLLABUS
REGULATION 2023

FOR THE STUDENTS ADMITTED DURING 2023-24

B.E - ELECTRONICS AND COMMUNICATION ENGINEERING

www.panimalar.ac.in

PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)
Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600 123.

Department of Electronics and Communication Engineering

B.E- Electronics and Communication Engineering

Curriculum and Syllabus

Regulation 2023

(Students admitted during the year 2023-2024)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To provide world class quality education and excelling research activities in electronics and communication engineering with strong ethical values and social challenges.

MISSION

M1: To impart high quality technical education by investing in faculty development and resources.

M2: To adapt best teaching and learning process with strong state of art facilities for academic and research activities.

M3: To enhance national and international collaborative activities for evolving indigenous technological solutions to meet social needs, nurture leadership and entrepreneurship qualities with ethical means.

M4: To facilitate partnership with leading core industries and R&Ds for global outreach

PROGRAM EDUCATIONAL OBJECTIVES(PEOS)

PEO1: Core Competencies

To prepare the graduates in fostering Electronics and Communication Engineering principles to provide socially relevant and sustainable engineering solution.

PEO2: Professional Integrity

To gain adequate knowledge to become good professional in electronics and communication engineering associated industries, higher education and research.

PEO3: Research & Global Responsibilities

To prepare graduates in an area of specialization, ethically develop innovative and research oriented methodologies to enhance the adaptability of technological and social challenges.

PROGRAM OBJECTIVES (POS)

PO1: Engineering Knowledge:

Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis:

Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions:

Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems:

Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage:

Create, select and apply appropriate techniques, resources and modern engineering &IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World:

Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PROGRAM OBJECTIVES (POS)

PO7: Ethics:

Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work:

Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication:

Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation,make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance:

Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning:

Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Graduates should demonstrate an understanding of the basic concepts in the primary area of Electronics and Communication Engineering, including: analysis of circuits containing both active and passive components, electronic systems, control systems, electromagnetic systems, digital systems, computer applications and communications.

PSO2: Graduates should demonstrate the ability to utilize the mathematics and the fundamental knowledge of Electronics and Communication Engineering to design complex systems which may contain both software and hardware components to meet the desired needs.

PSO3: The graduates are capable of excelling in Electronics and Communication Engineering industry/Academic /Software companies through professional careers.

B.E.- ELECTRONICS AND COMMUNICATION ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

I – VIII SEMESTERS CURRICULUM AND SYLLABI (REGULATION 2023)

(For the Students admitted during 2023-24)

Semester I							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23MA1101	Matrices and Calculus	BS	3/1/0	4	4	60/40
2.	23ES1101	Problem Solving using C Programming	ES	3/0/0	3	3	60/40
3.	23ES1103	Engineering Graphics	ES	2/0/2	4	3	60/40
Theory Cum Practical Courses							
4.	23HS1101	Communicative English and Language Skills	HS	2/0/2	4	3	50/50
5.	23PH1101	Engineering Physics	BS	2/0/2	4	3	50/50
Laboratory Courses							
6.	23ES1111	Problem solving using C Programming Laboratory	ES	0/0/4	4	2	40/60
Mandatory Course							
7.	23TA1101	தமிழர் மரபு/ Heritage of Tamils	HS	1/0/0	1	1	60/40
			TOTAL		**24**	**19**	

Semester II							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23MA1201	Complex Variables and Laplace Transform	BS	3/1/0	4	4	60/40
2.	23EC1201	Electronic Devices	PC	3/0/0	3	3	60/40
3.	23ES1201	Python Programming	ES	3/0/0	3	3	60/40
Theory Cum Practical Courses							
4.	23HS1201	Communicative and Aptitude Skills	HS	2/0/2	4	3	50/50
5.	23ES1204	Basic Electrical Circuits and Engineering	ES	3/0/2	5	4	50/50
Laboratory Courses							
6.	23EC1211	Circuits and Devices Laboratory	PC	0/0/4	4	2	40/60
7.	23ES1211	Python Programming Laboratory	ES	0/0/4	4	2	40/60
8.	23ES1212	Technical Skill Practices I	EEC	0/0/2	2	1	40/60
Mandatory Course							
9.	23TA1201	தமிழரும் தொழில்நுட்பமும்/ Tamils and Technology	HS	1/0/0	1	1	60/40
10.		Mandatory Course I	MC	2/0/0	2	0	0/100
			TOTAL		**32**	**23**	

Semester III							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23MA1302	Linear Algebra and Numerical Analysis	BS	3/1/0	4	4	60/40
2.	23EC1301	Signals and Systems	PC	3/0/0	3	3	60/40
3.	23EC1302	Electronic Circuits I	PC	3/0/0	3	3	60/40
4.	23EC1303	Digital Electronics	PC	3/0/0	3	3	60/40
5.	23EC1304	Control Systems Engineering	PC	3/0/0	3	3	60/40
Laboratory Courses							
6.	23EC1311	Electronic Circuits and Simulation Laboratory I	PC	0/0/4	4	2	40/60
7.	23EC1312	Control Systems Engineering Laboratory	PC	0/0/4	4	2	40/60
8.	23ES1312	Coding Practices I	EEC	0/0/2	2	1	40/60
Mandatory Course							
9.		Mandatory Course II	MC	2/0/0	2	0	0/100
			TOTAL		**28**	**21**	

Semester IV							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23MA1402	Probability and Random Processes	BS	3/1/0	4	4	60/40
2.	23CS1403	Principles of Data Structures	ES	3/0/0	3	3	60/40
3.	23EC1401	Communication Theory	PC	3/0/0	3	3	60/40
4.	23EC1402	Electronic Circuits II	PC	3/0/0	3	3	60/40
5.	23EC1403	Analog Integrated Circuits	PC	3/0/0	3	3	60/40
6.	23EC1404	Electromagnetic Fields	PC	3/0/0	3	3	60/40
Laboratory Courses							
7.	23EC1411	Electronic Circuits and Simulation Laboratory II	PC	0/0/4	4	2	40/60
8.	23EC1412	Analog and Digital Circuits Laboratory	PC	0/0/4	4	2	40/60
9.	23CS1412	Principles of Data Structures Laboratory	ES	0/0/4	4	2	40/60
10.	23ES1412	Coding Practices II	EEC	0/0/2	2	1	40/60
			TOTAL		**33**	**26**	

Semester V							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23EC1501	Digital Communication	PC	3/0/0	3	3	60/40
2.	23EC1502	Discrete Time Signal Processing	PC	3/0/0	3	3	60/40
3.	23EC1503	Microprocessors and Microcontrollers	PC	3/0/0	3	3	60/40
4.	23EC1504	Transmission Lines and Waveguides	PC	3/0/0	3	3	60/40
5.		Professional Elective I	PE	3/0/0	3	3	60/40
6.		Open Elective I	OE	3/0/0	3	3	60/40
Laboratory Courses							
7.	23EC1511	Discrete Time Signal Processing Laboratory	PC	0/0/4	4	2	40/60
8.	23EC1512	Microprocessors and Microcontrollers Laboratory	PC	0/0/4	4	2	40/60
9.	23EC1513	Analog and Digital Communication Laboratory	PC	0/0/4	4	2	40/60
10.	23ES1512	Coding Practices III	EEC	0/0/2	2	1	0/100
			TOTAL		**32**	**25**	

Semester VI							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23EC1601	Wireless Communication	PC	3/0/0	3	3	60/40
2.	23EC1602	Antenna and Wave Propagation	PC	3/0/0	3	3	60/40
3.	23EC1603	Data Communication Networks	PC	3/0/0	3	3	60/40
4.	23EC1604	VLSI Design	PC	3/0/0	3	3	60/40
5.		Professional Elective II	PE	3/0/0	3	3	60/40
6.		Open Elective II	OE	3/0/0	3	3	60/40
Laboratory Courses							
7.	23EC1611	Wireless Communication and Networks Laboratory	PC	0/0/4	4	2	40/60
8.	23EC1612	VLSI Design Laboratory	PC	0/0/4	4	2	40/60
9.	23ES1612	Coding Practices IV	EEC	0/0/2	2	1	0/100
			TOTAL		**28**	**23**	

Semester VII							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23EC1701	Embedded Systems	PC	3/0/0	3	3	60/40
2.	23EC1702	Optical Communication and Networks	PC	3/0/0	3	3	60/40
3.	23EC1703	Microwave Engineering	PC	3/0/0	3	3	60/40
4.		Professional Elective III	PE	3/0/0	3	3	60/40
5.		Professional Elective IV	PE	3/0/0	3	3	60/40
Laboratory Courses							
7.	23EC1711	Embedded Systems Laboratory	PC	0/0/4	4	2	40/60
8.	23EC1712	Optical and Microwave Communication Laboratory	PC	0/0/4	4	2	40/60
9.	23EC1713	Community Service Project	EEC	0/0/2	2	1	0/100
Employment Enhancement Courses							
10.	23EC1714	Industrial Training/Internship#	EEC	-	-	2	0/100
11.		Value Added Course##	EEC	-	-	0	0/100
			TOTAL		**25**	**22**	

#The students shall undergo One 4-week or Two 2-Week internship/ Industrial Training during the summer / winter vocation from semester III to VI. The same will be Evaluated in Semester VII. Two weeks of Internship / Industrial Training carries one credit.

Semester VIII							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.		Professional Elective V	PE	3/0/0	3	3	60/40
2.		Professional Elective VI	PE	3/0/0	3	3	60/40
Laboratory Courses							
1.	23EC1811	Project Work	EEC	0/0/16	16	8	40/60
			TOTAL		**22**	**14**	

Total No. of Credits: 173

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Sl. No	Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI	Vertical VII	Vertical VIII
	Biomedical Technologies	**IoT Architecture and Applications**	**Signal Processing**	**Advanced Communication Technology**	**VLSI Design and Testing**	**RF Technologies**	**Sensor System Technology**	**Emerging Technologies**
1.	23EC1901 Biomedical Instrumentation	23EC1908 Wireless Networks	23EC1915 DSP Architecture and Programming	23EC1922 Cognitive Radio Networks	23EC1929 ASIC Design	23EC1936 Electromagnetic Interference and Compatibility	23EC1943 Principles of Sensors	23EC1950 Cryptography and Security Practices
2.	23EC1902 Diagnostic and Therapeutic Equipments	23EC1909 IoT Architectures and Protocols	23EC1916 Advanced Digital Signal Processing	23EC1923 High Speed Access Technologies	23EC1930 CAD for VLSI Design	23EC1937 RFID system and Applications	23EC1944 Sensors and Actuators	23EC1951 Block chain Technologies and Applications
3.	23EC1903 Wearable Devices	23EC1910 IoT Security	23EC1917 Digital Image and Video Processing	23EC1924 Advanced Wireless Communication Techniques	23EC1931 System Verilog	23EC1938 RF MEMS	23EC1945 Flexible and Wearable Sensors	23EC1952 Data Science and Analytics
4.	23EC1904 Body Area Networks and its Applications	23EC1911 Data Analytics for IoT	23EC1918 Biosignal Processing	23EC1925 Massive MIMO Networks	23EC1932 Low-Power IC Design	23EC1939 Smart Antennas	23EC1946 Microsystems and Hybrid Technology	23EC1953 5G and Beyond Communication Networks
5.	23EC1905 Telemedicine and Telehealth	23EC1912 IoT for Industry Automation	23EC1919 Speech Processing	23EC1926 Artificial Intelligence and Machine Learning for Communication Engineers	23EC1933 VLSI Testing and Design for Testability	23EC1940 RF System Design	23EC1947 Nanomaterials and Sensors	23EC1954 Space Communication
6.	23EC1906 Medical Image Analysis	23EC1913 IoT for Smart Cities	23EC1920 Computer Vision	23EC1927 Machine Learning For Future Wireless Communication	23EC1934 System On Chip	23EC1941 Signal Integrity for High Speed Design	23EC1948 Data Acquisition and Hardware Interfaces	23EC1955 Human Computer Interaction
7.	23EC1907 Brain Computer Interface	23EC1914 IoT and Edge Computing	23EC1921 Underwater Imaging Systems and Image Processing	23EC1928 Terahertz Communication	23EC1935 Network On Chip	23EC1942 Computational Electro Magnetics	23EC1949 Wireless Sensor Networks	23EC1956 Virtual Reality and Augmented Reality

List of Open Electives I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EE1008	Energy Conservation and Management	OE	3	3	0	0	3
2.	23CS1001	Fundamentals of Database Management Systems	OE	3	3	0	0	3
3.	23CS1003	Cloud Computing	OE	3	3	0	0	3
4.	23EC1001	Basic of Biomedical Instrumentation	OE	3	3	0	0	3
5.	23EC1005	Intelligent Automation	OE	3	3	0	0	3
6.	23CB1001	C++ Programming	OE	3	3	0	0	3
7.	23ML1001	Data Structures and Algorithms	OE	3	3	0	0	3
8.	23ML1002	Fundamentals of Machine Learning	OE	3	3	0	0	3
9.	23EC1007	Product Design and Development	OE	3	3	0	0	3
10.	23ME1004	Industrial Pollution and Prevention	OE	3	3	0	0	3

List of Open Electives II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23GE1001	Disaster Management	OE	3	3	0	0	3
2.	23GE1006	Intellectual Property Rights	OE	3	3	0	0	3
3.	23EC1011	Telehealth Technology	OE	3	3	0	0	3
4.	23CS1002	Software Engineering	OE	3	3	0	0	3
5.	23EE1003	Logic and Distributed Control Systems	OE	3	3	0	0	3
6.	23EC1008	Robotics and Automation	OE	3	3	0	0	3
7.	23IT1001	Web Design and Management	OE	3	3	0	0	3
8.	23CB1002	Mobile Application Development	OE	3	3	0	0	3
9.	23EE1929	Intelligent Control of Electric Vehicles	OE	3	3	0	0	3
10.	23ME1005	Hospital Management	OE	3	3	0	0	3

MANDATORY COURSES

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
Mandatory Courses							
1.	23MC1001	Environmental Science	MC	2/0/0	2	0	0/100
2.	23MC1002	Constitution of India	MC	2/0/0	2	0	0/100
3.	23MC1003	Human Values	MC	2/0/0	2	0	0/100
4.	23MC1004	Energy Studies	MC	2/0/0	2	0	0/100
5.	23MC1005	Essence of Indian Traditional Knowledge	MC	2/0/0	2	0	0/100
6.	23MC1006	Soft Skills and Personality Development	MC	2/0/0	2	0	0/100
7.	23MC1007	Value Education, Human Rights &Legislature Procedure	MC	2/0/0	2	0	0/100

Credit Distribution

Sl.No	Subject Area	CREDITS PER SEMESTER								Total	Percentage (%)
	Semester	I	II	III	IV	V	VI	VII	VIII		
1.	**HS**	4	4	-	-	-	-	-	-	8	4.62
2.	**BS**	7	4	4	4	-	-	-	-	19	10.98
3.	**ES**	8	9	-	5	-	-	-	-	22	12.71
4.	**PC**	-	5	16	16	18	16	13	-	84	48.55
5.	**PE**	-	-	-	-	3	3	6	6	18	10.41
6.	**OE**	-	-	-	-	3	3	-	-	6	3.47
7.	**EEC**	-	1	1	1	1	1	3	8	16	9.25
8.	**MC**	-	0	0	-	-	-	-	-	0	0
TOTAL		**19**	**23**	**21**	**26**	**25**	**23**	**22**	**14**	**173**	**100**

SEMESTER I

23MA1101	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To comprehend matrices as mathematical structures used to represent data, equations,and transformations in various engineering applications.
- To introduce the concepts of limits, continuity, derivatives and maxima and Minima.
- To familiarize the functions of two variables and finding its extreme points.
- To provide understanding of various techniques of integration.
- To introduce integral ideas in solving areas, volumes and other practical problems.

UNIT - I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix - Characteristic equation -Properties of Eigenvalues and Eigenvectors -Cayley Hamilton theorem -Diagonalization of matrices- Reduction of a quadratic form to canonical form by orthogonal transformation - Nature of quadratic forms.

UNIT - II DIFFERENTIAL CALCULUS 9+3

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (Sum, Product & Quotient rule, Chain rule, logarithmic and implicit differentiation) - Maxima and Minima of functions of one variable and its applications**.**

UNIT - III FUNCTIONS OF SEVERAL VARIABLES 9+3

Partial differentiation - Total derivative - Change of variables –Jacobian's- Taylor's series for functions of two variables - Maxima and minima of functions of two variables - Lagrange's method of undetermined multipliers.

UNIT - IV INTEGRAL CALCULUS 9+3

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts -Bernoulli's formula- Integration of rational functions by partial fraction - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.

UNIT - V MULTIPLE INTEGRALS 9+3

Double integrals in Cartesian and polar coordinates - Change of order of integration in Cartesian coordinates - Area enclosed by plane curves - Change of variables in double integrals -Triple integrals - Volume of Solids.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Apply matrix operations to solve engineering problems efficiently.

CO2 Apply limit definition and rules of differentiation to differentiate functions.

CO3 Understand familiarity in the knowledge of Maxima and Minima, Jacobian,Taylor series and apply the problems involving Science and Engineering.

CO4 Understand the knowledge of Integration by parts, Integration of rational functions by partial fraction.

CO5 Understand the knowledge of Area enclosed by plane curves, Change of variables in double integrals, Triple integrals, Volume of Solids.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, NewDelhi,44th Edition,2018.
2. James Stewart, "Calculus: Early Transcendental", Cengage Learning, 9th Edition, NewDelhi,2015.
3. Bali N., Goyal M. and Walkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvtt. Ltd.,), New Delhi, 7th Edition, 2015.

REFERENCE BOOKS:

1. Sundar Raj. M and Nagarajan. G, “Engineering Mathematics-I”,3rd Edition, Sree Kamalamani Publications, Chennai, 2020.
2. Sivaramakrishna Dass, C. Vijayakumari, “Engineering Mathematics”, Pearson Education India, 4th Edition 2019.
3. Srimantha Pal and Bhunia,S.C, "Engineering Mathematics "Oxford University Press, 2015.
4. Erwin Kreyzig, Advanced Engineering Mathematics, JohnWiley sons, 10th Edition,2015.
5. Narayanan, S. and Manicavachagom Pillai, T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt., Ltd., Chennai, 2007.
6. B.V. Ramana “Higher Engineering Mathematics”, McGraw Hill Education, India.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ma60/preview
2. https://onlinecourses.nptel.ac.in/noc21_ma58/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	3	3								1	1	2	1
CO2	3	3	3								1	1	2	1
CO3	3	3	3								1	1	2	1
CO4	3	3	3								1	1	2	1
CO5	3	3	3								1	1	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ES1101	PROBLEM SOLVING USING C PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn the syntax for C programming
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop applications in C using functions, pointers
- To develop applications using structures and union

UNIT - I BASICS OF C PROGRAMMING 9

Introduction to programming paradigms – Algorithms – Flowchart - Structure of C program - C programming: Data Types – Storage classes - Constants – Enumeration Constants - Type Conversion Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Format specifiers, Assignment statements – Decision making statements - Switch statement – Break – Continue - Goto statement - Looping statements – Pre-processor directives - Compilation process.

UNIT - II ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization — One dimensional array — Example Program: Computing Mean, Median and Mode - Two dimensional arrays — Example Program: Matrix Operations (Addition, Multiplication, Determinant and Transpose) - String operations: length, compare, concatenate, copy, Reverse and Palindrome – Selection sort, Insertion sort - linear and binary search.

UNIT - III FUNCTIONS AND POINTERS 9

Introduction to functions: Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion – Example Program: Computation of Sine series, Scientific calculator using built-in functions, Binary Search using recursive functions – Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program: Sorting of names – Parameter passing: Pass by value, Pass by reference – Example Program: Swapping of two numbers and changing the value of a variable using pass by reference.

UNIT - IV STRUCTURES AND UNION 9

Structure - Nested structures– Pointer and Structures– Array of structures — Example Program using structures and pointers – Self-referentials structures – Dynamic memory allocation – Singly linked list– typedef and Union.

UNIT - V FILE PROCESSING 9

Files — Types of file processing: Sequential access, Random access — Sequential access file - Example Program: Finding average of numbers stored in sequential access file - Random access file - Example Program: Transaction processing using random access files — Command line arguments.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

- **CO1** Learn the syntax for C programming
- **CO2** Develop simple applications in C using basic constructs
- **CO3** Design and implement applications using arrays and strings
- **CO4** Develop and implement applications in C using functions and pointers.
- **CO5** Develop applications in C using structures and union.
- **CO6** Design applications using sequential and random access file processing.

TEXT BOOKS:

1. Reema Thareja, —Programming in C, Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, —The C Programming language, Second Edition, Pearson Education, 2006.

REFERENCE BOOKS:

1. Paul Deitel and Harvey Deitel, —– C How to Program, Seventh edition, Pearson Publication, 2015
2. Juneja, B. L and Anita Seth, —Programming in C, CENGAGE Learning India pvt. Ltd., 2011.
3. Anita Goel and Ajay Mittal, —Computer Fundamentals and Programming in C, Dorling Kindersley (India) pvt., Ltd., Pearson Education in South Asia, 2011.
4. Pradip Dey, Manas Ghosh, —Fundamentals of Computing and Programming in C, First Edition, Oxford University Press, 2009.
5. Byron S. Gottfried, "Schism's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.

WEB REFERENCES:

1. https://github.com/tscheffl/ThinkC/blob/master/PDF/Think-C.pdf
2. https://freecomputerbooks.com/langCBooks.html

ONLINE COURSES / RESOURCES:

1. https://www.programiz.com/c-programming
2. https://www.tutorialspoint.com/cprogramming/index.htm
3. https://www.javatpoint.com/c-programming-language-tutorial
4. https://www.geeksforgeeks.org/c-programming-language/
5. https://en.wikibooks.org/wiki/C_Programming
6. https://www.cprogramming.com/tutorial/c-tutorial.html?inl=hp

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	2	1	1	1		1						1	2	2
CO2	2	1	1	1	2	1						1	2	2
CO3	3	2	2	1	3	1						1	2	2
CO4	3	2	2	1	3	1						1	2	2
CO5	2	1	1	1	2	1						1	2	2
CO6	2	1	1	1	2	1						1	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ES1103	ENGINEERING GRAPHICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- To draw engineering curves
- To draw orthographic projections of lines and planes
- To draw orthographic projections of solids
- To draw section and development of the surfaces of objects
- To draw isometric views and intersection curves of simple solids
- To draw free hand sketches of basic geometrical shapes, multiple views of objects and Applications of Engineering Graphics

UNIT - 0 CONCEPTS AND CONVENTIONS (Not for Examination) 2

Importance of drawing in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning - Introduction to Scales - Geometric construction - to draw perpendiculars, parallel lines, divide a line and circle, to draw equilateral triangle, square, regular polygons. Introduction to drafting packages like CAD and demonstration of their use in engineering fields.

UNIT - I ENGINEERING CURVES AND PROJECTION OF POINTS AND LINES 6+6

Basic construction of cycloid, epicycloid and hypocycloid - Drawing of tangents and normal to the above curves. Construction of involutes of square, pentagon and circle - Drawing of tangents and normal to the above involutes.

Orthographic projection — Introduction to Principal Planes of projections - First angle projection - Projection of points. Projections of straight lines (only in First angle projections) inclined to both the principal planes - Determination of true lengths, true inclinations and traces by rotating line method

UNIT - II PROJECTIONS OF PLANES AND PROJECTIONS OF SOLIDS 6+6

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method and auxillary plane method.

Projection of simple solids like prisms, pyramids, cylinder, and cone when the axis is inclined to one principle planes by rotating object method.

UNIT - III SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES 6+6

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

Development of lateral surfaces of simple solids and frustum and truncated solids — Prisms, pyramids cylinders and cones.

UNIT - IV INTERSECTION OF SOLIDS AND ISOMETRIC PROJECTIONS 6+6

Line of intersection - Determining the line of intersection between surfaces of two interpenetrating two square prisms and Intersection of two cylinders with axes of the solids intersecting each other perpendicularly, using line method.

Principles of isometric projection — isometric scale –Isometric projections and isometric views of simple solids and frustum and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.

UNIT - V FREE-HAND SKETCHING 5+5

Steps in free hand sketching - Orthographic views (front, top and side views) of simple blocks from their Isometric view, Isometric view of simple blocks from their Orthographic views (front, top and side views)

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

- **CO1** Draw the engineering curves and draw orthographic projections of lines and planes
- **CO2** Draw orthographic projections of planes and solids
- **CO3** Draw the sections and development of the surfaces of objects
- **CO4** Draw isometric projections and intersection of curves of simple solids.
- **CO5** Draw free hand sketching of basic geometrical shapes, multiple views of objects

TEXT BOOKS:

1. Natarajan, K. V., “A text book of Engineering Graphics”, 28th Ed., Dhanalakshmi Publishers, Chennai, 2015.
2. Venugopal, K. and Prabhu Raja, V., “Engineering Graphics”, New Age Publications, 2008.

REFERENCE BOOKS:

1. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015.
2. Bhatt, N.D.,Panchal V M and Pramod R. Ingle, “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2014.
3. Agrawal, B. and Agrawal C.M., “Engineering Drawing”, Tata McGraw, N.Delhi, 2008.

WEB REFERENCES:

1. https://nptel.ac.in/courses/105/104/105104148/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112/103/112103019/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	3	3							3	3	1	2	1
CO2	3	3	3							3	3	1	2	1
CO3	3	3	3							3	3	1	2	1
CO4	3	3	3							3	3	1	2	1
CO5	3	3	3							3	3	1	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23HS1101	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- To induce the basic reading and writing skills among the first year engineering and technology students.
- To assist the learners to develop their listening skills, which will enable them listening to lectures and comprehend them by asking questions and seeking clarifications
- To succor the learners to develop their speaking skills and speak fluently in real contexts.
- To motivate the learners to develop vocabulary of a general kind by developing their reading skills for meeting the competitive exams like GATE, TOFEL, GRE, IELTS, and other exams conducted by Central and State governments
- To learn to use basic grammatical structures in suitable contexts

UNIT - I INFORMAL COMMUNICATION 6

Listening: Listening and filling details, Listening to Speeches by Specialists and Completing Activities such as Answering Questions, Identifying the Main Ideas, Style, etc. **Speaking**: Introducing One-self — Introducing a Friend/ Family. **Reading**: Descriptive Passages (From Newspapers / Magazines).**Writing**: Autobiographical Writing, Developing Hints. **Grammar**: Noun, Pronoun & Adjective. **Vocabulary Development**: One Word Substitution

UNIT - II CONVERSATIONAL PRACTICE 6

Listening: Listening to Conversations (Asking for and Giving Directions).**Speaking**: Making Conversation Using (Asking for Directions, Making an Enquiry), Role Plays, and Dialogues. **Reading**: Reading a Print Interview and Answering Comprehension Questions. **Writing**: Writing a Checklist, Dialogue Writing **Grammar**: Tenses and Voices, Regular and Irregular Verbs. **Vocabulary Development**: Prefix &Suffix, Word formation.

UNIT - III OFFICIAL COMMUNICATIONS 6

Listening: Listening for specific information. Speaking: Giving Short Talks on a given Topic. **Reading**: Reading Motivational Essays on Famous Engineers and Technologists (Answering Open-Ended and Closed Questions).**Writing**: Writing Permission Letters/Editor, Complaint, and Invitation. Emails and Review Writing-Books, Films. **Grammar**: Adverb, Prepositions & Conjunctions. **Vocabulary Development**: Collocations — Fixed Expressions.

UNIT - IV COMMUNICATION AT WORK PLACE 6

Listening: Listening to Short Talks (5 Minutes Duration and Fill a Table, Gap-Filling Exercise) Note Taking/Note Making .**Speaking**: Small Group Discussion, Giving Recommendations. **Reading**: Reading Problem — Solution Articles/Essays Drawn From Various Sources .**Writing**: Making Recommendations. **Grammar**: Subject-Verb Agreement, Framing Questions. **Vocabulary Development**: Infinitives and Gerunds, Reference Words, Technical Vocabulary.

UNIT - V DEFINITIONS AND PRODUCT DESCRIPTION 6

Listening: Listening to a Product Description (Labelling and Gap Filling) Exercises. **Speaking**: Describing a Product and Comparing and Contrasting it with Other Products. **Reading**: Reading Graphical Material for Comparison (Advertisements).**Writing**: Essay Writing. Compare and Contrast Paragraphs, Essay writing. **Grammar**: Phrasal Verbs — Cause and Effect Sentences –Compound Nouns and Definitions. **Vocabulary Development:** Use of Discourse Markers.

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

- **CO1** Comprehend conversation and short talks delivered in English.
- **CO2** Participate effectively in informal conversation; introduce themselves and their friends and express opinions English.
- **CO3** Read articles of a general kind in magazines and newspaper
- **CO4** Write short essays of a general kind and personal letters and emails in English.
- **CO5** Gain understanding of basic grammatical structures and use them in right context.
- **CO6** Use appropriate words in a professional context.

TEXT BOOKS:

1. N P Sudharshana& C Savitha. English for Technical Communication Delhi: CUP, 2019.
2. Board of Editors. English for Engineers and Technologists Volume 1 Orient Black Swan Limited, 2020.

REFERENCE BOOKS:

1. Board of Editors. Using English-A course book for Undergraduate engineers and Technologists Orient Black Swan Limited, 2017.
2. Bailey, Stephen. Academic Writing: A Practical Guide for Students. New York: Rutledge, 2011.
3. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011.
4. Means, L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning, USA:2007.
5. Redston, Chris &Gillies Cunningham Face2Face (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005.

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1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabulary-exams/wordformation
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20180316 21.pdf
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.html.
4. https://www.edudose.com/english/grammar-degree-of-comparison-rules/

ONLINE COURSES / RESOURCES:

1. https://basicenglishspeaking.com/wh-questions/
2. https://agendaweb.org/verbs/modals-exercises.html
3. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/2018031621.pdf
4. https://www.ego4u.com/en/cram-up/grammar/prepositions

LANGUAGE SKILLS LAB
LIST OF EXPERIMENTS

1. Listen to lectures- articulate a complete idea as opposed to producing fragmented utterances- Tedtalks, Science Fiction- My Fair Lady
2. Listening – following, responding to explanations, giving directions and instructions in academic and business contexts- IELTS,TOEFL.
3. Listening to transcripts and answer to the questions.
4. Listening for specific information: accuracy and fluency – BEC.
5. Reading: Different Text Type.
6. Reading: Predicting Content using pictures and titles.
7. Reading: Use of Graphic Organizers to review.
8. Reading: Aid Comprehension.
9. Reading: Speed Reading Techniques.
10. Reading and Comprehending the passages in the competitive exams like GATE, TOEFL, GRE, IELTS, and other exams conducted by Central and state governments.

TOTAL: 30 PERIODS

REFERENCE BOOKS:

1. Suresh Kumar.E and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Blackswan: Hyderabad,2012
2. Davis, Jason and Rhonda Liss. Effective Academic Writing (level 3) Oxford University Press: Oxford,2006
3. Withrow, Jeans and et al. Inspired to write. Reading and Tasks to develop writing skills. Cambridge University Press: Cambridge,2004

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1								3	3		2	1	1	1
CO2								3	3		2	1	1	1
CO3								2	3		2	1	1	1
CO4								2	3		2	1	1	1
CO5								2	3		2	1	1	1
CO6								3	3		2	1	1	1

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

23PH1101	ENGINEERING PHYSICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- To impart knowledge in basic concepts of physics relevant to engineering applications
- To introduce advances in technology for engineering applications

UNIT - I PROPERTIES OF MATTERS 6

Elasticity: Stress, strain, Hooke's law and elastic moduli – stress-strain diagram – twisting couple per unit twist for solid cylinder – torsional pendulum (theory) – bending moment of beam – non-uniform and uniform bending (theory)– I-shape girder.

Thermal Physics: Mode of heat transfer: conduction, convection and radiation – thermal expansion of solids – bimetallic strips – thermal conductivity – Forbe's method and Lee's disc method; theory and experiment – thermal insulation – applications

UNIT - II SEMINCONDUCTING AND MAGNETIC MATERIALS 6

Semiconducting Materials: Intrinsic Semiconductors – energy band diagram – carrier concentration in intrinsic semiconductors – extrinsic semiconductors (N-type & P-type) – variation of carrier concentration with temperature — variation of Fermi level with temperature and impurity concentration –Zener and avalanche breakdown in p-n junctions – Ohmic contacts – Schottky diode – tunnel diode.

Magnetic Materials: Magnetism in materials — Basic definitions — Classifications of Magnetic Materials- Ferromagnetic Domain theory – M versus H ehavior- Hard and Soft Magnetic materials- Magnetic principle in Computer data storage – Magnetic Hard Disc and Embedded systems.

UNIT - III MODERN OPTICS 6

Laser: Population of energy levels, Einstein's A and B coefficients derivation — optical

amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction– **Fiber Optics**: components and principle of fiber optics — numerical aperture and acceptance angle derivation — types of optical fibers (material, refractive index, mode) — losses associated with optical fibers– fiber as pressure and displacement sensors.

UNIT - IV QUANTUM PHYSICS AND NANOSCIENCE 6

Quantum Physics: Blackbody radiation — Planck's hypothesis and derivation — wave particle duality of light: concepts of photon — de Broglie hypotheses — concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations.

Nanoscience: Introduction – Classification of nanomaterials – preparation (bottom up and top down approaches), mechanical, optical and electrical properties – applications: NEMS and MEMS– carbon nanotubes: types.

UNIT - V **ELECTROMAGNETIC WAVES** **6**

Divergence — curl — integral calculus — Gauss divergence theorem — Stoke's theorem — equation of continuity — displacement current — Maxwell's equations — Gauss's laws — Faraday's law –Ampere-Maxwell law – mechanism of electromagnetic wave propagation – Hertz observation – production and detection of electromagnetic wave – properties of electromagnetic waves.

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS

1. Determination of Moment of Inertia of the disc and Rigidity Modulus of the material of the wire — Torsional Pendulum
2. Determination of Young's Modulus – Non - Uniform Bending
3. Determination of Thermal Conductivity of the Bad Conductor – Lee's Disc Method
4. Determination of thickness of a thin wire – Air wedge method
5. (i) Determination of wavelength of Laser using Grating and Particle size determination
   (ii) Determination of Numerical Aperture and Acceptance angle of an Optical Fibre
6. Determination of Velocity of ultrasonic waves in a liquid and compressibility of the liquid — Ultrasonic Interferometer.
7. Determination of wavelength of Hg source using Grating by normal incidence method using spectrometer
8. Determine the band gap energy of a semiconductor.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Ajoy Ghatak, Optics, 5th Ed., Tata McGraw Hill, 2012.
2. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, Concepts of Modern Physics, 6th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2014.
3. B. K. Pandey and S. Chaturvedi, Engineering Physics, 1st edition, Cengage Learning India Pvt Ltd., New Delhi, 2017.
4. Karl F. Renk, Basics of laser physics: for students of science and engineering, 2017.

REFERENCE BOOKS:

1. Halliday, D., Resnick, R. & Walker, J.-Principles of Physics, Wiley, 2015.
2. Tipler, P.A. &Mosca, G.- Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.
3. Ruby Das, C.S. Robinson, Rajesh Kumar, Prashant Kumar Sahu, A Textbook of Engineering Physics Practical, University Science Press, Delhi, II Edition (2016).

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Understand the basics properties of materials, especially elastic and thermal properties of materials.

CO2 Acquire the knowledge on the concepts of lasers, fiber optics and their technological applications.

CO3 Adequate knowledge on the concepts of semiconducting and magnetic materials and their applications in memory storage.

CO4 Knowledge on fundamental concepts of quantum theory, nanoscience its applications

CO5 Gain knowledge on the basics of electromagnetic waves and its properties.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	3	2	1	1	1						2	2	2
CO2	3	3	2	1	2	1						2	2	2
CO3	3	3	2	2	2	1					1	2	2	2
CO4	3	3	1	1	2	1						2	2	2
CO5	3	3	1	1	2	1						2	2	2
CO6	3	3	2	1	1	1						2	2	2

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

23ES1111	PROBLEM SOLVING USING C PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To write, test, and debug simple C programs.
- To implement C programs with conditional and looping statement
- To develop applications in C using strings, pointers, functions.
- To implement C programs with structures and union.
- To develop applications in C using file processing
- To develop an application in real time situation

LIST OF EXPERIMENTS

1. Programs using I/O statements and expressions.
2. Programs using decision-making constructs.
3. Write a program to find whether the given year is leap year or Not? (Hint: not every centurion year is a leap. For example 1700, 1800 and 1900 is not a leap year)
4. Design a calculator to perform the operations, namely, addition, subtraction, multiplication, division and square of a number.
5. Check whether a given number is Armstrong number or not?
6. Given a set of numbers like <10, 36, 54, 89, 12, 27>, find sum of weights based on the following conditions
   a) if it is a perfect cube
   b) if it is a multiple of 4 and divisible by 6
   c) if it is a prime number
   d) Sort the numbers based on the weight in the increasing order as shown below <10,its weight>,<36,its weight><89,its weight>
7. Populate an array with height of persons and find how many persons are above the average height.
8. Given a string —a$bcd./fgǁ find its reverse without changing the position of special characters. (Example input:a@gh%;j and output:j@hg%;a)
9. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
10. From a given paragraph perform the following using built-in functions:
    a) Find the total number of words.
    b) Capitalize the first word of each sentence.
    c) Replace a given word with another word.
11. a) Sort the list of numbers using Selection sort and insertion sort
    b) Sort the list of numbers using pass by reference.
12. a) Search an element from an unsorted array using linear search
    b) Search an element in an array using Binary search recursion call.
13. Generate salary slip of employees using structures and pointers.

14. a) Programs using Pointers
    b) Pointer demonstration the use of & and *
    c) Access Elements of an Array Using Pointer
    d) Perform the string operations like Length of the String , Concatenation of string and compare the string using Pointer
    e) Count number of words, digits, vowels using pointers
    f) Add two matrices using Multidimensional Arrays with pointers
    g) Multiply two matrices using pointers
    h) Multiply two numbers using Function Pointers
15. Compute internal marks of students for five different subjects using structures and functions.
16. Program to demonstrate the difference between unions and structures
17. Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.
18. Count the number of account holders whose balance is less than the minimum balance using sequential access file.
19. **MINI PROJECT**

    Create a ―Railway reservation system‖ with the following modules
    a) Booking
    b) Availability checking
    c) Cancellation
    d) Prepare chart

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Write, test, and debug simple C programs.

CO2 Implement C programs with conditionals and loops.

CO3 Develop C programs for simple applications making use arrays and strings.

CO4 Develop C programs involving functions, recursion, pointers, and structures and union.

CO5 Design applications using sequential and random access file processing.

CO6 Perform task as an individual and / or team member to manage the task in time

WEB REFERENCES:

1. https://www.programiz.com/c-programming/examples
2. https://beginnersbook.com/2015/02/simple-c-programs/
3. https://www.programmingsimplified.com/c-program-examples
4. https://www.tutorialgateway.org/c-programming-examples/
5. https://www.javatpoint.com/c-programs
6. https://www.tutorialspoint.com/learn_c_by_examples/simple_programs_in_c.html

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	3	3	2								1	2	2
CO2	3	2	2	1	3							1	2	2
CO3	3	3	3	2	3							1	2	2
CO4	3	2	2	1	3							1	2	2
CO5	3	3	3	2	3							1	2	2
CO6	3	2	2	1	3							1	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23TA1101	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT - I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages –Tamilas 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.

UNIT - II HERITAGE-ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

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.

UNIT - III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance- Sports and Games of Tamils.

UNIT - IV THINAI CONCEPT OF TAMILS 3

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.

UNIT - V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

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

TOTAL: 15 PERIODS

23TA1101	தமிழர் மரபு	L	T	P	C
		1	0	0	1

UNIT – I **மொழி மற்றும் இலக்கியம்** **3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமய சார்பற்ற 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.

UNIT – II **மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை** **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக்கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

UNIT – III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்** **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

UNIT –IV **தமிழர்களின் திணைக் கோட்பாடுகள்** **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

UNIT –V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு** **3**

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Total : 15 PERIODS

TEXT-CUM REFERENCE BOOKS:

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர். இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை)
5. Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published 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: InternationalInstitute of Tamil Studies
7. Historical 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 C ivilization 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

SEMESTER II

23MA1201	COMPLEX VARIABLES AND LAPLACE TRANSFORM	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To solve the linear differential equations with constant coefficients.
- To help the engineering students with vectors as it gives the insight into how to trace along the different types of curves.
- To develop an understanding of the standard technique of a complex variable theory in particular of analytics functions and its mapping property.
- To study complex variable techniques used in a wide areas of engineering.
- To learn Laplace Transform to solve the problems in engineering and technology.

UNIT - I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Higher order linear differential equations with constant coefficients -Method of variation of parameters — Homogenous equation of Euler's and Legendre's type — System of simultaneous first order linear differential equations with constant coefficients.

UNIT - II VECTOR CALCULUS 9+3

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration: Green's theorem in a plane - Gauss divergence and Stokes' theorem (excluding proofs) — Simple applications involving cubes, rectangular parallelepiped, sphere and cylinder**.**

UNIT - III ANALYTIC FUNCTIONS 9+3

Functions of a complex variable–Analytic functions -Cauchy-Riemann equations — Necessaryandsufficientconditions–Harmonicandorthogonalpropertiesofanalytic function – Harmonic conjugate — Construction of analytic functions by Milne Thomson method– Conformal mapping: w =z+c,cz,1/z and bilinear transformation.

UNIT - IV COMPLEX INTEGRATION 9+3

Line integrals- Cauchy's integral theorem-Cauchy's integral formula - Singularities — Residues– Cauchy's residue theorem - Taylor's and Laurent's series expansions — Application of residue theorem for evaluation of real definite integrals — Use of circular contour and semi- circular contour (excluding poles on the real axis).

UNIT - V LAPLACE TRANSFORM 9+3

Laplace transform: Sufficient conditions for existence – Transform of elementary functions –Basic properties–Transforms of derivatives and integrals of functions-Derivatives and integrals of transforms - Transforms of unit function, unit step function and UNIT - Impulse functions — Transforms of periodic functions– Initial and final value theorems. Inverse Laplace transforms: Convolution theorem–Solution of linear ODE of second order with constant coefficients using the techniques of Laplace transformation.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Apply various techniques in solving differential equations.

CO2 Identify the gradient, divergence and curl of a vector point function and related identities. Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.

CO3 Understand the concepts of analytic functions, harmonic functions and conformal mapping.

CO4 Determine the types of singularities, residues and contour integration.

CO5 Solve differential equations using Laplace transform.

TEXT BOOKS:

1. Grewal B.S.,- "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition,2018.
2. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill Education, India.
3. Bali N., Goyal M. and Walkins C., "Advanced Engineering Mathematics", Firewall.

REFERENCE BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John wiley and Sons, 10th Edition, New Delhi.
2. Sastry, S.S, "Engineering Mathematics", Vol.I& II, PHI LearnigPvt. Ltd, 4th Edition, New Delhi, 2014.
3. Wyile, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt Ltd, 6thEdition, New Delhi, 2012.
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
5. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt. Ltd, New Delhi, 2007.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ma69
2. https://onlinecourses.nptel.ac.in/noc21_ma57

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	3	3								1	2	2	2
CO2	3	3	3								1	2	2	2
CO3	3	3	3								1	2	2	2
CO4	3	3	3								1	2	2	2
CO5	3	3	3								1	2	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1201	ELECTRONIC DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the working of PN junction diode.
- To study the basic working of BJT.
- To gain knowledge on FET.
- To acquaint the knowledge on special semiconductor and power devices.
- To know the operation of optical devices.

UNIT - I SEMICONDUCTOR DIODE 9

PN junction behavior, PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitance, Switching Characteristics, Breakdown in PN Junction Diodes, Half wave and Full Wave Rectifier, Voltage Regulator, Characteristics of PN diode using simulation tool.

UNIT - II BIPOLAR JUNCTION TRANSISTORS 9

NPN -PNP - Operations-Early effect -Current equations — Input and Output characteristics of CE, CB, CC - h-parameter model, Ebers Moll Model, Multi Emitter Transistor. Case studies, Characteristics of BJT using simulation tool.

UNIT - III FIELD EFFECT TRANSISTORS 9

JFETs — Drain and Transfer characteristics, -Current equations -Pinch off voltage and its significance- MOSFET- Characteristics- Threshold voltage -Channel length modulation, D- MOSFET, E- MOSFET- Characteristics – Comparison of MOSFET with JFET. Characteristics of JFET and MOSFET using simulation tool.

UNIT - IV SPECIAL SEMICONDUCTOR DEVICES AND POWER DEVICES 9

Semiconductor Devices: Metal-Semiconductor Junction- MESFET, DUAL GATE MOSFET, Zener diode-Varactor diode - Gallium Arsenide device, LDR.
Power Devices: UJT, SCR, Diac, Triac, Power BJT.
Characteristics of Zener diode, UJT, and SCR using simulation tool.

UNIT - V OPTICAL DEVICES 9

Optical absorption, solar cells, Photodetector, Photoluminescence, electroluminescence, Photo transistor, Opto- Coupler, LCD, CCD.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Illustrate the V − I characteristics of semiconductor diode.
CO2 Interpret the configurations of BJT and understand its equivalence circuits.
CO3 Infer the drain – transfer characteristics of FET.
CO4 Outline the concepts of special semiconductor devices and power devices.
CO5 Summarize the operation of optical devices.

TEXT BOOKS:

1. Donald A Neaman, —Semiconductor Physics and Devicesǁ, Fourth Edition, Tata Mc Graw Hill Inc. 2012.
2. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, —Electronic Devices and circuits, Third Edition, Tata McGraw- Hill, 2008.

REFERENCE BOOKS:

1. Robert Boylestad and Louis Nashelsky, —Electron Devices and Circuit Theory Pearson Prentice Hall, 10th edition, July 2008.
2. R.S.Sedha, — A Text Book of Applied Electronics Chand Publications, 2006.
3. Yang, —Fundamentals of Semiconductor devices, McGraw Hill International Edition.

WEB REFERENCES:

1. https://www.digimat.in/nptel/courses/video/108101091/L01.html

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	1	1	3	3						1	3	1	1
CO2	3	1	2	3	3						1	3	2	1
CO3	3	1	1	3	3						1	3	1	1
CO4	3	1	1	3	3						1	3	1	1
CO5	3	1	1	3	3						1	3	2	1
CO6	3	1	1	3	3						1	3	1	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ES1201	PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To know the basic programming constructs and control structures in python
- To use python data structures – Lists, Tuples and Dictionary
- To define Python functions and use Strings
- To learn about input/output with files in Python.
- To understand python packages and GUI concepts

UNIT - I INTRODUCTION TO PYTHON PROGRAMMING AND CONTROL STRUCTURES 9

Introduction to Python, Demo of Interactive and script mode, Tokens in Python — Variables, Keywords, Comments, Literals, Data types, Indentation, Operators and its precedence, Expressions, Input and Print functions, Type Casting. Illustrative problems: find minimum in a list, guess an integer number in a range, Towers of Hanoi.

Control Structures: Selective statements — if, if-else, nested if, if — elif ladder statements ; Iterative statements - while, for, range functions, nested loops, else in loops, break, continue and pass statements. Illustrative programs: exchange the values of two variables,circulate the values of n variables, distance between two points.

UNIT - II FUNCTIONS AND STRINGS 9

Functions: Types, parameters, arguments: positional arguments, keyword arguments, parameters with default values, functions with arbitrary arguments, Scope of variables: Local and global scope, Recursion and Lambda functions.Illustrative programs:power of a number,sorting,Fibonacci series using lambda.

Strings: Formatting, Comparison, Slicing, Splitting, Stripping, Negative indices, String functions, Regular expression: Matching the patterns, Search and replace. Illustrative programs:check whether the string is symmetrical,reverse a string,length of a string.

UNIT - III COLLECTIONS 9

List: Create, Access, Slicing, Negative Indices, List Methods, and comprehensions

Tuples: Create, Indexing and Slicing, Operations on tuples.

Dictionary: Create, add, and replace values, operations on dictionaries.

Sets: Create and operations on set.

Illustrative programs: Interchange first and last element in a list,maximum and minimum N elements in a tuple, sort dictionary by key or value, size of a set.

UNIT - IV FILES AND EXCEPTION HANDLING 9

Files: Open, Read, Write, Append and Close. Tell and seek methods. Illustrative programs: word count, copy file. Command line arguments, Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, Exception Chaining, User-defined Exceptions, Defining Clean-Up actions. Illustrative programs: prompt the user to input an integer and raises a ValueError exception if the input is not a valid integer, open a file and handles a FileNotFoundError exception if the file does not exist, prompt the user to input two numbers and raises a TypeError exception if the inputs are not numerical, executes an operation on a list and handles an IndexError exception if the index is out of range.

UNIT - V **PACKAGES & GUI** **9**

Python packages: Simple programs using the built-in functions of packages matplotlib, numpy, pandas etc. Illustrative programs:create a pandas series using numpy, make a pandas dataframe with 2D list.

GUI Programming: Tkinter introduction, Tkinter and Python Programming, Tk Widgets, Tkinter examples. Python programming with IDE. Illustrative programs: create a GUI mark sheet, calendar, file explorer using Tkinter.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

- **CO1** Develop and execute simple Python programs using conditionals and loops for solving problems.
- **CO2** Express proficiency in the handling of strings and functions
- **CO3** Represent compound data using Python lists, tuples, dictionaries, sets, etc.,
- **CO4** Read and write data from/to files and handle exceptions in Python programs
- **CO5** Implement python packages in data analysis and design GUI
- **CO6** Examine various problem solving concepts in python to develop real time applications.

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. ReemaThareja,”Problem Solving and Programming with Python’’, 2nd edition, Oxford University Press, New Delhi, 2019.
3. Alan D. Moore, Python GUI Programming with Tkinter, Design and Build Functional and User-friendly GUI Applications, Packt Publishing, 2021.

REFERENCE BOOKS:

1. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
2. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018
3. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.

ONLINE COURSES / RESOURCES:

1. https://docs.python.org/3/tutorial/
2. https://www.w3schools.com/python/
3. https://www.tutorialspoint.com/python/index.htm
4. https://www.javatpoint.com/python-tutorial
5. https://nptel.ac.in/courses/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	2	3	3	1	2						1	2	2	2
CO2	2	3	3	1	2						1	2	2	2
CO3	2	3	3	1	2						1	2	2	2
CO4	2	3	3	1	2						1	2	2	2
CO5	2	3	3	1	2						1	2	2	2
CO6	2	3	3	1	2						1	2	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23HS1201	COMMUNICATIVE AND APTITUDE SKILLS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- To develop linguistic and strategic competence in workplace context and to enhance language proficiency and thereby the employability of budding engineers and technologists.
- To improve the relevant language skills necessary for professional communication.
- To help learners to develop their listening skills, which will, enable them to listen to lectures and comprehend them by asking questions; seeking clarification and developing their speaking skills and to speak fluently in real contexts.
- To improve the verbal ability skill and communicative skill of the students.
- To enhance the analytical and problem solving skills of the students.
- To prepare them for various public and private sector exams & placement drives.

UNIT - I INTERPERSONAL COMMUNICATION 6

Listening: Listening to Telephone Etiquettes and Conversations. **Speaking**: Role Play Exercises Based on Workplace Contexts, Introducing Oneself - PEP Talks. **Reading**: Reading the Interview of an Achiever and Completing Exercises (Skimming, Scanning and Predicting). **Writing**: Writing a Short Biography of an Achiever Based on Given Hints, **Grammar**: Comparative Adjective, Numerical Expressions and Sentence pattern. **Vocabulary Development**: Idioms and Phrases

UNIT - II TECHNICAL COMMUNICATION 6

Listening: Listening to Talks/Lectures Both General and Technical and Summarizing the Main Points. **Speaking**: Participating in Debates, TED Talks. **Reading**: Reading Technical Essays/ Articles and Answering Comprehension Questions. **Writing**: Summary Writing, Minutes of the meeting. **Grammar**: Prepositional Phrases and Relative Clauses. **Vocabulary Development:** Abbreviations and Acronyms.

UNIT - III PROCESS DESCRIPTION 6

Listening: Listening to a Process Description and Drawing a Flowchart. **Speaking**: Participating in Group Discussions, Giving Instructions, Presentation. **Reading**: Reading Instruction Manuals **Writing**: Process Descriptions — Writing Instructions **Grammar**: Use of Imperatives, Tenses, Impersonal Passive Voice and Phrasal verbs **Vocabulary Development**: Misspelt words. Homophones and Homonyms.

UNIT - IV REPORT WRITING 6

Listening: Listening to a Presentation and Completing Gap-Filling Exercises. **Speaking**: Making Formal Presentations, **Reading**: Reading and Interpreting Charts/Tables and diagrams. **Writing**: Interpreting Charts/Tables and Diagrams, Writing a Report. **Grammar**: Reported Speech; Interrogatives- Question Tags and Articles — omission of articles **Vocabulary Development**: Technical Jargon

UNIT - V **INTERVIEW SKILLS** **6**

Listening: Listening to a Job Interview and Completing Gap-Filling Exercises **Speaking**: Mock Interview, Telephone Interviews & Etiquette, and Group Discussion .**Reading:** Reading a Job Interview, SOP, Company Profile and Completing Comprehension Exercises **Writing**: Job Applications and Resume. **Grammar**: Conditional Clauses, Modal verbs **Vocabulary Development:** Technical Vocabulary, Purpose Statement. **Aptitude Skills: Ratio and Proportion —** Ratio, Proportion, Simple equations, Problems on Ages. **Percentages** - Percentages increase/decrease, Simple and Compound interest. **Number system -** Factors, Multiples - HCF and LCM. **Permutation** - Combination and Probability

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Board of Editors. English for Engineers and Technologists Volume 2 Orient Black Swan Limited, 2020
2. Richards, C. Jack. Interchange, New Delhi: CUP, 2017
3. Aggarwal R.S, Quantitative Aptitude for Competitive Examinations 3rd (Ed.) New Delhi: S.Chand Publishing, 2017.

REFERENCE BOOKS:

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi, 2014.
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007.
3. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007.
4. Sharma Arun, Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd., 2016.

WEB REFERENCES:

1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabularyexams/word-formation.
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018.
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.html.
4. https://www.edudose.com/english/grammar-degree-of-comparison-rules/
5. https://www.math-only-math.com/practice-test-on-ratio-and-proportion.html
6. https://www.hitbullseye.com/Simple-Interest-and-Compound-Interest.php

ONLINE COURSES / RESOURCES:

1. https://basicenglishspeaking.com/wh-questions/
2. https://agendaweb.org/verbs/modals-exercises.html
3. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/2018031621.pdf
4. https://www.ego4u.com/en/cram-up/grammar/prepositions
5. https://www.classcentral.com/course/quantitative-methods-4340
6. https://www.classcentral.com/subject/qualitative-research

LIST OF EXPERIMENTS

1. Speaking- sharing personal information- self introduction
2. Speaking- Group Discussion, Small talk or Peb Talk
3. Speaking- Presentation- Formal and Informal
4. Speaking- Mock Interview
5. Speaking- FAQ's on Job Interview
6. Speaking – JAM
7. Speaking- Debate and Story Narration
8. Writing: Error Detection- Spotting and reasoning the errors from the passages in competitive exams.
9. Writing: Letter of recommendation
10. Writing: Elements of a good essay
11. Writing: Types of essays. Descriptive – Narrative-Issue based.

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Recognise the need for life skills; apply them to different situations, the basic communication practices in different types of communication.

CO2 Gain confidence to communicate effectively in various situations to acquire employability skills.

CO3 Develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others.

CO4 Communicate effectively & appropriately in real life situation and enhance student's problem solving skill.

CO5 Prepare for various public and private sector exams & placement drives.

CO6 Enhance students' problem solving skills.

REFERENCE BOOKS:

1. Kumar, Suresh. E., Engineering English, Orient lackswan:Hyderabad,2015.
2. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi, 2014.
3. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007.
4. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007.
5. Sharma Arun, Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.,2016.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1								3	3		2			
CO2								3	3		2			
CO3								2	3		2			
CO4								2	3		2			
CO5								2	3		2			
CO6								3			3			

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

23ES1204	BASIC ELECTRICAL CIRCUITS AND ENGINEERING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

- To learn the basic concepts and behaviour of DC and AC circuits.
- To understand various methods of circuit/ network analysis using network theorems.
- To impart knowledge in types, construction and working of Electrical machines
- To introduce the functional elements and working of measuring instruments
- To understand the concepts of Solar PV system &Hybrid Electric Vehicle.

UNIT - I BASIC CIRCUITS ANALYSIS 9

Basic Components of electric Circuits, Ohms Law, Kirchoff's Law, Resistors in Series and Parallel, Voltage and current division, Nodal analysis, Mesh analysis.

UNIT - II NETWORK THEOREMS AND TWO PORT NETWORK 9

Thevenin's and Norton's Theorems – Superposition Theorem – Maximum power transfer theorem – Two port Parameter: Z,Y and h parameters

UNIT - III ELECTRICAL MACHINES 9

Principles and operation, characteristics of DC Motors, DC Generators, Single Phase Transformer, single phase induction Motor.

UNIT - IV MEASUREMENTS & INSTRUMENTATION 9

Functional elements of an instrument, Standards and calibration, Operating Principle , types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT,DSO- Block diagram- Data acquisition

UNIT - V SOLAR PV SYSTEM AND ELECTRIC VEHICLE 9

Solar PV system- Introduction-Comparison with Electrical and Hybrid Electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs- Solar and Battery powered Electric Vehicle

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis",McGraw Hill education, 9th Edition, 2018.
2. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
4. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & 49 Instrumentation', DhanpatRai and Co, New Delhi, 2015

REFERENCE BOOKS:

1. Kothari DP and I.J Nagrath, “Basic Electrical Engineering”, Fourth Edition, McGraw Hill Education, 2019.
2. Joseph Edminister and MahmoodNahvi, —Electric Circuits, Schaum‘s Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016
3. Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, John Wiley & Sons, Inc. 2015.
4. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
5. Chakrabarti A, “Circuits Theory (Analysis and synthesis), Dhanpath Rai& Sons, New Delhi, 1999.

WEB REFERENCES:

1. https://www.electrical4u.com/electrical-engineering-articles/basic-electrical/
2. https://library.automationdirect.com/basic-electrical-theory/

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee90/preview
2. https://onlinecourses.nptel.ac.in/noc22_ee53/preview

LIST OF EXPERIMENTS

1. **Electrical House Wiring:**
   (i)Residential house wiring using switches, fuse, indicator, lamp and energy meter.
   (ii)Fluorescent lamp wiring.
   (iii)Stair case wiring
   (iv)Study of Home Appliances- wiring and assembly
   (v)Study of Protective Devices
2. Measurement of electrical quantities – voltage, current, power, &power factor in RLC circuit.
3. (i)Study of Electronic components and equipment’s – Resistor color coding
   (ii)Soldering practice – Components Devices and Circuits –Using general purpose PCB.
4. Experimental verification of Kirchhoff’s current and voltage law
5. Simulation and Experimental verification of Thevenin’s and Norton's theorem
6. Simulation and Experimental verification of Superposition theorem
7. PCB design using Suitable Software.

SOFTWARE REQUIRED: MATLAB, Fusion 360

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Apply the basic concepts of circuit analysis such as Kirchoff's laws, mesh current and node voltage method for analysis of DC and AC circuits.

CO2 Apply network theorems to analyse AC and DC circuits

CO3 Explain the Construction and working of DC machines.

CO4 Understand the construction and working principle of Ac Machines

CO5 Explain the types and operating principles of measuring instruments

CO6 Illustrate the concepts related in the solar PV system and Hybrid Electric Vehicles

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	1						3	3	1	1
CO2	3	3	3	2	1						3	3	2	1
CO3	3	3	2	2	1						1	3	1	1
CO4	3	3	2	2	1						1	3	1	1
CO5	3	2	3	2	1						1	3	2	1
CO6	3	2	2	2	1						2	3	1	1

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

23EC1211	CIRCUITS AND DEVICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To study the characteristics of basic electronic devices and rectifiers.
- To explain the characteristics of CE and CB.
- To analyse SCR and UJT characterstics.
- To examine transistor as switch.
- To inspect the characteristics of LDR, Photo Diode and Photo Transistor.
- To demonstrate the characteristics of TRIAC and DIAC

LIST OF EXPERIMENTS

1. Characteristics of PN Junction Diode
2. Characteristics of rectifiers and voltage regulators.
3. Characteristics of Zener diode & Zener diode Load Regulation
4. Common Emitter input-output Characteristics
5. Common Base input-output Characteristics
6. FET Characteristics
7. SCR Characteristics
8. Observe Transistor as an Electronic Switch
9. V-I Characteristics of UJT
10. Characteristics of LDR, Photo Diode and Photo Transistor
11. Characteristics of TRIAC and DIAC
12. Characteristics of LED

Demonstration: Characteristics of semiconductor devices like PN diode, Zener diode, BJT, FET, and SCR using a simulation tool.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Understand the characteristics of basic electronic devices and rectifiers.

CO2 Demonstrate the characteristics of CE and CB.

CO3 Analyse SCR and UJT characterstics.

CO4 Design transistor as switch.

CO5 Inspect the characteristics of LDR, Photo Diode and Photo Transistor.

CO6 Demonstrate the characteristics of TRIAC and DIAC

REFERENCE BOOKS:

1. H. Hayt, Jr. Jack E. Kemmerly and steven M. Durbin, “Engineering Circuit Analysis”, McGraw Hill Science Engineering, Eighth Edition, 11th Reprint ,2016.
2. Donald A Neaman, “Semiconductor Physics and Devices”, Tata McGrawHill Inc. 2012.
3. Robert Boylestad and Louis Nashelsky, -Electron Devices and Circuit Theory Pearson prentice Hall,10th edition, July 2008.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2							3	1	1
CO2	3	2	1	2	2							3	2	1
CO3	3	2	1	2	2							3	1	1
CO4	3	2	1	2	2							3	1	1
CO5	3	2	1	2	2							3	2	1
CO6	3	2	1	2	2							3	1	1

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23ES1211	PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To write, test, and debug simple Python programs
- To implement Python programs with conditions and loops
- To use functions for structuring Python programs.
- To represent compound data using Python lists, tuples, dictionaries.
- To learn to implement string functions and file operations
- To understand python packages and GUI development.

LIST OF EXPERIMENTS

1. Basic Python Programs
2. Write programs to demonstrate different number data types in python
3. Develop python programs to demonstrate various conditional statements
4. Implement user defined functions using python
5. Develop python scripts to demonstrate built-in functions
6. Develop python programs to perform various string operations like slicing, indexing & formatting
7. Develop python programs to perform operations on List & Tuple
8. Demonstrate the concept of Dictionary with python programs
9. Develop python programs to perform operations on Sets.
10. Develop python codes to perform matrix addition, subtraction and transpose of the given matrix
11. Develop python codes to demonstrate the concept of function composition and anonymous functions.
12. Demonstrate python codes to print try, except and finally block statements
13. Implement python programs to perform file operations
14. Write a python code to raise and handle various built in exceptions.
15. Implement python programs using packages numpy and pandas
16. UI development using tkinter

Mini Project :Suggested Topics(but not limited to)

- Dice roll simulator
- Guess the number game
- Random password generator

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Develop and execute simple Python programs

CO2 Implement programs in Python using conditionals and loops for solving problems.

CO3 Deploy functions to decompose a Python program.

CO4 Develop programs using string operations.

CO5 Utilize Python packages in data analysis

CO6 Create GUI for python applications

WEB REFERENCES:

1. https://www.programiz.com/python-programming/examples
2. https://www.geeksforgeeks.org/python-programming-examples/
3. https://beginnersbook.com/2018/02/python-programs/
4. https://www.javatpoint.com/python-programs
5. https://www.w3schools.com/python/python_examples.asp

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	1	2						1	2	2	2
CO2	2	3	3	1	2						1	2	2	2
CO3	2	3	3	1	2						1	2	2	2
CO4	2	3	3	1	2						1	2	2	2
CO5	2	3	3	1	2						1	2	2	2
CO6	2	3	3	1	2						1	2	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23ES1212	TECHNICAL SKILL PRACTICES I	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To impart essential problem solving skills through general problem solving concepts.
- To provide basic knowledge on programming essentials using C as implementation tool.
- To introduce various programming methods using C.

LIST OF EXPERIMENTS

1. Data Types, Variables, Operators
2. Expressions, Precedence , Operators
3. Conditional Statements , Switch Statements
4. Looping, Nested Loops
5. Problems on Bit Manipulation
6. Patterns
7. Number Problems
8. Array Basics , Static vs Dynamic Array, Two Dimensional Matrix
9. Structure , Union ,Storage Classes
10. Function , Parameters passing
11. Recursion
12. Strings
13. Pointers
14. Command Line Arguments, Pre-processors
15. File Handling & Exception Handling.

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Propose solutions for a given problem.

CO2 Infer the fundamental programming elements in C language and learn to apply basic control structures in C.

CO3 Demonstrate the applications of structures and unions.

CO4 Visualize the capabilities of modular programming approach in C.

CO5 Understand the basic principles of pointers and their association during implementations.

CO6 Apply various input, output and error handling functions in C.

TEXT BOOKS:

1. ReemaThareja, ``Programming in C"", 2nd edition, OXFORD University Press, New Delhi, 2019.
2. Paul Deitel and Harvey Deitel, “C How to Program”, Seventh edition, Pearson Publication,2016.

REFERENCE BOOKS:

1. Stephen G. Kochan, “Programming in C”, 3rd edition, Pearson Education,2014.
2. Herbert Schildt, “C: The Complete Reference”, Fourth Edition, McGraw Hill, 2000.

ONLINE COURSES / RESOURCES:

1. https://www.javatpoint.com/c-programming-language-tutorial
2. https://www.tutorialspoint.com/cprogramming/
3. https://nptel.ac.in/Courses/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3						3	1	2	2
CO2	3	3	3	3	3						3	1	2	2
CO3	3	3	3	3	3						3	1	2	2
CO4	3	3	3	3	3						3	1	2	2
CO5	3	3	3	3	3						3	1	2	2
CO6	3	3	3	3	3						3	1	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23TA1201	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT - I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age — Ceramic technology –Black and Red Ware Potteries (BRW) –Graffiti on Potteries.

UNIT - II DESIGN AND CONSTRUCTION TECHNOLOGY 3

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.

UNIT - III MANUFACTURING TECHNOLOGY 3

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 - Archaeological evidences - Gem stone types described in Silappathikaram.

UNIT - IV AGRICULTUREAND IRRIGATION TECHNOLOGY 3

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.

UNIT - V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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.

TOTAL: 15 PERIODS

24TA1201	தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

UNIT – I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்** **3**

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

UNIT – II **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்** **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமானப் 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 - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசோனிக் கட்டிடக் கலை.

UNIT – III **உற்பத்தி தொழில்நுட்பம்** **3**

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

UNIT –IV **வேளாண்மை மற்றும் நீர்பாசனத் தொழில்நுட்பம்** **3**

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

UNIT –V **அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்** **3**

அறிவியல் தமிழின் வளர்ச்சி - கணினித்தமிழ் - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக் கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

Total : 15 PERIODS

TEXT-CUM REFERENCE BOOKS:

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை)
5. Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published 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: InternationalInstitute of Tamil Studies
7. Historical 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 C ivilization 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

SEMESTER III

23MA1302	LINEAR ALGEBRA AND NUMERICAL ANALYSIS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To understand the concepts of vector space and Sub space.
- To understand the concepts of linear Transformations and diagonalization.
- To apply the concept of inner product spaces in orthogonalization.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.

UNIT - I VECTOR SPACES 9+3

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions.

UNIT - II LINEAR TRANSFORMATION AND DIAGONALIZATION 9+3

Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformation — Eigen values and eigenvectors — Diagonalizability.

UNIT - III INNER PRODUCT SPACES 9+3

Inner product, norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.

UNIT - IV SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations: Fixed point theorem (without proof)– Newton Raphson method - Solution of linear system of equations : Gauss elimination and Gauss Jordan method - Iterative methods of Gauss Jacobi and Gauss Seidel method — Eigen values of a matrix by Power method.

UNIT - V INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals: Lagrange's interpolation – Newton’s divided difference interpolation - Interpolation with equal intervals: Newton’s forward and backward difference formulae- Numerical Differentiation using interpolation formulae.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Understand the concepts of vector space.

CO2 Demonstrate the matrix techniques in solving the linear transformations.

CO3 Construct orthonormal basis by the concepts of normalization.

CO4 Apply the concept of inner product spaces in orthogonalization.

CO5 Understand the basic concepts and techniques of solving algebraic and transcendental equations.

CO6 Apply the numerical techniques of interpolation and approximations in various intervals in real life situations.

TEXT BOOKS:

1. Friedberg, A.H., Insel, A.J. and Spence, L., —Linear Algebra, Prentice Hall of India, New Delhi, 2015.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers,10th Edition, New Delhi, 2015.
3. Kumaresan, S., —Linear Algebra – A Geometric Approach, Prentice – Hall of India, New Delhi, Reprint, 2010.
4. Kandasamy, P., Thilagavathy, K.,andGunavathy,S., 'Numerical Methods', Chand and Co.,2016.

REFERENCE BOOKS:

1. Kolman, B. Hill, D.R., —Introductory Linear Algebrall, Pearson Education, New Delhi,First Reprint, 2013.
2. Lay, D.C., —Linear Algebra and its Applicationsll, 5th Edition, Pearson Education, 2015.
3. Burden, R.L. and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
4. Sundarapandian, V. —Numerical Linear Algebrall, Prentice Hall of India, New Delhi, 2008.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1									1	2	1
CO2	3	3	2		1							1	2	1
CO3	3	3	2									1	2	1
CO4	3	3	2	2	1						1	1	2	1
CO5	3	3	2	1	1						1	1	2	1
CO6	3	3	2	2	1						1	1	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1301	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To Understand the basic properties of signals.
- To Discuss the classification of systems using properties.
- To Apply Fourier and Laplace transforms for continuous time signals.
- To Explain an LTI continuous time system in time and frequency domain.
- To Illustrate discrete time signals from the Fourier and Z domains.

UNIT - I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Standard signals: Step, Ramp, Pulse, Impulse, Real and complex exponentials, and Sinusoids - Classification of signals: Continuous time (CT) and Discrete Time (DT) signals, Periodic &Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems: CT systems and DT systems, Static & Dynamic, Causal & Non-causal, Linear & Nonlinear, Time variant & Time invariant, Stable & Unstable.

UNIT - II ANALYSIS OF CONTINUOUS TIME SIGNALS 9

Fourier Series of standard periodic signals: Sine, Cosine, Sawtooth and Square wave - Analysis of Continuous Time Signals: Fourier Transform, Properties of FT, Inverse FT, Laplace Transform, Unilateral LT and Bilateral LT, Properties of Unilateral LT - Inverse LT. Case study: Application of FS and FT- Filter, Modulation.

UNIT - III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9

Impulse response - convolution integral — Graphical method - Properties of convolution integral-Overall impulse response for interconnected systems - Fourier and Laplace transforms in analysis of CT systems - Solving of Differential Equation.

UNIT - IV ANALYSIS OF DISCRETE TIME SIGNALS 9

Baseband signal sampling - notion of aliasing with examples, Analysis of Discrete Time Signals: Discrete Time Fourier Transform (DTFT), Properties of DTFT, Inverse DTFT-Analysis of Discrete Time Signals: Z Transform, Properties of Z Transform, Inverse Z Transform.

UNIT - V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9

Impulse response - Convolution sum - Graphical method - Properties of Discrete Convolution - Overall impulse response for interconnected systems - Solving of Difference equations - Solution of Difference equation using DTFT- Solution of difference equation using Z-transform.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Understand the basics of signals and its classifications.
CO2 Explain the basic systems and its classifications.
CO3 Apply Fourier and Laplace transforms for continuous time signals.
CO4 Demonstrate the analysis of CT- LTI systems using Fourier and Laplace Transform.
CO5 Analyze the Characteristics of DT signals using DTFT and Z- Transform
CO6 Investigate the DT- LTI systems using Fourier and Z- Transform

TEXT BOOKS:

1. Signals & Systems, Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, 2nd Ed., Pearson Education, 2013.
2. B.P.Lathi,"Principles of Linear Systems and Signals",Second Edition,Oxford,2009.

REFERENCE BOOKS:

1. S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2003.
2. R.E. Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.
3. Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

WEB REFERENCES:

1. http://www.1201nptelvideos.in/2012/12/signals-and-system.html
2. https://freevideolectures.com/course/3177/signals-and-systems

ONLINE COURSES / RESOURCES:

1. https://www.edx.org/course/signals-and-systems-part-1
2. https://www.edx.org/course/signals-and-systems-part-2

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2								1	3	3	2
CO2	3	3	2								1	3	3	2
CO3	3	3	3	2							1	3	3	2
CO4	3	3	3	3							1	3	3	2
CO5	3	3	2								1	3	3	2
CO6	3	3	3	3							1	3	3	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1302	ELECTRONIC CIRCUITS I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To study Biasing concepts of Bipolar Junction Transistor
- To analyse the construction and operation of Field Effect Transistor
- To discuss the small scale and hybrid models of BJT and FET
- To derive and determine frequency response of BJT amplifiers
- To understand the concepts of short and narrow channel effects in MOSFET

UNIT - I BIASING OF BIPOLAR JUNCTION TRANSISTORS 9

BJT– Need for biasing – DC load line and Bias point – Various biasing methods of BJT – Bias circuit design – Thermal stability – Stability factors – Bias compensation techniques using Diode, thermistor and sensistor.

UNIT - II JFET AND MOSFET 9

Construction and operation of JFET and MOSFET – MOSFET as an amplifier and as a switch — Biasing in MOS Amplifier Circuits — Frequency response of FET amplifiers — Parasitic capacitance effect of MOSFET – FET voltage variable resistor and active load.

UNIT - III BJT AND FET AMPLIFIERS 9

Analysis of CE, CC and CB amplifiers using hybrid π equivalent circuits – Early effect of small scale signal analysis – Darlington amplifier – Cascade and cascode configurations – MOSFET small signal model – Analysis of CS, CG and Source follower.

UNIT - IV FREQUENCY RESPONSE OF BJT AMPLIFIER 9

Low and High Frequency response of transistor amplifiers – Miller effect – Short circuit current gain – cut off frequency – fα, fβ and unity gain bandwidth.

UNIT - V SHORT AND NARROW CHANNEL EFFECTS IN MOSFETS 9

Velocity saturation from horizontal field — Mobility degradation from the vertical field — Weak Inversion in MOS Transistors – Transistor frequency in weak inversion – Narrow & Short Channel Effects in MOSFETs.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Understand the biasing concepts of transistors
CO2 Outline the working principles of FET
CO3 Analyse the performance of small signal equivalent circuits
CO4 Determine high and low frequency response of amplifiers
CO5 Classify the operation of short and narrow channels in MOSFET

TEXT BOOKS:

1. S Salivahanan and N Suresh Kumar, Electronic Devices and Circuits, 5th Edition, Mc Graw Hill Education (India) Private Ltd., 2022.
2. Donald .A. Neamen, Electronic Circuit Analysis and Design – 2nd Edition, Tata Mc Graw Hill, 2009.

REFERENCE BOOKS:

1. Robert Boylestad and Louis Nashelsky, Electron Devices and Circuit Theory, Printice Hall Publications, 11th Edition , 2015.
2. Millman and Halkias, Electronic devices and circuits, 2nd Edition, McGraw Hill Publication, 2007.
3. Anwar A. Khan and Kanchan K. Dey, A First Course on Electronics, PHI, 2006.
4. David A.Bell, Electronic Devices and Circuits, Oxford Higher Education Press, 5th Edition, 2010.
5. S.M.Kang & Y.Leblibici, CMOS Digital Integrated Circuits-Analysis & Design, 3rd Edition, Tata Mc Graw Hill, 2011.

WEB REFERENCES:

1. https://link.springer.com/chapter/10.1007/0-387-37766-2_14.
2. https://www.sciencedirect.com/topics/physics-and-astronomy/junction-transistor1.

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/transistor-field-effect-transistor-bipolar-junction-transistor
2. https://rkthenua.in/electronics-engineering/
3. https://ekeeda.com/degree-courses/electrical-engineering/electronic-devices-and-circuits
4. https://www.udemy.com/course/moseft-transistor-the-complete-course-for-beginners/
5. https://pdfkeys.com/download/2537297-Electronic-Circuits-Ii-By-S-Ramalatha.pdf
6. https://www.ee.iitm.ac.in/videolectures/doku.php?id=ec3102_2012a:start

CO-PO MAPPING

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

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1303	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals in logical minimization methods
- To explain the concept of combinational circuits using logic gates.
- To interpret the design procedure of Synchronous Sequential Circuits
- To interpret the design procedure of Asynchronous Sequential Circuits
- To explain the concepts of Programmable Logic Devices and Digital Integrated Circuits

UNIT - I BOOLEAN ALGEBRA AND MINIMIZATION METHODS OF LOGIC CIRCUITS 9

Introduction to Binary Addition and Subtraction, different type of codes, boolean theorems and postulates, logic gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map and Quine - McCluskey method of minimization.

UNIT - II DESIGN OF COMBINATIONAL CIRCUITS 9

Design of Half and Full Adders, Half and Full Subtractors, binary Parallel Adder, carry look ahead adder. Code Converter, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.

UNIT - III ANALYSIS AND DESIGN OF SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Flip flops: SR, JK, T, D, Master/Slave FF, operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits, design of Moore and Mealy models, state minimization, state assignment, and circuit implementation. Design of Counters, Ripple Counters, Ring Counters, Shift registers.

UNIT - IV ANALYSIS AND DESIGN OF ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

Analysis and Design of Asynchronous sequential circuits - State reduction, race free assignments, Hazards, Essential Hazards. Design of Hazard free circuits, cycles and races.

UNIT - V PROGRAMMABLE LOGIC DEVICES AND DIGITAL INTEGRATED CIRCUITS 9

Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Implementation of combinational logic circuits using PLA and PAL, Sequential Programming Logic Device. Architecture of Field Programmable Gate Array, Complex Programmable Logic Device,Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, Logic families and their characteristics: ECL,TTL and CMOS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Define the Boolean theorems and laws for logic circuit simplifications

CO2 Infer the combinational circuits using logic gates

CO3 Apply the knowledge of designing the synchronous sequential circuits

CO4 Apply the knowledge of designing the asynchronous sequential circuits

CO5 Analyze the various Programming Logic Devices

CO6 Examine the Digital Integrated Circuits in the design of logic gates

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, “Digital Design”, 6th Edition, Pearson, 2018.
2. Charles H.Roth. "Fundamentals of Logic Design", 7th Edition, Thomson Learning, 2014.

REFERENCE BOOKS:

1. Thomas L.Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2018.
2. Leach, Malvino and Saha “Digital Principles and Applications”, McGraw Hill Education, 8th Edition, 2014.
3. Ronald J. Tocci, Neal S. Widmer and Gregory L. Moss, “Digital Systems: Principles and Applications”, 12th Edition, Pearson Education, 2017.
4. Soumitra Kumar Mandal, "Digital Electronics", Mc Graw Hill Education Private Limited, 2016.
5. Dr. P. Kannan, M. Saraswathi, “Digital Electronics”, Sree Kamalamani Publication, 2nd Edition, 2017.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee10/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3									2	3	2	2
CO2	3	3	2								2	3	2	2
CO3	3	3	3	1							2	3	2	2
CO4	3	3	3	1							2	3	2	2
CO5	3	3	3	1							2	3	2	2
CO6	3	3	3	1							2	3	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1304	CONTROL SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To define the fundamentals of various mathematical models of physical systems.
- To explain the concept of various time domain parameters.
- To illustrate the various frequency response plots and its system.
- To apply the different compensation techniques required for the systems.
- To analyse and examine the concepts of various system stability criterions and state variable analysis methods.

UNIT - I MATHEMATICAL MODEL OF PHYSICAL SYSTEMS 9

Basic components of a control system - Feedback and its effect - Types of feedback control systems - Modelling of Physical systems: Electrical and Mechanical transfer function models - free body diagram - Analogous Systems - Armature controlled and Field controlled DC motor - Block diagram reduction - Signal flow graphs

UNIT - II TIME RESPONSE ANALYSIS 9

Time response: Time domain specifications — Types of test input — I and II order system response - effect on an additional zero and an additional pole - Steady-State error - Static error coefficients - Error analysis for different types of systems - Effects of PI, PD, PID control systems

UNIT - III FREQUENCY RESPONSE ANALYSIS 9

Closed loop frequency response - Performance specification in frequency domain - Frequency response of standard second order system - Bode Plot - Polar Plot - Nyquist plots — Effect of Lag, Lead and Lag-Lead compensation on frequency response using Bode Plots

UNIT - IV STABILITY ANALYSIS 9

Concepts of stability — Bounded-Input Bounded-Output stability (BIBO) - Routh Hurwitz criterion - Relative stability - Root locus concept - Guidelines for sketching root locus - Nyquist stability criterion

UNIT - V ANALYSIS OF STATE VARIABLE METHODS 9

State variable representation - Conversion of state variable models to transfer functions - Conversion of transfer functions to state variable models - Solution of state equations - Concepts of Controllability and Observability - Stability of linear systems - Equivalence between transfer function and state variable representations

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Define the various mathematical models of physical systems.

CO2 Interpret the various system using time domain specifications.

CO3 Infer the various system using frequency domain specifications.

CO4 Apply the knowledge of different compensation techniques required for the systems.

CO5 Analyze the concepts of stability of the system using RH and Nyquist methods.

CO6 Examine the concepts of various state variable analysis methods.

TEXT BOOKS:

1. J. Nagrath and M. Gopal, “Control System Engineering”, New Age International Publishers, 6th Edition, January 2017.
2. M. Gopal, “Control System – Principles and Design”, Tata McGraw Hill, 4th Edition, 2012.

REFERENCE BOOKS:

1. A. Nagoor Kani, “Control System Engineering”, CBS Publication and Distributors, 2020.
2. Richard C. Dorf, Robert H. Bishop, “Modern Control System”, Pearson, 13th Edition, 2016.
3. Benjamin.C.Kuo, “Automatic Control Systems”, Prentice Hall of India, 9th Edition, 2010.
4. S.K.Bhattacharya, “Control System Engineering”, Pearson, 3rd Edition, 2013.
5. K.Ogata, “Modern Control Engineering”, PHI, 5th Edition, 2012.

WEB REFERENCES:

1. https://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=SystemModeling
2. https://reference.wolfram.com/language/guide/ControlSystems.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/107106081/
2. https://www.coursera.org/learn/modeling-feedback-systems
3. https://www.udemy.com/topic/control-systems

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1								1	3	3	2
CO2	3	3	1								1	3	3	2
CO3	3	3	1								1	3	3	2
CO4	3	3	1								1	3	3	2
CO5	3	3	1								1	3	3	2
CO6	3	3	1								1	3	3	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1311	ELECTRONIC CIRCUITS AND SIMULATION LABORATORY I	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To study about the biasing amplifier circuits.
- To demonstrate the frequency response of BJT and FET Amplifiers.
- To explain transistor configurations using h-parameters.
- To analyze the frequency response of cascade and cascode amplifiers.
- To examine narrow and wide band amplifiers
- To inspect the characteristics of CE and CS amplifiers using PSPICE.

LIST OF EXPERIMENTS

1. Fixed bias common emitter amplifier circuit.
2. Frequency response of Common base amplifier circuit.
3. Common collector amplifier with voltage divider bias.
4. Measurement of h-parameters of transistor in
   a) Common base configuration
   b) Common emitter configuration
   c) Common collector configuration
5. Frequency response of FET CS amplifier.
6. MOSFET CS amplifier and buffer circuit.
7. Frequency response of cascade amplifier.
8. Frequency response of cascode amplifier.
9. CMRR measurement of differential amplifier.
10. Voltage gain and bandwidth of narrow band amplifier.
11. Voltage gain and bandwidth of wide band amplifier.
12. **SIMULATION USING PSPICE**
    a) Common emitter amplifier
    b) Common source amplifier

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Demonstrate the characteristics of amplifiers.
CO2 Summarize the frequency response of BJT and FET Amplifiers
CO3 Classify the parameters of amplifier circuits.
CO4 Experiment the operation of cascade and cascode amplifiers.
CO5 Analyze the voltage gain and bandwidth of narrow and wide band amplifiers.
CO6 Design of CE and CS amplifiers using PSPICE Tool.

WEB REFERENCES

1. https://www.circuitlab.com/
2. https://wiki.analog.com/university/labs/circuits
3. https://www.falstad.com/circuit/
4. https://www.sciencedirect.com/topics/physics-and-astronomy/junction-transistor1.

5. https://www.javatpoint.com/c-programs
6. https://digilent.com/reference/test-and-measurement/guides/complementary-labs/lab1/start

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3						1	3	2	1
CO2	3	3	3	2	3						1	3	2	1
CO3	3	3	3	2	3						1	3	2	1
CO4	3	3	3	2	3						1	3	2	1
CO5	3	2	3	2	3						1	3	2	1
CO6	3	2	2	1	3						1	3	2	1

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23EC1312	CONTROL SYSTEMS ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To identify different toolboxes and understand the basic operations used in MATLAB.
- To infer the transfer function and the output responses of control system.
- To compute the steady state errors of the given system.
- To analyze the time response of the given system.
- To analyze the frequency response of the given system.
- To evaluate the output responses of different controllers.

LIST OF EXPERIMENTS

1. To study the basic of MATLAB and introduction to Control Systems Toolbox.
2. Determine transpose, inverse values of given matrix.
3. Determine the transfer function for given closed loop system in block diagram representation.
4. Determine the time response of the closed and open loop system.
5. Plot the pole-zero configuration in s-plane for the given transfer function.
6. Plot unit step response of given transfer function and determine delay time, rise time, peak time and peak overshoot.
7. Determine the steady state errors of a given transfer function.
8. Determine the time response of given system subjected to any arbitrary input.
9. Plot bode plot for the given transfer function. Also determine the relative stability by measuring gain and phase margins.
10. Plot polar plot for the given transfer function. Also determine the relative stability by measuring gain and phase margins.
11. Plot root locus of given transfer function, locate closed loop poles for different values of k.
12. For the given transfer function, obtain the response of the system using P, PI, PD and PID controllers.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Understand the basics of control systems tools used in MATLAB.
CO2 Identify the responses of open loop and closed loop system.
CO3 Simulate the given system to determine the steady state errors.
CO4 Analyze the response of the system using arbitrary inputs.
CO5 Analyze the system stability using frequency response of the system.
CO6 Investigate the suitable controller based on the system response.

WEB REFERENCES

1. https://www.mathworks.com/matlabcentral/fileexchange/73716-implementation-of-control-system-experiments-in-matlab?s_tid=FX_rc2_behav
2. https://www.worldscientific.com/worldscibooks/10.1142/9260#t=aboutBook.
3. https://ctms.engin.umich.edu/CTMS/index.php?aux=Home.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3			3						1	3	3	2
CO2	3	3	1		3						1	3	3	2
CO3	3	3	2	3	3						1	3	3	2
CO4	3	3	2	3	3						1	3	3	2
CO5	3	3	2	3	3						1	3	3	2
CO6	3	3	2	3	3						1	3	3	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23ES1312	CODING PRACTICES I	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE

- To impart essential problem-solving skills through general problem-solving concepts..
- To provide basic knowledge on programming essentials using Python as implementation Tool.
- To introduce various Collection Data types and Exception handling using Python.

LIST OF EXPERIMENTS

1. Data Types, Variables, Operators.
2. Expressions, Precedence of Operators.
3. Conditional Statements.
4. Built-in Functions including Range, len, input, map and split.
5. Looping, For and While.
6. User Defined Functions.
7. List.
8. Tuple.
9. Dictionary.
10. Recursion and Lambda Functions.
11. String Handling.
12. Regular Expressions.
13. Packages.
14. Exception Handling.
15. GUI using TKinter.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Propose solutions for a given problem.

CO2 Infer the fundamental programming elements in Python language and learn to apply basic control structures in Python.

CO3 Demonstrate the applications of Collection data types in Python.

CO4 Visualize the capabilities of String and Regular expressions.

CO5 Understand the basic principles of Exception Handling.

CO6 Design and Develop GUIs.

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. Reema Thareja,”Problem Solving and Programming with Python"", 2nd edition,Oxford University Press, New Delhi, 2019.
3. Alan D. Moore, Python GUI Programming with Tkinter, Design and Build Functional and User-friendly GUI Applications, Packt Publishing, 2021.

REFERENCE BOOKS:

1. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.
2. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.

ONLINE COURSES / RESOURCES:

1. https://docs.python.org/3/tutorial/
2. https://www.w3schools.com/python/
3. https://www.tutorialspoint.com/python/index.htm
4. https://www.javatpoint.com/python-tutorial
5. https://nptel.ac.in/courses/

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

SEMESTER IV

23MA1402	PROBABILITY AND RANDOM PROCESSES	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To provide necessary basic concepts in probability and some standard distributions applicable to engineering.
- To understand concepts of two dimensional random variables phenomenon.
- To understand the basic concepts of random processes which are widely used in Communication fields.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

UNIT - I RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT - II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (Without Proof).

UNIT - III RANDOM PROCESSES 9+3

Classification – Stationary process – Markov process - Markov chain - Poisson process.

UNIT - IV CORRELATION AND SPECTRAL DENSITIES 9+3

Auto correlation functions — Cross correlation functions — Properties — Power spectral density – Cross spectral density – Properties.

UNIT - V LINEAR SYSTEMS WITH RANDOM INPUTS 9+3

Linear time invariant system — System transfer function — Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Understand the basic concepts of one dimensional random variables and apply in engineering applications.

CO2 Utilise standard distributions to solve the real-world problems.

CO3 Recognise the fundamental ideas behind two-dimensional random variables and use them in engineering applications.

CO4 Apply the concept random processes in engineering disciplines.

CO5 Develop skills in solving problems on power spectral density function relevant to the various branches of engineering.

CO6 Analyse the response of random inputs to linear time invariant systems.

TEXT BOOKS:

1. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.
3. Veerarajan.T.,"Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks", McGraw Hill, 3rd Edition,2016.

REFERENCE BOOKS:

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., —Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., —Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., —Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3									1	1	2	1
CO2	3	3	1								1	1	2	1
CO3	3	3	1	1	1						1	1	2	1
CO4	3	3	1	1	1						1	1	2	1
CO5	3	3	1								1	1	2	1
CO6	3	3	1								1	1	2	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23CS1403	PRINCIPLES OF DATA STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the different types of data structures and its operations for real-time programming applications
- To understand Linear Data Structures such as arrays, stacks, queues and linked lists and their applications in problem solving
- To learn about Non Linear Data Structures - Graph and its implementations.
- To learn about Non Linear Data Structures – Trees and its traversals.
- To know the different techniques for solving problems like sorting and searching.

UNIT - I BASIC CONCEPTS OF DATA STRUCTURES 9

Introduction to Data Structures - Abstract data types - Basic Analysis of Algorithms — Notations, Efficiency of algorithms, Notion of time and space complexity.

UNIT - II LINEAR DATA STRUCTURES 9

Array-Operations on Arrays–Insertion and Deletion-Applications on Arrays. Abstract Data Types (ADTs), List ADT, Array Based Implementation - Stacks and Queues, Linked List - Linked list-based implementation of Stacks and Queues– Applications of Stacks and Queues.

UNIT - III NON LINEAR DATA STRUCTURES – TREES 9

Trees-General Trees-Tree Terminologies-Tree representation - Binary Trees, Tree Traversals, Tree Operations - Binary Search Tree, Expression Trees - Applications of trees.

UNIT - IV NON LINEAR DATA STRUCTURES – GRAPH 9

Graphs - Representation of Graph – Types of graphs – Breadth first traversal – Depth first traversal — Applications - Minimum Spanning Tree : Prim's and Kruskal's Algorithm — Single Source Shortest Path: Dijkstra’s Algorithm.

UNIT - V SORTING AND SEARCHING TECHNIQUES 9

Sorting: Merge Sort - Quick Sort — Insertion Sort — Selection Sort - Searching: Linear Search — Binary Search.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Define the fundamentals of data structures and their applications essential for programming/problem solving..

CO2 Understand the performance of the implementations of basic linear data structures.

CO3 Implement different types of Trees and apply them to the problem solutions

CO4 Understand Graph structure and various operations on graphs and their applicability.

CO5 Analyze the various Sorting and Searching algorithms.

CO6 Adapt the different data structures to various computing problems.

TEXT BOOKS:

1. Chandan Banerjee and Atanu Das, Data Structures and Algorithms in C and Python,Universities Press, 2023.
2. Reema Thareja, "Data Structures Using C", 2nd Edition, OXFORD University Press, New Delhi, 2018.

REFERENCE BOOKS:

1. Jean-Paul Tremblay and Paul G. Sorenson, "An Introduction to Data Structures with Applications", 2nd Edition, McGraw Hill, 2013.
2. Langsam, Augenstein and Tanenbaum, "Data Structures Using C and C++", 2nd Edition, Pearson Education, 2015.
3. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, "Data Structures and Algorithms", 1st Edition, Pearson, 2002.
4. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education 4th Edition, 2014.Yates.
5. R. Kruse, C. L. Tondo and B. Leung, "Data Structures and Program Design in C", 2nd Edition, Pearson Education, 2006.

WEB REFERENCES:

1. https://www.programiz.com/dsa
2. https://www.w3schools.in/data-structures/tutorials/
3. https://www.javatpoint.com/data-structure-tutorial
4. https://www.geeksforgeeks.org/data-structures/
5. https://en.wikibooks.org/wiki/Data_Structures
6. https://www.simplilearn.com/tutorials/data-structure-tutorial

ONLINE COURSES / RESOURCES:

1. https://www.codechef.com/certification/data-structures-and-algorithms/prepare.
2. https://www.coursera.org/learn/data-structures
3. https://nptel.ac.in/courses/106102064
4. https://www.edx.org/learn/data-structures

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2									2	1	2	2
CO2	3	2	1								2	1	2	2
CO3	3	2	1								2	1	2	2
CO4	3	2	1								2	1	2	2
CO5	3	2	2								2	1	2	2
CO6	3	2	2								2	1	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1401	COMMUNICATION THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce concepts of various Amplitude Modulation techniques and their spectral characteristics.
- To interpret Frequency Modulation and Phase Modulation techniques and their spectral characteristics.
- To apply concepts of Noise and analyze the effect of Noise in Communication Systems.
- To evaluate different types of Source Coding Techniques.
- To propose Applications pertaining to Communication Theory.

UNIT - I AMPLITUDE MODULATION 9

Amplitude Modulation – DSBSC, DSBFC, SSB, VSB - Modulation index, Spectra, Power relations and Bandwidth – AM Generation – Square law and Switching modulator, DSBSC Generation – Balanced and Ring Modulator, SSB Generation – Filter Method, Phase Shift Method, VSB Generation – Filter Method, Demodulation, Envelope Detector – Comparison of different AM techniques.

UNIT - II ANGLE MODULATION 9

Phase and Frequency modulation, Narrow Band and Wide band FM — Modulation index, Spectra, Power relations and Transmission Bandwidth, FM modulation – Direct and Indirect methods, FM Demodulation, Detector — FM to AM conversion, FM Discriminator, PLL as FM Demodulator — Comparison of different FM techniques.

UNIT - III NOISE CHARACTERIZATION 9

Noise sources — Noise Figure, Noise Temperature and Noise Bandwidth — Noise in Cascaded Systems, Representation of Narrowband Noise – In-phase and Quadrature, Envelope and Phase – Noise performance analysis in AM and FM systems – Threshold effect, Pre-emphasis and Deemphasis for FM.

UNIT - IV INFORMATION THEORY 9

Discrete Memoryless Source, Information, Entropy, Source Coding theorem, Shannon – Fano Coding, Huffman Coding — Codewords, Average Codeword Length, Efficiency, Redundancy, Code Variance – Shannon Hartley Theorem, Mutual Information.

UNIT - V APPLICATIONS IN COMMUNICATION THEORY 9

AM Radio Broadcasting, FM Radio Broadcasting, Repeaters for Communication Signal Transmission, Channel Capacity in Communication Channel, Frequency Division Multiplexing of Communication signals.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Define AM communication systems and its allied types.
CO2 Classify Angle modulated communication systems and Infer Frequency Modulation and Phase modulation.
CO3 Analyze Noise in Cascaded Systems.
CO4 Evaluate Noise performance in AM and FM systems.

CO5 Design Source Coding techniques to improve coding efficiency.
CO6 Develop Applications using concepts of Communication Theory.

TEXT BOOKS:

1. Simon Haykin, "Communication Systems", 4th Edition,Wiley Student Edition, Wiley India (P.) Ltd.,Reprinted 2012.
2. J.G.Proakis, M.Salehi, "Fundamentals of Communication Systems", 2nd Edition, Pearson Education, 2014.

REFERENCE BOOKS:

1. Wayner Tomasi, Electronic Communications Systems, Fundamentals through advanced, 5th Edition, Pearson Education, 2019.
2. Dr. Sanjay Sharma, "Communication Systems (Analog and Digital)", 7th Edition, S.K. Kataria & Sons, 2017.
3. Dennis Roddy, John Coolen, "Electronic Communications", 4th Edition Pearson Education, 2014.
4. B.P.Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2010.

WEB REFERENCES:

1. https://www.electronics-notes.com/articles/radio/modulation/amplitude-modulation-am.php
2. https://www.javatpoint.com/angle-modulation
3. https://www.agilebroadcast.com.au/types-of-radio-broadcasting

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/106106097
2. https://nptel.ac.in/courses/117102059
3. https://www.classcentral.com/course/swayam-principles-of-communication-systems-i-7963
4. https://courseware.cutm.ac.in/courses/analog-communication-systems

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2								2	3	2	1
CO2	3	2	2								2	3	1	2
CO3	3	2	2								2	3	2	2
CO4	3	2	2								2	3	2	2
CO5	3	2	2								2	3	2	2
CO6	3	2	2								2	3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1402	ELECTRONICS CIRCUITS II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To define the fundamentals of Amplifiers and Oscillators constructed with discrete components.
- To understand the concept of feedback amplifiers and oscillators principles.
- To design Oscillator Circuits
- To design Tuned Amplifiers and Multivibrators.
- To analyze and observe the concepts of Power Amplifiers and DC Converters.

UNIT - I FEEDBACK AMPLIFIERS AND STABILITY 9

Feedback Concepts, Gain with feedback, Effect of feedback on gain stability, Distortion, Bandwidth, Input and Output Impedances; Topologies of feedback amplifiers, Analysis of series-series, shunt- shunt and shunt-series feedback amplifiers, Stability problem, Gain and Phase-margins, Frequency compensation.

UNIT - II TUNED AMPLIFIERS 9

Coil losses, Unloaded and loaded Q of tank circuits, Small signal tuned amplifiers, Analysis of capacitor coupled single tuned amplifier, Double tuned amplifier, Effect of cascading single tuned and double tuned amplifiers on bandwidth, Stagger tuned amplifiers, Stability of tuned amplifiers, Neutralization, Hazeltine neutralization method, Neutralization using coils & Rice neutralization.

UNIT - III OSCILLATORS 9

Barkhausen criterion for oscillation, Phase shift, Wien bridge, Hartley & Colpitts's oscillators, Clapp Oscillator, Ring oscillators and Crystal oscillators, Armstrong and Franklin Oscillators.

UNIT - IV WAVE SHAPING AND MULTIVIBRATOR CIRCUITS 9

RC & RL Integrator and Differentiator circuits, Diode clampers and clippers, Diode comparators, Multivibrators, Astable multivibrator, Monostable multivibrator, Bistable multivibrator, Schmitt Trigger, UJT Oscillator, Characteristics and applications of 555 Timer.

UNIT - V POWER AMPLIFIERS AND DC CONVERTERS 9

Buck,Boost analysis and design, Power amplifiers, Class A, Class B, Class AB, Class C, Power MOSFET, Temperature Effect, Class AB Power amplifier using MOSFET, DC/DC convertors, Buck, Boost, Buck,Boost analysis and design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Define the effect of negative feedback on amplifiers parameters, and analyze the various types of feedback amplifiers and their stability analysis.

CO2 Design of RC and LC oscillators by deriving their frequency of oscillation.

CO3 Analyze the frequency response of small signal tuned amplifiers and learn their stabilization techniques.

CO4 Analyze and design of various multivibrators circuits.

CO5 Explain the response of wave shaping circuits for various types of input signals.

CO6 Analyze the efficiency of various power amplifiers and learn operation of DC, DC converters.

TEXT BOOKS:

1. Sedra and Smith, —Micro Electronic Circuits‖; Seventh Edition, Oxford University Press, 2014.
2. Jacob Millman,Microelectronics‘, McGraw Hill, 2nd Edition, Reprinted, 2017.

REFERENCE BOOKS:

1. Robert L. Boylestad and Louis Nasheresky, —Electronic Devices and Circuit Theory, 11th Edition, Pearson Education / PHI, 2013
2. Donald. A. Neamen, Electronic Circuits Analysis and Design, 3rd Edition, Mc Graw Hill Education (India) Private Ltd., 2010.
3. David A. Bell, —Electronic Devices and Circuitsc‖, Fifth Edition, Oxford University,
Press, 2008.
4. Millman J. and Taub H., —Pulse Digital and Switching Waveforms‖, TMH, 2000

WEB REFERENCES:

1. http:// www.introni.it/pdf/Millman-Taub- Pulse and Digital Switching Waveforms 1965.pdf
2. https://www.google.co.in/books/edition/Pulse_and_Digital_Circuits/5v5ct06-kbwC?hl=en&gbpv=0
3. https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/pages/syllabus/

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee55/preview
2. https://archive.nptel.ac.in/courses/108/102/108102095/
3. https://www.electronics-tutorials.ws/sequential/seq_3.html
4. https://semiconductorclub.com/downloads/theory-and-design-of-electronic-circuits/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1				1	1	2	1	1
CO2	3	3	2	1	1	1				1	1	2	2	1
CO3	3	2	2	1	1	1				1	1	2	1	1
CO4	3	3	2	1	1	1				1	1	2	2	1
CO5	3	1	2	1	1	1				1	1	2	1	1
CO6	3	2	2	1	1	1				1	1	2	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1403	ANALOG INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To Introduce the basics of operational amplifiers.
- To learn the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of analog multipliers.
- To introduce the theory and applications of PLL.
- To learn the theory of ADC and DAC.
- To introduce, study and analyze some special function ICs.

UNIT I BASICS OF OPERATIONAL AMPLIFIERS 9

Introduction of operational amplifier, Ideal Operational Amplifier, General operational amplifier stages, Internal circuit diagram of IC 741 - DC performance characteristics – Input bias current, Input offset current, Input offset voltage, Total output offset voltage, Thermal drift, AC performance characteristics — Frequency response, stability, frequency compensation, slew rate, Open and closed loop configurations, Introduction of Advanced operational amplifiers - JFET Operational Amplifiers — LF155 and TL082, CMOS Operational amplifier — MC14573, BiMOS Operational amplifier — CA3140.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, Operational Transconductance Amplifier (OTA), Adder, Subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, Low-pass, high-pass and wide band-pass Butterworth filters.

UNIT III ANALOG MULTIPLIER AND PLL 9

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell — Variable transconductance technique, Analog multiplier Monolithic ICs-AD633 and its applications-Voltage divider, Squarer, square rooter, frequency doubler and phase angle detector, Operation of the basic PLL, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronisation.

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

Analog and Digital Data Conversions, D/A converter — specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R - 2R Ladder types - A/D Converters — specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type, Nyquist rate A/D converter - Two step A/D Converter, Pipelined A/D converter.

UNIT V SPECIAL FUNCTION ICs 9

Function generator IC8038, Timer IC 555- Modes of Operation, IC Voltage regulators — Three terminal fixed voltage regulators-IC78XX,IC 79XX, adjustable voltage regulators-IC LM317, ICLM337 - IC 723 general purpose regulator, Audio Power amplifier LM380, Isolation Amplifier ISO100 and Optocoupler IC TLP112, MOC3009,TLP141G,TLP521.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Infer the basics of operational amplifier.
CO2 Demonstrate linear and nonlinear applications of op-amps.
CO3 Illustrate the functions of analog multiplier.
CO4 Illustrate the functions of Phase Locked Loop (PLL).
CO5 Compare the working principles of data conversion methods (ADCs & DACs).
CO6 Analyze some special function ICs.

TEXT BOOKS

1. D.Roy Choudhry, ShailJain,"Linear Integrated Circuits", New Age International Pvt. Ltd., 2000. Circuits", 4 th Edition, Tata McGraw-Hill, 2017.
2. Millman J. and Taub H., "Pulse, Digital and Switching waveforms", 3rd Edition, TMH, 2017.
3. D.Roy Choudhry, ShailJain,"Linear Integrated Circuits", New Age International Pvt. Ltd., 2000. Circuits", 4 th Edition, Tata McGraw-Hill, 2017.

REFERENCE BOOKS

1. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.
2. Tony Chan Carusone, David Johns, Kenneth William Martin, Analog Integrated Circuit Design, John Wiley and Sons,2012.
3. B.S.Sonde, "System design using Integrated Circuits", 2nd Edition, New Age Pub, 2001.
4. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International, 2005.
5. Ramakant A.Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall /Pearson Education, 2001.
6. William D.Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson Education, 2004.

WEB REFERENCES

1. https://www.analog.com/media/en/training-seminars/design-handbooks/basic-linear-design/chapter1.pdf
2. http://fa.ee.sut.ac.ir/Downloads/AcademicStaff/24/Courses/73/%5BGray____Meyer%5D_Analysis_and_Design_of_Analog_Integrated_Circuits_5th_ed.pdf

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3											3	3	1
CO2	3	3	3								3	3	3	3
CO3	3	2										3	3	3
CO4	3										3	3	3	3
CO5	3											3	3	3
CO6	2		3							3	2	3	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1404	ELECTROMAGNETIC FIELDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To study the concepts of vector algebra and electric fields.
- To understand the applications of static electric fields.
- To attain the information of magnetic fields and its applications.
- To analyse the concept of Maxwell's equations and time varying fields.
- To assess the behaviour of Electromagnetic Wave Propagation for various medium.

UNIT - I STATIC ELECTRIC FIELD 9

Review of vector algebra, Coordinate Systems, Vector Identities, Operators and Theorems, Point Charges, Charge Distributions, Coulomb's Law, Gauss's Law and its Applications, Electric field Intensity, Electrical field due to Point charges, Line, Surface and Volume Charge Distributions, Absolute Electric Potential, Potential Difference and its Calculation of for different configurations.

UNIT - II STATIC ELECTRIC FIELD AND ITS APPLICATIONS 9

Electric dipole, Electrostatic Energy and Energy Density, Current and current density, Ohms Law in Point form, Continuity equation, Boundary conditions of conductors and dielectric materials. Capacitance, Capacitance of a two-wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation.

UNIT - III STEADY MAGNETIC FIELD 9

Lorentz force equation, Ampere's law, Biot-Savart law and applications, Scalar and Vector Magnetic Potential, Magnetic field intensity and idea of relative permeability, Calculation of magnetic field intensity for various current distributions, Forces on Charged Particles and Current Elements, Magnetostatic Boundary Conditions, Inductance of Solenoid, Toroid, Transmission Line and Parallel Transmission Lines.

UNIT - IV MAXWELL's EQUATIONS AND TIME-VARYING FIELDS 9

Faraday's Law, Transformer and motional EMF, Maxwell's Equations, Boundary conditions in Electromagnetic Field, Time Varying Potentials.

UNIT - V ELECTROMAGNETIC WAVES 9

Solution for Free Space Conditions, Uniform Plane Wave Propagation, Wave Equation for Conducting and Dielectric medium, Reflection of Waves at interface between Conductors and Dielectrics for Normal Incidence, Skin Depth, Power Flow and Poynting Vector, Standing Waves.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Outline the proficiency in vector algebra, coordinate systems and enumerate the fundamental laws to analyze static electric fields.

CO2 Summarize the concepts of Static Electric Fields in various applications.

CO3 Apply the concept of Steady Magnetic Fields and associated principles.

CO4 Analyze Faraday's Law and Maxwell's Equations to determine the significance of time varying fields.

CO5 Evaluate and understand the behaviour of Electromagnetic Wave Propagation.

CO6 Solve wave equations for conducting and dielectric mediums and understand the reflection of waves.

TEXT BOOKS:

1. M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press, New Delhi , Sixth Edition 2015.
2. W. H. Hayt Jr. and J. A. Buck, Engineering Electromagnetics, McGraw Hill, New York , 2014.

REFERENCE BOOKS:

1. D.K. Cheng, Field and Wave Electromagnetics, Pearson Education, Singapore , 2003.
2. Edward C. Jordan and Keith G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall inc., Second Edition, 2010.
3. A. Pramanik, Electromagnetism, Vol. 1 (Theory), PHI, New Delhi , 2014.

WEB REFERENCES:

1. https://onlinelibrary.wiley.com/doi/epdf/10.1002/9780470124581.fmatter
2. https://empossible.net/academics/emp3302/

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/electromagnetic-field-theory-transmission-lines/
2. https://www.classcentral.com/course/swayam-electromagnetic-theory-5223.
3. https://ocw.mit.edu/courses/8-311-electromagnetic-theory-spring-2004/
4. https://onlinecourses.nptel.ac.in/noc21_ee83/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1								2	3	2	1
CO2	3	2	1								2	3	2	1
CO3	3	2	1								2	3	1	1
CO4	3	2	1								2	3	2	1
CO5	3	2	1								2	3	2	1
CO6	3	2	1								2	3	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1411	ELECTRONICS CIRCUITS AND SIMULATION LABORATORY II	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To understand the hands-on experience in designing electronic circuits
- To apply the simulation software used in circuit design
- To analyse the fundamental principles of amplifier circuits
- To design the differentiate feedback amplifiers and oscillators.
- To infer the operation of various multivibrators

LIST OF EXPERIMENTS

DESIGN AND ANALYSIS OF THE FOLLOWING CIRCUITS

1. Series and Shunt Feedback Amplifiers-Frequency response, Input and output impedance
2. RC Phase shift oscillator and Wien Bridge Oscillator
3. Hartley Oscillator and Colpitts Oscillator
4. Single Tuned Amplifier
5. RC Integrator and Differentiator circuits
6. Astable and Monostable multivibrators
7. Clippers and Clampers

SIMULATION USING PSPICE (Using Transistor):

1. Tuned Collector Oscillator
2. Twin -T Oscillator / Wein Bridge Oscillator
3. RC and RL Differentiator & Integrator Circuits
4. Double and Stagger tuned Amplifiers
5. Bistable Multivibrator
6. Schmitt Trigger circuit with Predictable hysteresis
7. Analysis of power amplifier
8. Study the characteristics of 555 Timer
9. A Stable Multivibrator using 555 Timer

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Understand and analyze the various types of feedback amplifiers

CO2 Design oscillators, tuned amplifiers, wave-shaping circuits and multivibrators

CO3 Design and simulate feedback amplifiers, oscillators, tuned amplifiers, wave-shaping circuits and multivibrators using SPICE Tool.

CO4 Analyze the waveform change of diode clipping and clamping circuits when the bias is applied.

CO5 Design and Simulate the A Stable Multivibrator using SPICE Tool.

CO6 Analyze the characteristics of 555 Timer using SPICE Tool.

TEXT BOOKS:

1. Donald. A. Neamen, Electronic Circuits Analysis and Design, 3rd Edition, Mc Graw Hill Education (India) Private Ltd., 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory",11th Edition, Pearson Education, 2013.

REFERENCE BOOKS:

1. David A. Bell, —Electronic Devices and Circuitsǁ, Fifth Edition, Oxford University, Press, 2008.

WEB REFERENCES:

1. https://www.circuitlab.com/
2. https://www.electroschematics.com

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1					1	2	2	2	1	1
CO2	2	2	2	1							2	2	2	1
CO3	3		2	2						1	3	2	1	1
CO4	3	3						1				2	2	1
CO5	3	3	3					1				2	1	1
CO6	3	3	3					1				1	1	1

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23EC1412	ANALOG AND DIGITAL CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To design amplifiers and Data converters using op-amps.
- To design and analyse different types of filters using OPAMP and its frequency response.
- To design DC power supply using Monolithic ICs
- To Understand and implement the concepts of combinational circuits
- To Understand and implement the concepts of sequential circuits

LIST OF EXPERIMENTS

1. Design and implementation of Inverting, Non inverting and differential amplifiers.
2. Design and implementation of Integrator and Differentiator.
3. Design and implementation of Active low-pass, High-pass and band-pass filters.
4. Implementation of R-2R Ladder Type D- A Converter using Op-amp.
5. Design and Implementation of Astable and Monostable multivibrators using NE555 Timer
6. Implementation of DC power supply using LM317 and LM723.
7. Study of logic gates and verify its truth table
8. Design and implementation of 4 bit binary Adder/ Subtractor
9. Design and implementation of Multiplexer and De-multiplexer using logic gates
10. Design and implementation of encoder and decoder using logic gates
11. Design and implementation of synchronous and asynchronous counter
12. Design and implementation of 3-bit synchronous up/down counter
13. Implementation of SISO, SIPO, PISO and PIPO shift registers using flip-flops

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Realize the Amplifiers and Data converters using operational amplifiers
CO2 Construct the various filters using OPAMP
CO3 Implement DC power supply using ICs
CO4 Understand the operation of basic gates
CO5 Implement the combinational circuits
CO6 Implement the sequential circuits

WEB REFERENCES:

1. https://classes.engineering.wustl.edu/jee2330/Exp09.pdf
2. https://www.ti.com/sc/docs/apps/msp/journal/aug2000/aug_07.pdf
3. https://www.homemade-circuits.com/ic-723-voltage-regulator-working-application-circuit/
4. https://link.springer.com/chapter/10.1007/978-3-642-03697-2_8
5. https://da-iitb.vlabs.ac.in/
6. https://vlab.amrita.edu/index.php?sub=59&brch=165&sim=903&cnt=6

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1					1	2	2	3	2	1
CO2	2	2	2	1							2	3	2	1
CO3	3		2	2						1	3	3	2	1
CO4	3	3						1				3	2	1
CO5	3	3	3					1				3	2	1
CO6	3	3	3					1				3	2	1

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23CS1412	PRINCIPLES OF DATA STRUCTURES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- Knowledge of basic Data Structures and their implementations.
- Skills to apply appropriate Data Structures in problem solving.
- Strength and weakness of different Data Structures.
- Importance of Data Structures in context of writing efficient programs.

LIST OF EXPERIMENTS

1. Write a program to implement the Stack operations.
2. Write a program to implement the Queue operations.
3. Write a program to implement the operations on Singly Linked List.
4. Write a program to implement the operations on Doubly Linked List.
5. Write a program to implement the operations on Circular Linked List.
6. Write a Program to perform the given operations on Trees.
   a) Insertion
   b) Deletion
   c) Searching
7. Write a Program to implement the following Tree Traversals Methods
   a) Pre-order
   b) In-order
   c) Post-order
8. Write a program to implement the following Graph Traversal Methods
   a) Breadth First Search
   b) Depth First Search
9. Write a program to implement Minimum Spanning Tree using the following algorithms
   a) Prim's Algorithm
   b) Kruskal's Algorithm
10. Write a Program to implement Single Source Shortest Path algorithm using Dijkstra's algorithm.
11. Write a program to sort the given list of elements using Quick Sort and Merge Sort.
12. Write a program to search an element in the given list of elements using Linear Search and Binary Search.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student will be able to;

CO1 Understand the concept of Stacks and Queues and its application

CO2 Explain the concept of Queues and its application.

CO3 Study about different types of Tree along with their operations and applications.

CO4 Solve problem involving Graphs and its applicability.

CO5 Design efficient algorithms for Sorting.

CO6 Implement efficient algorithms for Searching.

WEB REFERENCES:

1. https://www.hackerrank.com/domains/data-structures
2. https://www.geeksforgeeks.org/data-structures/
3. https://www.codechef.com/learn/topic/data-structures-and-algorithms
4. https://www.javatpoint.com/data-structure-tutorial
5. https://www.programiz.com/dsa.
6. http://www.java2s.com/example/java/data-structure/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2						2	1	2	1
CO2	3	3	3	3	2						2	1	2	1
CO3	3	3	3	3	2						2	1	2	1
CO4	3	3	3	3	2						2	1	2	1
CO5	3	3	3	3	2						2	1	2	1
CO6	3	3	3	3	2						2	1	2	1

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23ES1412	CODING PRACTICES II	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To understand the concepts of Arrays,List ADT.
- To learn linear data structures–stacks and queues ADTs.
- To understand and apply Tree data structures.
- To analyze sorting and searching algorithms.
- To understand and apply Graph structures.

LIST OF EXPERIMENTS

1. Arrays
   a. Initialization of an array
   b. One dimensional array declaration
   c. Two dimensional array declaration
   d. Merge two sorted arrays
   e. Merge sub arrays
   f. Kth largest element in array
   g. Pascal's triangle.

2. ListADT
   a. Print linked list
   b. Linked list to array
   c. Print reverse linked list
   d. Kth element in list
   e. Add an element at kth position in linked list
   f. Remove an element at kth position in linked list
   g. Merge two linked sorted list and remove duplicates from sorted List

3. Queue ADT
   a. Implement queue using arrays.
   b. Implement queue using linked list
   c. Implement queue using stacks
   d. Balanced parentheses.

4. StackADT
   a. Implement stack using arrays
   b. Implement stack using linked list
   c. Implement stack using queues.

5. Problems on Postfix anf Infix expressions.

6. BinaryTreeTraversal

7. Binary Search Tree

8. Linear search algorithm & Binary search algorithm.

9. Sorting algorithms
   a. Selection Sort
   b. Insertion Sort
   c. Merge Sort
   d. Quick sort

10. Graph Traversal algorithms
    a. BFS
    b. DFS
    c. Topological Sorting
11. Minimum Spanning tree
    a. Kruskal Algorithm
    b. Prim's Algorithm

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Implement arrays in data structures.
CO2 Solve real world problems using appropriate linear list data structures.
CO3 Apply appropriate tree data structures in problem solving.
CO4 Implement various searching algorithms.
CO5 Implement various sorting algorithms.
CO6 Implement appropriate Graph representations and solve real-world applications.

SOFTWARE REQUIREMENTS:

1. Anaconda Python Distribution/ TURBO C.

TEXT BOOKS:

1. G. A. Vijayalakshmi Pai," A Textbook of Data Structures and Algorithms, Volume 1", Wiley-ISTE,January 2023.
2. G. A. Vijayalakshmi Pai,"A Textbook of Data Structures and Algorithms, Volume 2: Mastering Nonlinear Data Structures", Wiley-ISTE,February2023.
3. Dr.HarshBhasin,"Data Structures with Python",BPBPublications,Delhi,March2023.
4. John Canning,Alan Broder,RobertLafore,``Data Structures & Algorithms in Python", Addison-Wesley Professional, October 2022.
5. DanielLiang,"IntroductionToPythonProgrammingAndDataStructures",Global Edition 3rd Edition ,Pearson Publications ,November 2022.

REFERENCE BOOKS:

1. Dr.Basant Agarwal,"Hands-On Data Structures and Algorithms with Python",3rd Edition, Packt Publishing,July 2022.
2. Narasimha Karumanchi, "Data Structures and Algorithms Made Easy", Career Monkk Publications, August 2016.
3. Michael H.Goldwasser,MichaelT.Goodrich,and Roberto Tamassia," Data Structures and Algorithms in Python",Wiley Publications 2013.

ONLINE COURSES/RESOURCES:

1. https://www.codechef.com/practice.
2. https://www.javatpoint.com/data-structure-tutorial.
3. https://www.simplilearn.com/tutorials/python-tutorial/data-structures.
4. https://nptel.ac.in/Courses/.

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

SEMESTER V

23EC1501	DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To discuss the concept of sampling and quantization in waveform coding techniques
- To explain various baseband transmission methods, ISI and its mitigation.
- To analyze the various digital modulation schemes
- To categorize the spread spectrum modulation schemes
- To apply Error Control algorithms in Channel coding

UNIT - I WAVEFORM CODING TECHNIQUES 9

PAM, PPM, PWM, Sampling–Aliasing–Quantization — Uniform & non-uniform quantization –Quantization noise –companding–PCM –DPCM –Delta modulation–ADM – Audio Encoding.

UNIT - II BASEBAND TRANSMISSION 9

Properties of Line codes, Power Spectral Density of Unipolar / Polar RZ & NRZ — Bipolar NRZ- Manchester– ISI -Nyquist criterion for distortion less transmission — Pulse shaping-Correlative coding - Eye pattern - Equalization

UNIT - III DIGITAL MODULATIONSCHEMES 9

Signal space representation – GSOP, Generation, detection, PSD & BER of coherent BASK, BPSK, BFSK,QPSK and DPSK – QAM

UNIT - IV SPREAD SPECTRUMMODULATION AND ITS APPLICATIONS 9

Pseudo noise sequences, properties, Generation of PN sequences, direct sequence spread spectrum, processing gain, slow and fast frequency hop spread spectrum. Synchronization- Acquisition, tracking & Jamming considerations.

UNIT - V ERROR CONTROL CODING 9

Channel coding theorem — Linear block codes — Hamming codes — Cyclic codes — Convolutional codes–Viterbi Decoder.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the concept of sampling and quantization in waveform coding techniques.
CO2 Interpret various baseband transmission methods, ISI and its mitigation.
CO3 Compare different digital modulation schemes and their performances.

CO4 Categorize spread spectrum modulation schemes.

CO5 Implement Error Control algorithms in Channel coding.

TEXT BOOKS:

1. HaykinS, Digital Communications, JohnWiley, Student edition, 2016.
2. Bernard Sklar & Fred Harris, Digital Communication Fundamentals and Applications, Pearson Education, third Edition,2021
3. WaynerTomasi, Electronic Communications Systems, Fundamentals through advanced, 5th Edition, Pearson Education, 2019

REFERENCE BOOKS:

1. ProakisJ.G,Digital Communication,TataMcGrawHillCompany,FifthEdition,2018.
2. Sathishkumar, Digital Communication, PHI publication, 2018
3. Lathi B. P, Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition,2017

WEB REFERENCES: (Only accessible Links)

1. http://www.gpmanesar.ac.in/GPContent/Digital%20Communication-e-notes.pdf
2. https://ocw.mit.edu/courses/6-450-principles-of-digital-communications-i-fall-2006/pages/lecture-notes/

ONLINE COURSES / RESOURCES:

1. https://courseware.cutm.ac.in/courses/digital-communication-systems-2/
2. https://www.udemy.com/course/digital-communication-information-theory/?couponCode=IND21PM
3. https://nptel.ac.in/courses/117101051

CO-PO MAPPING

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

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	**60**	**40**	**60**	**100**
40%				**60 %**

23EC1502	DISCRETE TIME SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn Discrete Fourier Transform (DFT) and its linear filtering application.
- To understand the characteristics and design of digital IIR filter.
- To Analyse the characteristics and design of digital FIR filter.
- To understand the effects of finite precision representation on digital filters.
- To Explain the fundamental concepts DSP processor and multi rate signal processing.
- To introduce the concepts of adaptive filters and its application to communication engineering.

UNIT - I DISCRETE FOURIER TRANSFORM & COMPUTATION 9

Analysis & synthesis equations for Discrete Fourier transform (DFT) - Relationship to the DFT to the other Transform-Properties of DFT - periodicity, symmetry, circular convolution, Filtering Long duration sequence - overlap save and overlap add method, Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-infrequency (DIF) Fast Fourier transform (FFT).

UNIT - II DESIGN OF INFINITE IMPULSE RESPONSE FILTERS 9

Characteristics of practical frequency selective filters, characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters, Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Impulse invariance method, Bilinear transformation, Frequency transformation in the analog domain, Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

UNIT - III DESIGN OF LINEAR PHASE FINITE IMPULSE RESPONSE FILTERS 9

Introduction of FIR filters - Design of linear phase FIR filters using windows Rectangular, Hamming and Hanning window, Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations

UNIT - IV FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS 9

Number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation — Signal Scaling.

UNIT - V DSP PROCESSOR AND APPLICATIONS 9

TMS320C54X fixed point and TMS320C3X floating point DSP architectures-DSP applications-Communication Systems, Audio Signal Processing, Control and data acquisition, Biometric information Processing, Image/Video Processing.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Apply DFT for linear filtering applications
CO2 Design IIR filters for various frequency band.
CO3 Design FIR Filters for various frequency band.
CO4 Characterize the effects of finite precision representation on digital filter.
CO5 Study the architecture details and instruction sets of fixed and floating point DSPs
CO6 Implement the signal processing algorithms in DSPs

TEXT BOOKS:

1. John G. Proakis, Dimitris G. Manolaxis," Discrete-Time Signal Processing", 4th Edition, Pearson, 2007.
2. Digital Signal Processing an Introduction, D. sundar rajan, Springer Nature Switzerland AG, ISBN 978-3-030-62368-5, 2021.
3. B. Venkataramani & M. Bhaskar, Digital Signal Processor, Architecture, Programming and Applications,(2/e), McGraw- Hill,2010

REFERENCE BOOKS:

1. P. Ramesh Babu, "Digital Signal Processing", fifth Edition, Scitech Publications in 2014.
2. Understanding Digital Signal Processing, Lyons Richard G, Person Education, ISBN 978-81-317-2114-5, Second impression 2009.
3. Starting Digital Signal Processing in Telecommunication Engineering, Tomasz P.Zielinski,Springer 2021.

WEB REFERENCES: (Only accessible Links)

1. https://www.coursera.org/learn/dsp1.
2. https://extendedstudies.ucsd.edu/courses/digital-signal-processing-(dsp)-ece-40016

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_ee16/preview
2. https://engineering.purdue.edu/online/programs/certificate-programs/digital-signal-processing

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3								1	3	2	2
CO2	3	3	3								1	3	2	2
CO3	3	3	3								1	3	2	2
CO4	3	3	3								1	3	2	2
CO5	3	2	3								1	3	2	2
CO6	3	3	3								1	3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1503	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the architecture and pin configuration of 8086 Microprocessor.
- To illustrate assembly language programs using 8086 microprocessor.
- To explain the architecture and pin configuration of 8051 Microcontroller.
- To interpret the interfacing of 8051 microcontroller.
- To summarize PIC microcontroller architecture.
- To classify different advanced microcontroller.

UNIT - I MICROPROCESSORS 9

Introduction to 8086– architecture– pin description –8086 system configurations- Minimum mode System configuration- Maximum mode system configuration Introduction to advanced microprocessors-80286,80386,80486,pentium I, pentium II,pentium III,pentium IV.

UNIT - II PROGRAMMING OF 8086 9

Addressing modes — Instruction set and assembler directives — Assembly language programming using MASM – Modular Programming – Linking and Relocation – Stacks – Procedures – Macros– Byte and String Manipulation.

UNIT - III 8051 MICROCONTROLLER 9

Architecture of 8051 — Special Function Registers(SFRs) - I/O Pins Ports and Circuits- Interrupts - Instruction set - Addressing modes - Assembly language programming.

UNIT - IV INTERFACING WITH 8051 MICROCONTROLLER 9

Programming 8051 Timers - Serial Port Programming - Interrupts Programming — LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation

UNIT - V ADVANCED MICROCONTROLLERS 9

PIC microcontrollers- architecture and memory organization, registers, I/O ports, interrupts, timer, instruction sets, PIC programming using C, Sensor interfacing, motor control. Introduction to AVR & ARM microcontrollers, Graphics Processing Units- Overview and Types

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Interpret the architecture and pin configuration of 8086 microprocessor.
CO2 Illustrate the instruction sets and addressing modes of 8086 microprocessor.
CO3 Outline the architecture and pin configuration of 8051.
CO4 Identify interfacing of various devices with 8051 microcontroller.
CO5 Explain the architecture of PIC microcontroller.
CO6 Compare the architecture and features of advanced microcontrollers.

TEXT BOOKS:

1. Krishna Kant, “Microprocessors and Microcontrollers”, Prentice Hall of India, 2019.
2. Sunil Mathur, “Microprocessors and Microcontrollers”, PHI learning private limted, 2018.
3. Yu-Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086 / 8088 Family – Architecture, Programming and Design”, Second Edition, Prentice Hall of India, 2007.
4. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, —The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Second Edition, Pearson education, 2011.
5. Mohamed Ali Mazidi, Rolin D. Mckinlay & Danny Sansey, “PIC Microcontroller and Embeded System SPI, UART using Assembly & C for PICI8,” Pearson International Edition, 2008.

REFERENCE BOOKS:

1. Doughlas V.Hall, —Microprocessors and Interfacing, Programming and Hardwarell,TMH,2012
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3 rd edition, Tata McGrawHill, 2012.
3. Advanced Microprocessors and Peripherals – A. K. Ray and K.M. Bhurchandani, TMH, 2nd Edition 2006.
4. The 8051Microcontrollers, Architecture and Programming and Applications -K.Uma Rao, Andhe Pallavi, Pearson, 2009.
5. John .B.Peatman , “Design with PIC Microcontroller”, Prentice Hall, 1997.

WEB REFERENCES: (Only accessible Links)

1. https://mprocessor8086.blogspot.com/p/home.html
2. http://80864beginner.com/
3. http://amcmp.blogspot.in/2012/06/8051-micro-controller.html
4. www.nptel.ac.in
5. http://opencourses.emu.edu.tr/

ONLINE COURSES / RESOURCES:

1. http://nptel.ac.in/courses/108107029/
2. http://nptel.ac.in/courses/106108100/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	1			1	1	3	2	3
CO2	3	3	3	3	2	1	1			1	1	3	2	3
CO3	3	3	3	3	3	1	1			1	1	3	2	3
CO4	3	3	3	3	3	1	1			1	1	3	2	3
CO5	3	3	3	3	2	1	1			1	1	3	2	3
CO6	3	3	3	3	3	1				1	1	3	2	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1504	TRANSMISSION LINES AND WAVEGUIDES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To give an insight on filters.
- To introduce the characteristics of transmission lines at low and high frequencies.
- To give thorough understanding about impedance transformation and matching.
- To use Smith chart in problem solving.
- To impart knowledge on waveguide theories.

UNIT - I FILTER NETWORKS 9

Characteristic impedance of symmetrical networks, Constant K filters: Low Pass, High Pass, Band Pass, and Band Elimination, m-derived filters: Low pass and High pass, Composite filter.

UNIT - II TRANSMISSION LINE THEORY 9

General theory of Transmission lines, General solution, The infinite line, Wavelength, Velocity of propagation, Waveform distortion, Distortion-less line, Loading and different methods of loading, Line not terminated in Z0, Reflection coefficient, Calculation of current, voltage, power delivered and efficiency of transmission, Input impedance, Open and short circuited lines.

UNIT - III HIGH FREQUENCY TRANSMISSION LINES 9

Transmission line equations at radio frequencies, Voltage and current on the dissipation-less line, Standing Waves, Standing Wave Ratio, Input impedance, Impedance matching - Quarter wave transformer, Single and Double stub matching, Solutions of problems using Smith chart.

UNIT - IV GUIDED WAVES BETWEEN PARALLEL PLATES 9

Transmission of TM, TE and TEM waves between Parallel plates, Characteristics of TE, TM and TEM waves - Cut-off frequency, Phase velocity, Group velocity, Phase constant, Wavelength and Impedance.

UNIT - V WAVEGUIDES AND CAVITY RESONATORS 9

Rectangular waveguide and circular waveguide: Transmission of TM and TE waves, Characteristics of TE and TM waves - Cut-off frequency, Phase velocity, Group velocity, Phase constant, Wavelength and Impedance, Impossibility of TEM waves in waveguide, Excitation of modes, Rectangular and Circular cavity resonators.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Design and analyze various filter networks.
CO2 Apply transmission line theory to practical problems.
CO3 Solve high-frequency transmission line problems with impedance matching
CO4 Categorize the characteristics of wave propagation between parallel plates.
CO5 Analyze the behavior of waveguides and cavity resonators.

TEXT BOOKS:

1. John D Ryder, “Networks, lines and fields”, Second Edition, Prentice Hall India, 2015.
2. E.C.Jordan and K.G.Balmain, "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, 2006.

REFERENCE BOOKS:

1. Kuester, Edward, “Theory of Waveguides and Transmission Lines”, 1st edition, CRC press, 2020.
2. G.S.N Raju " Electromagnetic Field Theory and Transmission Lines ” , Pearson Education,First edition 2005
3. Magnusson,P.,Weisshaar,A.,Tripathi,V.,Alexander,G.,“Transmission Lines and Wave Propagation”, 4th edition, CRC Press. 2017.
4. Joseph Edminister, Schaum’s Series, Electromagnetics, TMH, 2007.

WEB REFERENCES:

1. https://www.electronics-notes.com/articles/radio/rf-filters/what-is-constant-k-filter.php#google_vignette
2. https://www.everythingrf.com/community/what-is-propagation-velocity-in-a-cable
3. https://www.rp-photonics.com/phase_velocity.html

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee43/preview
2. https://www.shiksha.com/online-courses/design-of-transmission-line-modelling-and-performance-course-courl6325

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1						1	3	3	3
CO2	3	1	1	1	1						1	3	3	3
CO3	3	1	1	1	1						1	3	3	3
CO4	3	1	1	1	1						1	3	3	3
CO5	3	1	1	1	1						1	3	3	3
CO6	3	1	1	1	1						1	3	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1511	DISCRETE TIME SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To implement generation of sequences.
- To realize Linear Convolution, Circular Convolution and Correlation.
- To analyze frequency spectrum techniques using DFT.
- To design and realize IIR filters
- To design and realize FIR filters.
- To implement signal processing algorithms using digital signal processor application to communication engineering.

LISTOFEXPERIMENTS

1. Generation of elementary Discrete-Time sequences
2. Linear and Circular convolution
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations
7. Study the architecture of Digital Signal Processor
8. Perofrm MAC operation using various addressing modes
9. Generation of various signals and random noise
10. Design and demonstration of FIR filters for Low pass , High pass, BAnd pass and Band stop filtering.
11. Design and demonstration of Butterworth and Chebyshev IIR filters for Low pass , High pass, BAnd pass and Band stop filtering.
12. Implement Up-sampling and Down sampling operation in DSP Processor

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1 Generate the basic signal sequences.

CO2 Implement the basic signal processing operations like convolution and correlation helps to resolve real time applications

CO3 Analyze the frequency domain techniques using DFT.

CO4 Design of IIR Filters for performing filtering operations over real-time signals

CO5 Design of FIR Filters for performing filtering operations over real-time signals.

CO6 Implement signal processing algorithms using digital signal processor.

REFERENCE BOOKS:

1. John G. Proakis, Dimitris G. Manolaxis, —Discrete-Time Signal Processingll, 4th Edition, Pearson, 2007.
2. P. Ramesh Babu, —Digital Signal Processingll, Scitech Publications in 2011.
3. Sanjit K. Mitra, —Digital Signal Processing – A Computer Based Approach, Tata Mc Graw Hill, 2007.

WEB REFERENCES:

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2							2	3	2	2
CO2	3	2	2	1	3						2	3	2	2
CO3	3	3	3	2	3						2	3	2	2
CO4	3	2	2	1	3						2	3	2	2
CO5	3	3	3	2	3						2	3	2	2
CO6	3	2	2	1	3						2	3	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation,Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23EC1512	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To explain the architecture, instruction sets and addressing modes of 8086/8051.
- To demonstrate the ALP concepts, features and Coding methods.
- To execute ALP for arithmetic and logical operations in 8086 and 8051
- To illustrate the instructions, addressing modes, conditional instructions and programming of advanced microcontrollers.
- To implement program for interfacing of external devices with 8051 microcontroller.
- To apply microprocessor/microcontroller based systems in real time applications.

LISTOFEXPERIMENTS

Assembly language programming experiments using 8086:

1. Addition/Subtraction/multiplication/division of 16 bit data.
2. Logical operations(AND/OR/NOT)
3. Data transfer/exchange between specified memory locations.
4. Largest/smallest from a series.
5. Sorting (Ascending/Descending) of data.
6. Matrix addition and subtraction
7. Code conversion-(Hex to Decimal / ASCII to Decimal and vice versa.

Assembly language programming using 8051 and PIC:

8. Addition/Subtraction/multiplication/division of 8/16 bit data
9. Square of a given number.
10. Cube of a given number.
11. Largest/smallest from a series.
12. 1's and 2's complement
13. Logical operations(AND/XOR/NOT/OR)

Interfacing experiments using 8051:

14. Display (LED/Seven segment/LCD) and keyboard interface
15. ADC interface.
16. DAC interface with wave form generation.
17. Stepper motor and DC motor interface
18. Traffic Light Controller .
19. Mini Projects using anyone microcontroller.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Explain the architecture, instruction sets, and addressing modes of 8086 microprocessor and 8051 microcontroller.

CO2 Demonstrate the concepts, features, and coding methods of Assembly Language Programming.

CO3 Develop ALP for arithmetic and logical operations using 8086 and 8051.

CO4 Examine C language programs for solving arithmetic and logical problems using PIC microcontroller.

CO5 Implement interfacing techniques for external devices with the 8051 microcontroller.

CO6 Design microprocessor/microcontroller-based systems for real-time applications.

TEXT BOOKS:

1. Krishna Kant, “Microprocessors and Microcontrollers”, Prentice Hall of India, 2019.
2. Sunil Mathur, “Microprocessors and Microcontrollers”, PHI learning private limted, 2018.
3. Yu-Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086 / 8088 Family — Architecture, Programming and Design”, Second Edition, Prentice Hall of India, 2007.
4. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, —The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Second Edition, Pearson education, 2011.
5. Mohamed Ali Mazidi, Rolin D. Mckinlay & Danny Sansey, “PIC Microcontroller and Embeded System SPI, UART using Assembly & C for PICI8,” Pearson International Edition, 2008

REFERENCE BOOKS:

1. Doughlas V.Hall, —Microprocessors and Interfacing, Programming and Hardwarell,TMH,2012
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3 rd edition, Tata McGrawHill, 2012.
3. Advanced Microprocessors and Peripherals – A. K. Ray and K.M. Bhurchandani, TMH, 2nd Edition 2006.
4. The 8051Microcontrollers, Architecture and Programming and Applications -K.Uma Rao, Andhe Pallavi, Pearson, 2009.
5. John .B.Peatman , “Design with PIC Microcontroller”, Prentice Hall, 1997

WEB REFERENCES:

1. https://mprocessor8086.blogspot.com/p/home.html
2. http://80864beginner.com/
3. http://amcmp.blogspot.in/2012/06/8051-micro-controller.html

CO PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2							1	3	2	3
CO2	3	2	2	1	3						1	3	2	3
CO3	3	3	3	2	3						1	3	2	3
CO4	3	2	2	1	3						1	3	2	3
CO5	3	3	3	2	3						1	3	2	3
CO6	3	2	2	1	3						1	3	2	3

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation,Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23EC1513	ANALOG AND DIGITAL COMMUNICATION LAB	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To study the AM and FM modulation and demodulation
- To learn and realize the effects of sampling and TDM.
- To understand the PCM& DM modulation and demodulation
- To understand Digital modulationand demodulation
- To simulate waveform coding techniques and Digital modulation schemes.
- To implement Error control coding schemes

LIST OF EXPERIMENTS

1. Amplitude Modulator and Demodulator
2. Delta Modulation and Demodulation
3. Line coding techniques
4. Digital modulation – ASK, FSK & PSK
5. Simulation of ASK, FSK and BPSK generation and detection schemes
6. Simulation of QPSK, DPSK and QAM generation schemes
7. Signal Sampling and reconstruction
8. Time Division Multiplexing
9. Pulse Code Modulation and Demodulation
10. Frequency Modulator and Demodulator
11. Simulation of DM, Slope overload noise and Granular noise
12. Simulation of Adaptive Delta modulation
13. Simulation of Frequency Hopping Spread Spectrum, Direct Sequence Spread Spectrum
14. Simulation of Linear Block and Cyclic Error control coding schemes
15. Simulation of Convolutional coding schemes

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Design AM, FM and Digital modulation for specific applications.

CO2 Compute the sampling frequency for digital modulation

CO3 Demonstrate their knowledge in waveform coding signaling schemes

CO4 Demonstrate their knowledge in Digital modulation schemes

CO5 Simulate and validate the various digital modulation schemes

CO6 Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of communication systems

TEXT BOOKS:

1. Simon Haykins,"Communication Systems", Wiley, 5th Edition, 2009
2. B.Preetham Kumar, "Communications System Laboratory, 1st edition, 2016

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2									3	2	3
CO2	3	2	2	1	3								3	2	3
CO3	3	3	3	2	3								3	2	3
CO4	3	2	2	1	3								3	2	3
CO5	3	3	3	2	3								3	2	3
CO6	3	2	2	1	3								3	2	3

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23ES1512	CODING PRACTICES III	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To understand Java Variables and Data Types.
- To perform mathematical operations using Java Operators and Typecasting.
- To learn Control Structures and Looping Statements
- To study Java Strings, Arrays, and Methods
- To implement Object-Oriented Programming with Classes and Objects

LIST OF EXPERIMENTS

1. Java Variables
2. Java Datatype
3. Java Typecasting
4. Java Operators
5. Java String
6. Java Math and Booleans
7. Java If..Else
8. Java Switch, While, for lop, Break and continue
9. Java Array
10. Java Methods
11. Java Classes

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Declare and Use Java Variables and Data Types

CO2 Apply various operators and typecasting techniques to develop efficient Java programs.

CO3 Implement Conditional and Looping Statements

CO4 Manipulate strings, use arrays for data storage, and create reusable methods.

CO5 Implement Java programs using classes, objects, and methods.

TEXT BOOKS:

1. Cay S. Horstmann," Core Java Volume 1: Fundamental", 9th Ed, Prentice Hall, January 2021.
2. Herbert Schildt,"Java: The complete Reference", 7th Ed.,Mc Graw Hill, 2020.

ONLINE COURSES/RESOURCES:

1. https://www.codingbat.com
2. https://www.w3school.com
3. https://www.duckduckgo.com
4. java-exercises/ (Online Practice)

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

SEMESTER VI

23EC1601	WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the concepts of Wireless Channels.
- To study the various multiple access techniques and cellular architecture.
- To explore various digital signaling techniques.
- To comprehend various Multipath mitigation techniques.
- To analyze the concepts of multiple antenna techniques.

UNIT - I **Wireless Channel** **9**

Large scale path loss — Path loss models: Free Space and Two-Ray models -Link Budget design — Small scale fading- Parameters of mobile multipath channels — Time dispersion parameters-Coherence bandwidth — Doppler spread & Coherence time, fading due to Multipath time delay spread — flat fading — frequency selective fading — Fading due to Doppler spread — fast fading — slow fading.

UNIT - II **Cellular Architecture** **9**

Multiple Access techniques for wireless communication - FDMA, TDMA, CDMA, SDMA. Cellular concept- Frequency reuse - channel assignment- hand off- interference & system capacity trunking & grade of service — Coverage and capacity improvement. Evolution of 5G and the Upcoming Utilization of 6G

UNIT - III **Digital Signalling for Fading Channels** **9**

Structure of a wireless communication link, Principles of Offset-QPSK, π/4- DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Modulation performance in fading and multipath Channels, Multicarrier Modulation -OFDM principle — Cyclic prefix, Windowing, PAPR. Introduction to OFDMA

UNIT - IV **Multipath Mitigation Techniques** **9**

Equalization — Adaptive equalization, Linear and Non-Linear equalization, Algorithms for Adaptive Equalization-Factors, Zero forcing, LMS Algorithms and RLS Algorithms. Diversity — Micro and Macro diversity, Selection Diversity Feedback Diversity, Diversity combining techniques, Rake receiver.

UNIT - V **Multiple Antenna** **9**

MIMO systems — spatial multiplexing -System model -Pre-coding- Introduction to Space Time Modulation and Coding-Alamouti scheme- Beam forming –transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels. Introduction to Massive MIMO.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the Concepts of Wireless Channels
CO2 Interpret the various multiple access techniques and cellular architecture.
CO3 Categorize various signaling techniques for wireless channel.
CO4 Investigate various multipath mitigation techniques for the wireless channel
CO5 Analyze the various concepts of multiple antenna techniques.

TEXT BOOKS:

1. Rappaport,T.S., "Wireless communications Principles and Practice", Pearson Education, updated Second Edition, 2024.
2. Andrea Goldsmith,"Wireless Communication", Dian Zi Gong Ye chu ban she, 2020

REFERENCE BOOKS:

1. Shillin Wang, Yunfei cai, Youyun Xu, Yuanyuang cai " Wireles Communicaiton Network Technology and Evolution" World Scientific Publishing-2022
2. T L Singal " Wireless Communications" McGraw Hill Education, 2018
3. ITI Saha Misra " Wireless Communications and Networks 3G and Beyond" McGraw Hill Education-2018
4. Andreas.F. Molisch, "Wireless Communications", John Wiley – India, 2012
5. Upena Dalal, "Wireless Communication", Oxford University Press, 2014.
6. David Tse and Pramod Viswanath,,"Fundamentals of Wireless Communication", Cambridge University Press, 2005.

WEB REFERENCES: (Only accessible Links)

1. https://www.sourcengine.com/blog/the-evolution-of-5g-and-the-upcoming-utilization-of-6g

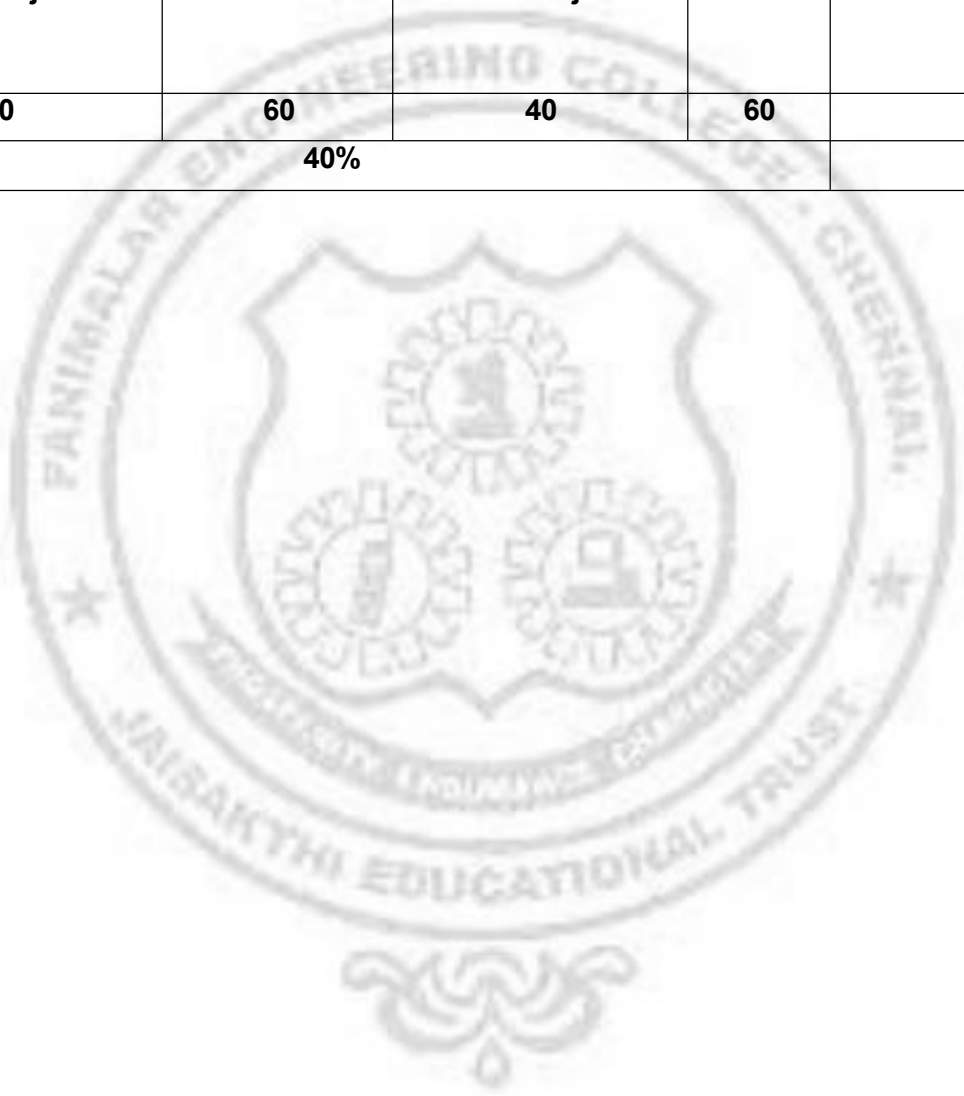
ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/wireless-communications
2. https://www.udemy.com/course/introduction-to-wireless-communications/?couponCode=LEADERSALE24A
3. https://archive.nptel.ac.in/courses/117/102/117102062/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	3	3	1		3	2	3	1
CO2	3	3	2	2	3	2	3	3			3	2	3	1
CO3	3	2	2	2	3	2	3	3			3	2	3	1
CO4	3	3	2	2	3	2	3	3	1		3	2	3	1
CO5	3	3	3		3		3	3			3	2	3	1
CO6	3	3	2	2	3	2	3	3			3	2	3	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %



23EC1602	ANTENNA AND WAVE PROPAGATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To impart knowledge on antenna parameters and wire antennas.
- To interpret the features of various antenna arrays.
- To analyse the radiation mechanism and design procedure of aperture and printed antennas.
- To explain the characteristics of special antennas and antenna
- To describe various radio wave propagation mechanisms.

UNIT I ANTENNA BASICS AND WIRE ANTENNAS 9

Physical concept of radiation, Near and far-field regions, Antenna Gain, Directivity and Efficiency, Radiation resistance, Radiation pattern, Beam width, Bandwidth, Aperture Efficiency and Effective Area, Polarization, Antenna Noise Temperature, Reciprocal of antennas, Friis transmission equation, Radiation Mechanisms of Linear Wire and Loop antennas.

UNIT II ANTENNA ARRAYS 9

Two-element array, n-element array, Array factor, Pattern multiplication, uniformly spaced arrays with uniform and non-uniform excitation amplitudes, Retrodirective arrays, Phased arrays, Yagi array antenna.

UNIT III APERTURE AND PRINTED ANTENNAS 9

Huygene's and Babinet's principles, Slot antenna, Horn antenna, Parabolic reflector antennas, Microstrip antennas, PIFA, Vivaldi antenna.

UNIT IV SPECIAL ANTENNAS AND MEASUREMENTS 9

Frequency independent antennas - Helical antenna, Spiral antenna, LPDA, Smart antenna, Reconfigurable antenna, Active antenna, Dielectric antennas, EBG antennas.Antenna Measurement - Measurement of Gain, Directivity, Polarization and Radiation pattern, Anechoic chamber.

UNIT V PROPAGATION MECHANISMS 9

Structure of atmosphere, Ground Wave Propagation, Ground Reflection, Surface waves, Diffraction, Space wave Propagation, Tropospheric Scatter. Ionospheric propagation: Sky waves, Skip distance, Virtual height, Critical frequency, MUF, Effects of earth's magnetic fields, Faraday rotation, Whistlers.

TOTAL :45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the concept of radiation, antenna parameters and wire antennas.

CO2 Explore the characteristics of uniform and non-uniform antenna arrays.

CO3 Interpret the radiation mechanism and design procedure of aperture and microstrip antennas..

CO4 Examine the characteristics of various special antennas and antenna measurement methods.

CO5 Analyse the various mechanisms of radio wave propagation.

TEXT BOOKS:

1. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, “Antennas and Wave Propagation”: Fifth Edition, Tata McGraw-Hill, 2017.
2. Constantine A.Balanis – “Antenna Theory and Applications”, Fourth edition, John Wiley India Pvt Ltd., 2011.

REFERENCE BOOKS:

1. K.D.Prasad, "Antennas and Wave propagation", Sathya Prabaskar - New Delhi, 2021.
2. Malik, Praveen Kumar, "Printed Antennas" 1st Edition , Softbound, CRC Press, 2022.
3. Robert S.Elliott “Antenna Theory and Design” Wiley Student Edition, 2006.

WEB REFERENCES:

1. https://www.antenna-theory.com/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-638-antennas-and-propagation-spring-2003/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117/104/117104101

CO PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	1						3	3	3	3
CO2	3	3	3	2	1						3	3	3	2
CO3	3	3	2	2	1						1	3	3	3
CO4	3	3	2	2	1						1	3	3	3
CO5	3	2	3	2	1						1	3	3	3
CO6	3	2	2	2	1						2	3	3	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1603	DATA COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the foundational concepts of data communication networks,
- To Apply knowledge of various switching techniques at the Physical layer to facilitate efficient data transmission.
- To analyse the error and flow control protocols in data link layer.
- To explore the different addressing techniques and Routing Protocols.
- To examine the required functionality of flow control and congestion control in transport layer.
- To validate the application layer protocols and security issues.

UNIT - I FUNDAMENTALS AND PHYSICAL LAYER 9

Overview of Data Communications- Networks - Types - Network models - Protocol Layering - TCP/IP protocol suite - OSI Model- Physical Layer- Transmission impairment — Performance, Transmission Modes -Switching- Circuit-Switched Networks- Packet Switching- Datagram Networks- Virtual-Circuit Networks.

UNIT - II DATALINK LAYER 9

Introduction to Data Link Layer - Link layer Addressing- Error Detection and Correction (Cyclic Redundancy Check, Checksum) -Forward Error Correction - Hamming Distance Overview of Datalink Control - DLCservices- Data-Link Layer Protocols - HDLC-Media Access Control (MAC)- Random Access- Controlled Access- Channelization - Standard Ethernet (IEEE 802.3).

UNIT - III NETWORK LAYER 9

Network Layer- Ipv4 Addresses -Internet Protocol (IPV4)- Next Generation IP- IPv6 Addressing- IPv6 Protocol- Transition From IPv4 TO IPv6, Unicast Routing- Routing Algorithms(Distance Vector, Link State, Path Vector)- Unicast Routing Protocols (RIP, OSPF, BGPV4) -Multicast Routing- Introduction- Intradomain Multicast Protocols- Interdomain Multicast Protocols.

UNIT - IV TRANSPORT LAYER 9

Introduction-Transport Layer Protocols -Services-Port Numbers-User Datagram Protocol-Transmission Control Protocol-Services-Segment-TCP Connection Management-TCP Congestion control, Flow Data-Flow Characteristics- Flow Control To Improve QOS.

UNIT - V APPLICATION LAYER 9

Standard Client-Server Protocols-World Wide Web (WWW)-Hyper Text Transfer Protocol (HTTP)- File Transfer Protocol (FTP)-Electronic Mail (SMTP, MIME, IMAP,POP3), Domain Name System (DNS) - Firewalls.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the foundational concepts of data communication networks.

CO2 Identify the various switching techniques in Physical layer.

CO3 Analyse the error and flow control protocols in data link layer.

CO4 Explore the different addressing techniques and Routing Protocols.

CO5 Examine the functionality of various flow control and congestion control mechanism in transport layer.

CO6 Validate various application layer protocols to enable users to access files efficiently.

TEXT BOOKS:

1. Behrouz A. Forouzan, "Data Communications & Networking with TCPIP Protocol Suite", 6th Edition, McGraw Hill, [New York], 2021

REFERENCE BOOKS:

1. JamesF. Kurose, KeithW.Ross,"Computer Networking–A Top-Down Approach Featuring the Internet",SeventhEdition,PearsonEducation,2016.
2. Nader.F.Mir,"Computer and Communication Networks", Pearson Prentice Hall Publishers,2nd Edition,2014.
3. Ying-DarLin, Ren-Hung Hwang,Fred Baker, "Computer Networks: An Open Source Approach",Mc Graw Hill Publisher,2011.
4. LarryL. Peterson, BruceS.Davie, "Computer Networks: A Systems Approach" ,Fifth Edition, Morgan Kaufmann Publishers,2011.

WEB REFERENCES: (Only accessible Links)

1. https://www.imperva.com/learn/application-security/osi-model/
2. https://www.tutorialspoint.com/data_communication_computer_network/physical_layer_switching.htm

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee61/preview
2. https://ocw.mit.edu/courses/6-263j-data-communication-networks-fall-2002/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1			1			1	3	2	2
CO2	3	3	2	1	1			1			1	3	2	2
CO3	3	3	2	1	1			1			1	3	2	2
CO4	3	3	2	1	1			1			1	3	2	2
CO5	3	3	2	1	1			1			1	3	2	2
CO6	3	2	2	1	1			1			1	3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1604	VLSI DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To study the fundamentals of CMOS circuits and its characteristics.
- To understand the process of IC fabrication.
- To familiarize logic styles and power optimization strategies in the design of combinational circuits.
- To analyze the design of sequential digital circuitsand timing issues.
- To apply Data Path Architectural choices involved in VLSI design.
- To discuss ASIC design, FPGA architectures, boards and testability of ICs.

UNIT I MOS TRANSISTOR AND FABRICATION PROCESS 9

MOS transistor basics and characteristics - nMOS, pMOS, Long-Channel I-V Characteristics, C-V Characteristics, Non ideal I-V Effects, DC transfer Characteristics- Static CMOS inverter, βn/βp ratio, Noise margin, CMOS Fabrication and Layout- Layout design rules, Stick Diagrams, Scaling, Fabrication process of pMOS, nMOS and CMOS, Device models.

UNIT II COMBINATIONAL CIRCUIT DESIGN 9

Circuit Families - Static CMOS, Ratioed Circuits, Pass Transistor, Transmission Gates, Dynamic Circuits, Domino, Cascode Voltage Switch Logic (CVSL), Adiabatic Logic, Performance estimation -Delay estimation, Logical effort, Power Consumption and optimization in CMOS - Dynamic Power, Static Power.

UNIT III SEQUENTIAL CIRCUIT DESIGN 9

Static latches and Registers-MUX based, Transmission Gate based, Pass Transistor based (SR, Master Slave, D latch), Dynamic latches and Registers - C2MOS, TSPC, TSPCR, Alternative register styles- Pulse Registers, Sense Amplifier Based Register, Sequential circuit optimization - pipelining, Latch versus Register based pipelines, Timing Issues - Synchronous Design, Clock Distribution Techniques.

UNIT IV DESIGN OF ARITHMETIC BUILDING BLOCKS AND SUBSYSTEM 9

Arithmetic Building Blocks- Data Paths, Adders- Static CMOS Full Adder, Ripple Carry Adder, Carry Bypass Adder, Carry Look Ahead Adder, Koggestone Adder, Carry Save Adder, Multipliers-Array Multiplier, Booth Multiplier, Wallace tree Multiplier, Dadda Multiplier, Barrel Shift Register, CMOS Memories - 4T,6T SRAM and1T,3T DRAM cells.

UNIT V ASIC DESIGN AND TESTING 9

Introduction to ASIC, Types of ASIC - Full Custom and Semi-Custom, FPGA Architectures - SRAM and Flash based, Study of FPGA Development Boards-ZYNQ 7000 series and PYNQ boards, Design for Testability - BIST, IDDQ Testing, Boundary Scan, Design Economics.

TOTAL :45 PERIODS

COURSE OUTCOME(S):

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

CO1 Remember the fundamental concepts of MOS transistors.
CO2 Understand the process of IC fabrication.
CO3 Apply logic styles and power optimization strategies in the design of combinational circuits.
CO4 Analyze the Sequential Circuits and Timing issues.
CO5 Interpret Data Path Architectural choices involved in VLSI System design.
CO6 Develop knowledge on the ASIC design, FPGA architectures, boards and testing of ICs.

TEXT BOOKS:

1. Neil H.E. Weste, David Money Harris , "CMOS VLSI Design: A Circuits and Systems Perspective ", 4th Edition, Pearson, 2017
2. Jan M. Rabaey, Ananta Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design perspective" , 2nd Edition, Pearson, 2016

REFERENCE BOOKS

3. M.J. Smith , " Application Specific Integrated Circuits ", Addisson Wesley, 1997
4. Taraate, Vaibbhav - ASIC Design and Synthesis: RTL Design Using Verilog, Springer Nature, 2021.
5. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim, "CMOS Digital Integrated Circuits: Analysis & Design " , 4th edition, McGraw Hill Education,2013
6. Uyemura, J. P , "CMOS Logic Circuit Design",4 th edition, Springer US ,2013
7. Stephen M. Trimberger, "Field-Programmable Gate Array Technology ", Springer US,2012.
8. Crockett, Louise Helen, Northcote, David, Ramsay, Craig, "Exploring Zynq MPSoC: With PYNQ and Machine Learning Applications" , Strathclyde Academic Media, 2019.

WEB REFERENCES: (Only accessible Links)

1. https://www.xilinx.com/products/silicon-devices/soc/zynq-7000.html
2. https://www.digikey.com/en/articles/build-and-program-fpga-based-designs-quickly-python-jupyter-notebooks
3. https://digilent.com/reference/programmable-logic/pynq-z1/reference-manual

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117106092
2. https://nptel.ac.in/courses/108107129

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	2	2				1	2	3	3	2	3
CO2	3	2	2	2	3				2	2	3	3	2	3
CO3	3	2	3	3	2				2	3	3	3	2	3
CO4	3	2	3	3	3				2	3	3	3	2	3
CO5	3	2	3	3	3				2	3	3	3	2	3
CO6	3	2	3	3	3				2	3	3	3	2	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1611	WIRELESS COMMUNICATION AND NETWORKS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To review various techniques in digital wireless communication.
- To Illustrate beam patterns and radiation characteristics using simulation tools.
- To apply multiple access techniques and reliable data transmission protocols.
- To explore different network protocols and routing algorithms.
- To categorize various network commands.
- To apply multiple access techniques and reliable data transmission protocols.

LIST OF EXPERIMENTS

1. To categorize various network commands.
2. Wireless Channel Simulation using Rayleigh Fading and Distribution
3. OFDM Signal Transmission and Reception
4. TDMA, FDMA and CDMA for wireless communication
5. Implementation of Stop and Wait and Sliding Window Protocols
6. Implementation of IP Commands such as ping, Trace route, nslookup and IP address configuration.
7. To create scenarios and study the performance of networks with CSMA / CA protocol and compare with CSMA/CD protocols.
8. Network Topology – Mesh, Star, Bus, Ring, Hybrid
9. Implementation of Distance vector algorithm
10. Implementation of Link state routing algorithms.
11. Study of Network simulator (NS) and simulation of Congestion Control Algorithms using NS.
12. Implementation of Encryption and Decryption Algorithms using any programming language.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Illustrate wireless channel characteristics and performance of wireless Communication systems.
CO2 Apply simulation tools to implement and test MIMO beam forming algorithms.
CO3 Implement multiple access techniques and Flow Control mechanisms to enhance data reliability in Communication Networks.
CO4 Analyze various network protocols and routing algorithms using appropriate tools.
CO5 Evaluate network performance and configuration using various IP commands.
CO6 Propose solutions for congestion control and security challenges in Communication systems.

TEXT BOOKS:

1. Rappaport,T.S., “Wireless communications Principles and Practice”, Pearson Education, updated Second Edition, 2024.
2. Andrea Goldsmith,“Wireless Communication”, Dian Zi Gong Ye chu ban she, 2020

REFERENCE BOOKS

1. Andreas.F. Molisch, “Wireless Communications”, John Wiley – India, 2012
2. Upena Dalal, “Wireless Communication”, Oxford University Press, 2014.
3. David Tse and Pramod Viswanath,,”Fundamentals of Wireless Communication”, Cambridge University Press, 2005.

WEB REFERENCES

1. https://in.mathworks.com/help/comm/get-started-with-communications-toolbox.html

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2								3	2	2
CO2	3	2	2	1	3							3	2	2
CO3	3	3	3	2	3							3	2	2
CO4	3	2	2	1	3							3	2	2
CO5	3	3	3	2	3							3	2	2
CO6	3	2	2	1	3							3	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23EC1612	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Learn Hardware Descriptive Language (Verilog/VHDL).
- Gain knowledge on fundamental principles Digital System Design using HDL.
- Familiarize importing of logical modules on FPGAs.
- Provide hands on design experience with professional design (EDA) platforms.
- Extract the layouts of Digital and Analog circuits using EDA tools.
- Analyze the performance parameters of Digital and Analog circuits.

LIST OF EXPERIMENTS

Part I: Digital System Design using HDL & FPGA

Simulate the following experiments using Xilinx/Altera Software, perform pre and post synthesis and also implement by Xilinx/Altera FPGA.

1. Design of basic combinational circuits (Multiplexer, Demultiplexer, Encoder and Decoder) using HDL.
2. Design of basic sequential (SR, JK, D, T Flip-flops) circuits using HDL.
3. Design an Adder (Min 8 Bit) using HDL.
4. Design a Multiplier (4 Bit Min) using HDL.
5. Design an ALU using HDL.
6. Design 3-bit synchronous up/down counter using HDL.
7. Design 4-bit Asynchronous up/down counter using HDL.
8. Design a Universal Shift Register using HDL.
9. Design Finite State Machine (Moore/Mealy) using HDL.
10. Design Memories using HDL.

Part-II Digital and Analog Circuit Design

11. Design and simulate a CMOS inverter using digital flow.
12. Design and simulate a CMOS Basic Gates & Flip-Flops .
13. Design and simulate a CMOS Inverting Amplifier.
14. Design and Simulate Basic Common Source, Common Gate and Common Drain Amplifiers.
15. Design and simulate simple 5 transistors differential amplifier. Analyze Gain, Bandwidth and CMRR by performing Schematic Simulations.
16. Mini Project in Digital System Design or Digital and Analog Circuit Design.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1	Write HDL code for basic as well as advanced digital integrated circuit
CO2	Import the logic modules into FPGA Boards
CO3	Synthesize, Place and Route the digital circuits using EDA tools.
CO4	Simulate Digital and Analog circuits using EDA tools
CO5	Extract the layouts of Digital and Analog circuits using EDA tools
CO6	Evaluate the performance parameters of Digital and Analog circuits.

TEXT BOOKS:

1. Neil H.E. Weste, David Money Harris - CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, Pearson, 2017
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje. Nikolic - Digital Integrated Circuits:A Design perspective, Second Edition,Pearson, 2016.

REFERENCE BOOKS

1. Cavanagh, Joseph. Verilog HDL: Digital Design and Modeling. United States: CRC Press, 2017.
2. Bruno, Frank. FPGA Programming for Beginners. United Kingdom: Packt Publishing, 2021.

WEB REFERENCES

1. https://archive.nptel.ac.in/courses/106/105/106105165
2. https://nptel.ac.in/courses/108103179

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1		2	2	1	3	3	2	3
CO2	3	3	3	2	2	1		3	3	1	3	3	2	3
CO3	3	3	3	2	3	2		3	3	2	3	3	2	3
CO4	3	3	3	2	3	2		3	3	2	3	3	2	3
CO5	3	3	3	2	3	2		3	3	2	3	3	2	3
CO6	3	3	3	2	3	2		3	3	2	3	3	2	3

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23ES1612	CODING PRACTICES IV	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To understand Database Querying.
- To perform Data Manipulation
- To design and Manage Databases.
- To analyze SQL Queries for Performance
- To implement Data Security and Access Control

LIST OF EXPERIMENTS

1. Execute queries against a database
2. Retrieve data from a database
3. Insert records in a database
4. Update records in a database
5. Delete records from a database
6. Create new databases
7. Create new tables in a database
8. Create stored procedures in a database
9. Create stored procedures in a database
10. Create views in a database
11. Set permissions on tables, procedures, and views
12. Real time Examples

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

Upon successful completion of the course, student will be able to;

CO1 Execute queries to retrieve specific data from database

CO2 Create, modify, and manage databases and tables.

CO3 Perform CRUD (Create, Read, Update, Delete) operations.

CO4 Implement stored procedures, views, and indexing techniques.

CO5 Manage user permissions and ensure data security.

TEXT BOOKS:

1. James Groff, Paul N Weinberg, Andrew J Oppel," SQL The Complete Reference", 3rd Edition,Mc Graw Hill, 2017.
2. Fawn watson"SQL Coding For Beginners", Notion Press,2022.

ONLINE COURSES/RESOURCES:

1. https://www.w3school.com
2. https://www.Mysql.com
3. https://www.sql server.com

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

SEMESTER VII

23EC1701	EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the concepts of embedded system.
- To study the architecture of ARM processor.
- To identify the basic concepts of embedded interfacing.
- To interpret the interfacing of ARM Processor.
- To explain the real time systems.
- To categorize the real time operating systems.

UNIT - I INTRODUCTION TO EMBEDDED SYSTEM 9

Introduction Embedded systems, Definition, components of embedded Systems, Embedded System Design Process, Design example: GPS , Design flows - Requirement Analysis – Specifications- System analysis and architecture design..

UNIT - II ARM PROCESSOR 9

ARM design philosophy, data flow model and core architecture, registers, program status register, instruction pipeline, interrupts and vector table, operating modes and ARM processor families.

UNIT - III INTERFACING WITH ARM 9

Addressing modes, Instruction Sets: Data processing instructions, branch, load, store instructions, PSR instructions, and conditional instructions. Interfacings- LED blinking, simple I/O Switch, ADC, DAC, Stepper Motor and Sensor Interfacing.

UNIT - IV REAL TIME SYSTEMS 9

Structure of a Real Time System — Estimating program run times – Task Assignment and Scheduling Scheduling Algorithms, Classical Uniprocessor Scheduling Algorithms- Rate-Monotonic Scheduling Algorithm, Earliest-Deadline-First Scheduling, Uniprocessor Scheduling of Iris Tasks.

UNIT - V PROCESSES AND OPERATING SYSTEMS 9

Introduction — Multiple tasks and multiple processes — Multirate systems- Preemptive realtime operating systems- Interprocess communication mechanisms, Example Real time operating systems-POSIX-Windows CE.

TOTAL :45 PERIODS

COURSE OUTCOME(S):

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

CO1 Summarize the concepts of embedded systems.
CO2 Interpret the architecture ARM processor.
CO3 Outline the basic concepts of embedded interfacing.
CO4 Illustrate interfacing techniques with ARM processor.
CO5 Analyze the real time systems
CO6 Discuss the real-time real time operating systems.

TEXT BOOKS:

1. Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Third Edition, Morgan Kaufmann, 2012.
2. Jane W.S.Liu," Real Time Systems", Pearson Education, Third Indian Reprint, 2003.

REFERENCE BOOKS:

1. Lyla B.Das, "Embedded Systems : An Integrated Approach" Pearson Education, 2013.
2. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.
3. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison Wesley Professional, 2007.
4. Raymond J.A. Buhr, Donald L.Bailey, "An Introduction to Real-Time Systems- From Design to Networking with C/C++", Prentice Hall, 1999.
5. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2005.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2								2	3	2	1
CO2	3	3	2								2	3	2	1
CO3	3	3	2								2	3	2	1
CO4	3	3	2								2	3	2	1
CO5	3	3	2								2	3	2	1
CO6	3	3	2								2	3	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	**60**	**40**	**60**	**100**
40%				**60 %**

23EC1702	OPTICAL COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To know about basic elements of optical fiber, various modes and configurations.
- To understand transmission characteristics and measurements of optical fibers.
- To study optical sources and its performance.
- To learn about optical detectors and its performance.
- To outline the concepts of optical fiber networks.
- To enrich the knowledge about optical networks routing and switching.

UNIT - I INTRODUCTION TO OPTICAL FIBER COMMUNICATION 9

Introduction - The General Systems - Advantages of Optical Fiber Communication- Ray Theory Transmission: Total Internal Reflection, Acceptance Angle, Numerical Aperture, Skew Rays - Electromagnetic Mode Theory for Optical Propagation: Modes in a Planar Guide, Phase and group velocity - Cylindrical Fiber: Step index fibers, Graded index fibers - Single mode fibers: cut-off wavelength.

UNIT - II TRANSMISSION CHARACTERISTICS AND MEASUREMENTS OF OPTICAL FIBERS 9

Attenuation - Material absorption losses in silica glass fibers: Intrinsic absorption, Extrinsic absorption - Linear scattering losses, Nonlinear scattering losses, Fiber Bend Loss — Dispersion- Chromatic dispersion: Material dispersion, Waveguide dispersion- Intermodal dispersion: Multimode step index fiber, Multimode graded index fiber. Measurement: Attenuation, Dispersion, Numerical Aperture, Cut off Wavelength.

UNIT - III OPTICAL SOURCES AND OPTICAL DETECTORS 9

LED: Power and Efficiency - LED structures: Planar LED, Dome LED, Surface emitter LED, Edge emitter LED- LED Characteristics, The laser: Basic concepts: Absorption and emission of radiation, Population inversion, Optical feedback and laser oscillation, Threshold condition for laser oscillation, Optical emission from semiconductors, Optical Detectors: Optical Detection Principles, Quantum Efficiency, Responsivity, P-N Photodiode, P-I-N Photodiode and Avalanche Photodiode.

UNIT – IV OPTICAL NETWORKS 9

Introduction- Optical Network Concepts: Optical Networking Terminology, Optical Network Node and Switching Elements, Wavelength Division Multiplexed Networks, Public Telecommunications Network Overview- Optical Network Transmission Modes, Layers and Protocols: Synchronous Networks, Asynchronous Transfer Mode, Open System Interconnection Reference Model

UNIT - V ROUTING AND SWITCHING OF OPTICAL NETWORKS 9

Wavelength Routing Networks- wavelength routing and assignments, Optical Switching Networks- circuit-switched and packet-switched networks, Optical Network Deployment- long haul networks, Metropolitan networks, Access networks, Local area networks, Optical Ethernet, Network protection, restoration and survivability.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Explain basic elements in optical fibers, different modes and configurations.
CO2 Illustrate the transmission characteristics and measurements associated with dispersion and polarization techniques.
CO3 Summarize optical sources with their use in optical communication systems.
CO4 Compare optical detectors and its performance.
CO5 Interpret the concepts of fiber optic networks.
CO6 Analyze optical networks routing and switching.

TEXT BOOKS:

1. John M. Senior, “Optical Fiber Communication”, Pearson Education, Fourth Edition, 2010.
2. Rongqing hui, “Introduction to optical Communication”, Elsevier Academic press, 2020.

REFERENCE BOOKS:

1. Gred Keiser, "Optical Fiber Communication”, McGraw Hill Education (India) Private Limited, Fifth Edition, Reprint 2013.
2. P Chakrabarti, "Optical Fiber Communication”, McGraw Hill Education (India) Private Limited, 2016.
3. T. L. Singal, “Optical Fiber Communications- Principles and Applications”, Cambridge University press, 2016.
4. Alberto Paradisi, “Optical Communication –Advanced systems and devices for next generation networks”, springer, 2019.
5. Partha Pratim Sahu, “Advances in Optical Networks and Components”, CRC press Taylor and Francis group, 2021.

WEB REFERENCES: (Only accessible Links)

1. https://www.tutorialspoint.com/principles_of_communication/principles_of_optical_fiber_communications.htm
2. https://ocw.mit.edu/courses/6-637-optical-signals-devices-and-systems-spring-2003/

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc23_ee76/preview
2. https://onlinecourses.nptel.ac.in/noc23_ee61/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2								1	3	2	2
CO2	3	3	2								2	3	2	2
CO3	3	3	2								1	3	2	2
CO4	3	3	2								1	3	2	2
CO5	3	2	1								1	3	2	2
CO6	3	2	1								1	3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1703	MICROWAVE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basic concepts of microwave networks
- To explore several microwave passive devices
- To study the working of microwave diodes
- To build a strong foundation on microwave tubes
- To interpret the various microwave measurement techniques
- To elaborate on applications of microwave engineering

UNIT - I MICROWAVE NETWORK THEORY 9

Microwave frequency bands, Elemental theory of low frequency parameters: Z, Y, H & ABCD. High Frequency parameters, Formulation of S parameters, S Matrix representation of multiport network, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix.

UNIT - II MICROWAVEPASSIVE DEVICES 9

Theory and analysis: Microwave T and Hybrid Junctions: E plane, H plane and Magic Tee. Waveguide Directional Coupler, T junction and Wilkinson Power Divider, Phase shifters, Attenuator, Circulator, Isolator, Matched termination.

UNIT - III MICROWAVE ACTIVE DEVICES 9

Crystal and Schottky diode, PIN diode, Gunn diode, Tunnel diode, IMPATT diode, Varactor diode. Microwave tubes: two cavity Klystron Amplifier, Reflex Klystron oscillator, Traveling wave tube amplifier, Cylindrical Magnetron oscillator.

UNIT - IV MICROWAVEMEASUREMENTS 9

Microwave Measuring Instruments: VSWR meter, Power meter, Spectrum analyzer, and Vector network analyzer. Measurement of Impedance, Q-factor, Dielectric constant, Attenuation, S-parameters, Frequency measurement methods: Wave meter, Slotted line and Down conversion. Power, VSWR and Return Loss measurement.

UNIT - V APPLICATIONS OF MICROWAVES 9

Microwave RADAR systems: Introduction, Duplexer, Pulsed Radar, CW Radar, Tracking Radar and Monopulse Radar, Radiometer systems: Total power radiometer, Dicke radiometer, Microwave communication systems: Terrestrial and Satellite, Industrial Applications, Heating, Power transfer and Medical Applications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Show the use of microwave networks

CO2 Demonstrate the use of various microwave passive devices

CO3 Interpret the working of microwave diodes

CO4 Familiarilize on microwave tubes

CO5 Infer several microwave parameter measurement techniques

CO6 Outline on applications of microwave engineering

TEXT BOOKS:

1. Annapurna Das and Sisir K Das, “Microwave Engineering”, Fourth Edition, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2020.
2. DavidM.Pozar,"MicrowaveEngineering",FourthEdition,WileyIndia,2012.

REFERENCE BOOKS:

1. Robert E Colin,“Foundations for Microwave Engineering”, JohnWiley & Sons Inc, 2005.
2. Samuel Y Liao, “Microwave Devices & Circuits”, Prentice Hall ofIndia,2006.
3. Thomas H Lee, “Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits”, Cambridge University Press, 2004.

WEB REFERENCES: (Only accessible Links)

1. http://www.ittc.ku.edu/~jstiles/622/handouts/section_2E_Microwave_Network_Theory_package.pdf
2. https://d13mk4zmvuctmz.cloudfront.net/assets/main/study-material/notes/electronics-communication_engineering_microwave-engineering_microwave-passive-devices_notes.pdf
3. https://www.ssgmce.ac.in/student_resource/Electronics%20&%20Telecommunication%20Engg./ UHF%20and%20Microwaves_4U/Unit_II.pdf
4. https://uspas.fnal.gov/materials/10MIT/Lecture13.pdf
5. https://www.slideshare.net/slideshow/presentation-on-applications-of-microwave/158755722

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/103/108103141/
2. https://archive.nptel.ac.in/courses/108/101/108101112/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3								3	3	2	2
CO2	3	3	3								3	3	2	2
CO3	3	3	3								3	3	2	2
CO4	3	3	3								3	3	2	2
CO5	3	3	3								3	3	2	2
CO6	3	3	3								3	3	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	**60**	**40**	**60**	**100**
40%				**60 %**

23EC1711	EMBEDDED SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To study the working of ARM processor.
- To understand the Building Blocks of Embedded Systems.
- To relate the concept of memory map and memory interface.
- To implement programs to interface memory, I/Os with processor.
- To demonstrate the interrupt performance
- To design ARM Processor based system

LIST OF EXPERIMENTS

EXPERIMENTS USING ARM

1. Study of ARM evaluation system
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Mailbox.
8. Interrupt performance characteristics of ARM and FPGA.
9. Flashing of LEDS.
10. Interfacing stepper motor and temperature sensor.
11. Implementing zigbee protocol with ARM.
12. Mini Project using Embedded systems.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify applications using ARM processor.
CO2 Illustrate programs in ARM for a specific Application.
CO3 Interface A/D and D/A convertors with ARM system
CO4 Analyze the performance of memory , interrupts.
CO5 Implement program for interfacing keyboard, display, motor and sensor.
CO6 Design a mini project using embedded system.

TEXT BOOKS:

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc20_cs93/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3								3	3	2	2
CO2	3	2	2								2	3	2	2
CO3	3	3	3								3	3	2	2
CO4	3	2	2								2	3	2	2
CO5	3	3	3								3	3	2	2
CO6	3	2	2								2	3	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

23EC1712	OPTICAL AND MICROWAVE COMMUNICATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To understand the working principle of optical sources, detector, fibers
- To learn simple optical communication link
- To demonstrate the measurement of BER, Pulse broadening
- To explain the characteristics of Microwave Devices
- To measure Various Microwave parameters
- To Identify the characteristics of Microwave IC Filter

LIST OF EXPERIMENTS

OPTICAL EXPERIMENTS

1. Measurement of connector, bending and fiber attenuation losses.
2. Numerical Aperture and Mod eCharacteristics of Fibers.
3. DC Characteristics of LED and PIN Photodiode.
4. Fiberoptic Analog and Digital Link Characterization-frequency response (analog), eye diagram and BER (digital)

MICROWAVE EXPERIMENTS

Study ofVarious Microwave Components

2. VSWR and Impedance Measurement and Impedance Matching
3. Characterization of Directional Couplers, Isolators, Circulators
4. Characteristics of Gunn Diode
5. Characteristics of Reflex Klystron Oscillator
6. Microwave IC–Filter Characteristics

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1 Demonstrate the performance of simple optical link by measurement of losses and analyzing the mode characteristics of fiber.
CO2 Illustrate the simple Optical communication Link.
CO3 Identify the Eye Pattern, Pulse broadening of optical fiber and the impact on BER.
CO4 Inspect the intricacies in Microwave System design.
CO5 Measure the various Microwave parameters.
CO6 Examine the characteristics of Microwave IC Filter.

TEXT BOOKS:

1. Annapurna Das and Sisir K Das, “Microwave Engineering”, Fourth Edition, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2020.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3								3	3	2	2
CO2	3	3	3								3	3	2	2
CO3	3	3	3								3	3	2	2
CO4	3	3	3								3	3	2	2
CO5	3	3	3								3	3	2	2
CO6	3	3	3								3	3	2	2

Internal Assessment		**End Semester Examination**
Evaluation of Laboratory Observation, Record	**Test**	**Practical**
75	**25**	**100**
60 %		**40%**

VERTICAL I BIOMEDICAL TECHNOLOGIES

23EC1901	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To explain the principles and challenges of bioelectrode interfaces.
- To demonstrate the methods for measuring various physiological signals.
- To analyse and evaluate different bio-potential amplifier designs to determine the most suitable one for specific applications.
- To identify techniques for measuring non-electrical physiological parameters.
- To describe and discuss biochemical measurement methods and sensors.
- To apply principles and techniques of Electrophoresis, photometer, blood cell counter.

UNIT I BIPOTENTIAL ELECTRODES 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode — skin interface and motion artifacts, polarizable and nonpolarizable electrodes. Body - surface recording electrodes, internal electrodes, microelectrodes and their equivalent circuits.

UNIT II ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT 9

Bio signal characteristics– frequency and amplitude ranges. ECG — Einthoven ‘s triangle, standard 12 lead system, block diagram. Measurements of heart sounds - PCG. EEG — 10- 20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG – unipolar and bipolar mode, block diagram, EOG and ERG block diagram.

UNIT III BIPOTENTIAL AMPLIFIERS 9

Bioelectric amplifier basic requirements, Basic amplifier configurations, Instrumentation amplifier, Isolation amplifier - Basic design, Battery powered, optically coupled, current loading, chopper stabilized amplifiers, Differential chopper amplifier, ECG preamplifier with right leg and shield drive.

UNIT IV NON ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT 9

Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure: indirect methods - auscultatory method, oscillometric method, ultrasound. Blood flow - Electromagnetic and ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method.

UNIT V BIOCHEMICAL MEASUREMENT 9

Blood gas and acid - base physiology, Biochemical sensors - measurement of pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors, Electrophoresis,, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify and explain the origin and propagation of bio-potentials.

CO2 Measure and analyse different physiological signals accurately.

CO3 Design and implement effective bio-potential amplifiers.

CO4 Analyse different non-electrical physiological signals accurately.

CO5 Utilize biochemical sensors and measurement techniques effectively.

CO6 Interpret data from Electrophoresis, photometer, blood cell counter to analyse lab experiments.

TEXT BOOKS:

1. John G. Webster and Amit J. Nimunkar, “Medical Instrumentation: Application and Design,” 5th Edition, Wiley-Blackwell, 2020.
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”, Pearson Education, 4th Edition, 2018

REFERENCE BOOKS:

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India, 2nd Edition, 2018.
3. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”,McGraw - Hill Publisher, 2013

WEB REFERENCES: (Only accessible Links)

1. https://www.coursera.org/learn/biomedical-instrumentation
2. https://www.nibib.nih.gov/
3. https://pubmed.ncbi.nlm.nih.gov/
4. https://openstax.org/details/books/biomedical-instrumentation

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/biomedical-instrumentation
2. https://www.edx.org/professional-certificate/epflx-biomedical-signal-processing
3. https://www.udemy.com/course/biomedical-engineering-fundamentals/
4. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-582j-medical-device-development-spring-2006/
5. https://nptel.ac.in/courses/103/104/103104122/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2									2	3	1	2
CO2	2	3		2	2						2	3	1	2
CO3	3	2	3	2	3					2	2	3	2	2
CO4	2	3		3	2						2	3	3	2
CO5	2	2	2	2	3					2	3	3	2	3
CO6	3	2	3	3	3					3	3	3	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1902	DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the operation and application of cardiac pacemakers and defibrillators.
- To describe various respiratory care equipment and their applications.
- To gain knowledge of physiotherapy, electrotherapy and phototherapy equipment.
- To demonstrate bone density measurement techniques and their diagnostic significance..
- To describe the sensory diagnostic equipment for hearing and skin response..
- To study surgical and therapeutic equipment and their clinical uses.

UNIT I CORONARY CARE EQUIPMENTS 9

Cardiac pacemakers: different modes of operation, external and implantable pacemakers, pacemaker standard codes, Defibrillator: AC and DC defibrillator, Implantable defibrillator and automated external defibrillator (AED), Pacer- cardioverter defibrillator, defibrillator analysers, Heart lung machine (HLM) and types of oxygenators.

UNIT II PHYSIOTHERAPY, ELECTROTHERAPY AND PHOTOTHERAPY EQUIPMENTS 9

Short wave diathermy, Microwave diathermy, Ultrasonic therapy unit, Electro diagnostic and therapeutic apparatus, Interferential current therapy, Transcutaneous electrical nerve stimulation (TENS), Spinal cord stimulator, bladder stimulator, deep brain stimulation, Photo therapy unit.

UNIT III INSTRUMENTS DEALING WITH BONES AND RESPIRATORY CARE 9

Respiratory care equipments: humidifier, nebulizer, aspirators, Ventilators and types, Anesthesia machine, Baby incubator, BMD measurements: Single X-ray absorptiometry (SXA), Dual X-ray absorptiometry (DXA), Quantitative ultrasound bone densitometer

UNIT IV SENSORY DIAGNOSIS AND HEARING AID EQUIPMENTS 9

Mechanism of hearing, sound conduction system, basic audiometer, pure tone audiometer, Speech audiometer, bekesyaudiometer system, Evoked response audiometry system, Hearing aids, cochlear implants, Tonometry, Measurement of basal skin response and galvanic skin response.

UNIT V SURGICAL AND THERAPEUTIC EQUIPMENTS 9

Surgical diathermy unit, Endoscopy basic components and types, Laparoscope, gastro scope, bronchoscope, Cryogenic techniques and application, Operating microscope, arthroscopy, Modern lithotripter system, laser lithotripsy

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Describe the modes of operation for cardiac pacemakers and types of defibrillators.

CO2 Explain respiratory care equipment like humidifiers, nebulizers, and ventilators.

CO3 Explain the principles of short wave diathermy, microwave diathermy, and ultrasonic diathermy.

CO4 Apply bone density measurement techniques using SXA, DXA and quantitative ultrasound.

CO5 Select, operate and troubleshoot hearing aids and cochlear implants.

CO6 Demonstrate the use and functioning of surgical instruments and endoscopes.

TEXT BOOKS:

1. John G. Webster and Amit J. Nimunkar, “Medical Instrumentation: Application and Design,” 5th Edition, Wiley-Blackwell, 2020.
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”, Pearson Education, 4th Edition, 2018.

REFERENCE BOOKS:

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
2. Robert M. Kacmarek, James K. Stoller, and Al Heuer, "Egan's Fundamentals of Respiratory Care" Elsevier Health Sciences, 2021
3. David C. Shelledy and Jay I. Peters, "Mechanical Ventilation: Clinical Applications and Pathophysiology", Jones & Bartlett Learning Publisher, 2019
4. Sydney Lou Bonnick, Bone Densitometry in Clinical Practice", Humana Press, 2017
5. Steven Kramer and David K. Brown, "Audiology: Science to Practice", Plural Publishing, 2019
6. Jan P. Schmulder and Mario Manto, "Evoked Potential Audiometry: Fundamentals and Applications", Springer, 2020
7. Massimo Bellini and Guido Monfrecola, "Endoscopy in the Diagnosis and Management of Acute and Chronic Disorders of the Gastrointestinal Tract", Springer, 2020
8. Xinguang Qiu, "Minimally Invasive Surgical Procedures: Advances in Research and Application" Nano Science Publishers, 2019

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1. https://www.aarc.org/
2. https://www.niams.nih.gov/
3. https://www.rsna.org/
4. https://www.asha.org/
5. https://hearinghealthfoundation.org/
6. https://www.asge.org/
7. https://www.psnacet.edu.in/BE-BME/BME-DTEL.php
8. https://www.drngpit.ac.in/study/undergraduate/bio-medical/laboratory/diagnostic-therap-equip

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/respiratory-care
2. https://iscd.org/learn/live-courses/quality-bone-densitometry-clinicians/
3. https://www.coursera.org/learn/surgical-procedures
4. https://onlinecourses.swayam2.ac.in/nou23_bt05/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1							3	3	1	2
CO2	3	2	2	1							3	3	1	2
CO3	3	2	2	1							3	3	2	2
CO4	3	2	2	1							3	3	3	2
CO5	3	2	2	1							3	3	2	3
CO6	3	2	2	1							3	3	2	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1903	WEARABLE DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To analyse the motivation and applications of wearable devices across industries.
- To evaluate the significance of wearable sensors in healthcare and other sectors.
- To apply knowledge of wearable inertial sensors to assess physical activity and health conditions.
- To design wearable device solutions for healthcare needs, integrating ecg, eeg, emg, and vital signs measurement.
- To compare and contrast various wearable sensors for tracking and monitoring purposes.
- To identify future trends and challenges in wearable device technology.

UNIT I INTRODUCTION TO WEARABLE DEVICES 9

Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview — sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

UNIT II WEARABLE INERTIAL SENSORS 9

Wearable Inertial Sensors - Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients. Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

UNIT III WEARABLE DEVICES FOR HEALTH CARE 9

Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode–Skin Interface; Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, electrodes and instrumentation; Wearable EMG devices: EMG/ SEMG Signals, EMG Measurement — wearable surface electrodes, SEMG Signal Conditioning, Epidermal Electronics Systems. Wearable Blood Pressure (BP) Measurement, Body Temperature sensor.

UNIT IV WEARABLE SENSOR FOR TRACKING AND MONITORING 9

Wearable devices with Global Positioning System (GPS) integration for tracking and navigation, Wearable Optical Sensors -chemical sensors, optical glucose sensors, UV exposure indicators, speech recognition using lasers; Photoplethysmography (PPG), 3D imaging and motion capture.

UNIT V SCOPE OF WEARABLE DEVICES 9

Role of Wearable sensors, Attributes of Wearable sensors, The Meta Wearables — Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearable: Challenges and Opportunities, Future and Research Roadmap.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the motivation behind wearable device development and its applications across various industry sectors.
CO2 Evaluate the effectiveness of wearable sensors in healthcare.
CO3 Apply knowledge of wearable inertial sensors to assess health conditions.
CO4 Generate innovative wearable device solutions for healthcare needs.
CO5 Compare and contrast different wearable sensors for tracking purposes.
CO6 Predict future trends and challenges in wearable device technology.

TEXT BOOKS:

1. Edward Sazonov, Michael R Neuman, “Wearable Sensors: Fundamentals, Implementation and Applications” Elsevier, 2021.
2. Onur Parlak, Alberto Salleo, Anthony Turner, “Wearable Bioelectronics” Matthew Deans, Elseiver, 2020..

REFERENCE BOOKS:

1. Giovanni Saggio and Antonio Esposito, Wearable Technology for Healthcare: From Diagnosis to Therapy", CRC Press, 2020.
2. Nilanjan Dey, Amira S. Ashour, Simon James Fong,” Wearable and Implantable Medical Devices: Applications and Challenges” Academic Press, 2020
3. Seamless Healthcare Monitoring”, Toshiyo Tamura and Wenxi Chen, Springer 2018
4. Raymond J. R. Wiley, “Wearable Technologies and Wireless Health Monitoring: The Future of Medicine”, CRC Press, 2017.

WEB REFERENCES: (Only accessible Links)

1. https://pubmed.ncbi.nlm.nih.gov/
2. https://www.wearable-technologies.com/
3. https://www.mobihealthnews.com/

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/wearable-sensors-healthcare
2. https://www.coursera.org/learn/wearable-electronics-measuring-human-physiology
3. https://www.coursera.org/learn/introduction-to-biomedical-imaging

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1							3	**3**	**1**	**2**
CO2	3	2	2	1							3	**3**	**1**	**2**
CO3	3	2	2	1							3	**3**	**2**	**3**
CO4	3	2	2	1							3	**2**	**3**	**3**
CO5	3	2	2	1							3	**2**	**2**	**3**
CO6	3	2	2	1							3	**2**	**3**	**3**

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1904	BODY AREA NETWORKS AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the technical challenges of body area networks (BAN) in healthcare.
- To analyse the hardware components and design considerations for BAN systems.
- To describe various communication technologies and network designs used in BAN.
- To evaluate coexistence issues, interferences, and regulatory concerns in BAN.
- To apply knowledge of BAN for developing patient monitoring and telemedicine solutions.
- To identify practical applications of BAN in healthcare and sports medicine.

UNIT I INTRODUCTION TO BAN 9

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture — Introduction.

UNIT II HARDWARE FOR BAN 9

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes, design of Implanted sensor nodes for WBAN.

UNIT III WIRELESS COMMUNICATION AND NETWORK 9

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee, WBAN Network Design Techniques.

UNIT IV COEXISTENCE ISSUES WITH BAN 9

Interferences — Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.

UNIT V APPLICATIONS OF BAN 9

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill, Telemedicine.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Discuss technical challenges and architecture of BAN.
CO2 Identify and explain hardware components and design considerations for BAN.
CO3 Analyse communication technologies and network design techniques in BAN.
CO4 Evaluate interference issues, regulatory requirements, and security protocols in BAN.
CO5 Develop BAN solutions for telemedicine and patient monitoring applications.
CO6 Assess effectiveness of BAN applications in chronic disease monitoring and sports medicine.

TEXT BOOKS:

1. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability’’, Cambridge University Press, 2013.
2. Mehmet R. Yuce, Jamil Y.Khan, “Wireless Body Area Networks Technology, Implementation, and Applications”, Pan Stanford Publishing Pte. Ltd., Singapore, 2012.

REFERENCE BOOKS:

1. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems’’, Springer, 2013.
2. Guang-Zhong Yang(Ed.), “Body Sensor Networks’’, Springer, 2006.
3. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011

WEB REFERENCES: (Only accessible Links)

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7412528/

ONLINE COURSES / RESOURCES:

1. https://www.tonex.com/training-courses/wireless-body-area-network-training-wban/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2		2						2	2	3	2	1
CO2	3	3	2	3						2	3	3	2	2
CO3	3	2	3	3						2	3	3	2	2
CO4	3	2	3	2					2	2	3	2	3	2
CO5	2	3	2	3					2	2	2	2	2	3
CO6	2	3	2	3					2	3	2	2	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1905	TELEMEDICINE AND TELEHEALTH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the principles and applications of wireless technology in patient monitoring.
- To explore various technologies employed in medical information processing.
- To analyse the deployment considerations and challenges of wireless telemedicine systems
- To develop robust measures to safeguard medical data and privacy.
- To apply telecare solutions for community healthcare support.
- To assess the impact of telemedicine on rural healthcare access.

UNIT I WIRELESS TECHNOLOGY IN PATIENT MONITORING 9

Different definitions of telemedicine, Wireless communication basics, Types of Wireless networks, Body Area Networks, Emergency Rescue - Smart Ambulance, Network Backbone, Remote Recovery - At Sea, Forests and Mountains, Buildings on Fire, Smart Hospital - Radiology Detects Cancer and Abnormality, Robot Assisted Telesurgery, Ward Management Using RFID.

UNIT II TECHNOLOGIES IN MEDICAL INFORMATION PROCESSING 9

Collecting Data form Patients - Body Temperature, Heart Rate, Blood Pressure, Respiration Rate, Blood Oxygen Saturation, Biosignal Transmission and Processing - Medical Imaging, Medical Image Transmission and Analysis - Image Compression - Biopotential Electrode Sensing - Patient Records and Data Mining Applications, knowledge Management for Clinical Applications ,Electronic Drug Store.

UNIT III WIRELESS TELEMEDICINE SYSTEM DEPLOYMENT 9

Planning and Deployment Considerations - OSI Model, Link Budget evaluation, antenna placement, Scalability to Support Future Growth - Modulation, Cellular configuration, Multiple Access, Orthogonal Polarization, Integration with existing IT infrastructure - Middleware, Involving different people, Evaluating IT Service and Solution Provider - outsourcing, coping with emerging technologies, Quality measurement.

UNIT V TECHNOLOGIES FOR SAFEGUARDING MEDICAL DATA AND PRIVACY 9

Information Security Overview, Cryptography - Symmetric Cryptography, Asymmetric Cryptography, Digital Signature, Safeguarding Patient Medical History - National Electronic Patient Record, Personal Controlled Health Record (PCHR), Anonymous Data Collection and Processing - Information Sharing Between Different Authorities and Agencies, Disease Control, Policy Planning, Biometric Security and Identification.

UNIT V CARING FOR THE COMMUNITY 9

Telecare, Safeguarding Senior Citizens and the Aging, Telemedicine in Physiotherapy - Movement Detection, Physical Medicine and Rehabilitation, Healthcare Access for Rural Areas, Healthcare technology and the environment - Medical Radiation: Risks, Myths, and Misperceptions.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify the knowledge of different wireless communication basics and their relevance in patient monitoring.
CO2 Apply various technologies for collecting and processing medical data from patients.
CO3 Design deployment strategies for wireless telemedicine systems.
CO4 Implement information security measures effectively.
CO5 Utilize telecare solutions for community healthcare.
CO6 Evaluate telemedicine's role in improving rural healthcare access.

TEXT BOOKS:

1. Telemedicine Technologies information technologies in medicine and telehealth, Bernard Fong, Wiley (2020)
2. Shashi Gogia, Fundamentals of Telemedicine and Telehealth, Academic Press, 2020

REFERENCE BOOKS:

1. A.C.Norris, “Essentials of Telemedicine and Telecare,” Wiley, 2022
2. Marjorie Gott, “Telematics for Health”, CRC Press, 2016
3. Halit Eren, John G.Webster, “Telehealth and Mobile Health”, CRC Press, 2016

WEB REFERENCES: (Only accessible Links)

1. http://www.telemedtoday.com/articlearchive/articles/telesurgery.htm
2. https://www.telehealthresourcecenter.org/
3. https://www.cchpca.org/
4. https://pubmed.ncbi.nlm.nih.gov/

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/telemedicine
2. https://www.edx.org/professional-certificate/harvardx-introduction-to-telemedicine
3. https://www.americantelemed.org/education/
4. https://www.edx.org/professional-certificate/harvardx-introduction-to-telemedicine

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2		2	2	2					2	2	**3**	**1**	**1**
CO2	3	2	3	3	2					2	3	**3**	**1**	**1**
CO3	3	3	3	3	2					2	3	**2**	**2**	**2**
CO4	2	2	2	2	2	3		2		2	2	**2**	**3**	**2**
CO5	2	2	2	2	3	2		2		2	2	**2**	**2**	**3**
CO6	2	2	2	2	3	2		2	2	3	2	**2**	**3**	**3**

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1906	MEDICAL IMAGE ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamental components and classification of medical image processing.
- To analyse different imaging modalities and matrix theory for medical image processing tasks..
- To evaluate various image filtering techniques for enhancement and restoration.
- To develop skills in medical image segmentation using statistical shape models and deformable models.
- To understand and apply medical image registration techniques to align multi modal medical images.
- To implement machine learning techniques in medical image analysis for segmentation and registration.

UNIT I BASICS OF MEDICAL IMAGE PROCESSING & MATHEMATICAL PRELIMINARIES 9

Introduction- Component of medical image processing, classification of digital images. Modalities and contrast mechanisms- X-ray transmission imaging, Molecular imaging, Optical imaging, Large wavelengths and transversal waves. Mathematical preliminaries- Relevant vector and matrix theory, Linear processing in the image domain, Images in the Fourier domain, Introduction to calculus and variations, Leibniz rule for interchanging integrals and derivatives.

UNIT II IMAGE FILTERING: ENHANCEMENT AND RESTORATION 9

Medical imaging filtering. Point-to-point operations - Basic operations, Contrast enhancement, Histogram processing. Spatial operations- Linear filtering, Non-linear filters. Operations in the transform domain- Linear filters in the frequency domain, Homomorphic processing. Model-based filtering: image restoration - Noise models, Point spread function, Image restoration methods.

UNIT III MEDICAL IMAGE SEGMENTATION 9

Statistical shape models-Representing structures with points, Comparing shapes, Aligning two shapes, Aligning a set of shapes, Building shape models, Constrained local models. Segmentation by deformable models-Boundary evolution, Forces and speed functions. Graph cut based segmentation-Energy function, image term, and regularization term, Graph optimization and necessary conditions, Interactive segmentation.

UNIT IV MEDICAL IMAGE REGISTRATION 9

Points registration, Surface registration, Graph-based image registration-Graphical model construction, Optimization, Application to lung registration. Parametric volumetric registration-Mathematical concepts, Parametric volumetric registration-Mathematical concepts, Transformations, Optimization. Non-parametric volumetric registration-Mathematical concepts, Optical flow and related non-parametric methods.

UNIT V MACHINE LEARNING IN MEDICAL IMAGE ANALYSIS 9

Learning as optimization -Multilayer perceptron, Activation functions, Loss functions, Normalization in deep learning, Regularization in deep learning. Inductive bias, invariance, and equivariance-Recapitulation. Transformer-based deep learning segmentation-Scaled dot-product attention, Positional embedding, Vision transformers, Image registration with deep learning.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify the components and classification of digital images in medical imaging.

CO2 Describe the principles and applications of different medical imaging modalities.

CO3 Apply image enhancement and restoration techniques in medical imaging.

CO4 Perform medical image segmentation using statistical and graph-based methods.

CO5 Evaluate parametric and non-parametric registration methods to solve complex medical images.

CO6 **I**ntegrate machine learning methods for advanced medical image analysis and interpretation.

TEXT BOOKS:

1. Alejandro F. Frangi,"Medical Image Analysis", Academic Press, Elsevier, 2024
2. Jiri Jan,"Medical Image Processing, Reconstruction and Analysis-Concepts and Methods", Second Edition, CRC Press, 2019

REFERENCE BOOKS:

1. A Baskar, Muthaiah Rajappa, "Digital Image Processing - 1st Edition", Routledge, 2023.
2. Guang Yang; Angelica Aviles-Rivero, “Medical Image Understanding and Analysis” Springer, 2022
3. Wilhelm Burger, Mark J. Burge,"Digital Image Processing: An Algorithmic Introduction", Springer, 2022
4. Atam P. Dhawan, "Principles and advanced methods in medical imaging and image analysis", World Scientific Publishing Company, 2008

WEB REFERENCES: (Only accessible Links)

1. https://mipav.cit.nih.gov/ (For detailed Understanding of concepts)
2. https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/

ONLINE COURSES / RESOURCES:

1. MathWorks Support - Medical Imaging Toolbox: https://in.mathworks.com/help/medical-imaging/
2. NPTEL Course:https://onlinecourses.nptel.ac.in/noc22_bt34/preview
3. Finding Medical Images: https://hslguides.med.nyu.edu/medicalimages
4. Medical Image Repositories: https://www.ucl.ac.uk/child-health/about-us/support-services/library/resources-z/medical-image-repositories
5. medical-imaging-datasets: https://github.com/sfikas/medical-imaging-datasets

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2		2	3	2	2				2	2	**3**	**1**	**2**
CO2	2	2	2	2	2	2				2	2	**3**	**1**	**2**
CO3	3	2	3	3	2	2				2	3	**3**	**2**	**2**
CO4	3	2	3	3	2					2	3	**3**	**3**	**2**
CO5	3	3	3	3	2					3	3	**3**	**2**	**3**
CO6	2	2	2	3	3	3				3	2	**3**	**3**	**3**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1907	BRAIN COMPUTER INTERFACE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To describe the fundamental concepts and types of brain-computer interfaces (bcis) and their components.
- To compare and contrast various invasive and non-invasive techniques for recording and stimulating brain activity.
- To identify different types of bci signals and the methods used to monitor brain activity.
- To explain and demonstrate signal processing techniques essential for bci, including spike sorting and wavelet analysis.
- To implement machine learning methods on bci data for classification and regression tasks.
- To analyse the practical applications of bcis in medical and non-medical fields and evaluate ethical considerations.

UNIT - I INTRODUCTION TO BCI 9

Brain computer interface types - Types of BCI Signals, Monitoring Brain Activity Using EEG, BCI System, BCI Monitoring Hardware and Software, Recording Signals from the Brain : Invasive and Noninvasive Techniques - Stimulating the Brain : Invasive and Noninvasive Techniques - Simultaneous Recording and Stimulation : Multielectrode Arrays, Neurochip.

UNIT - II BRAIN COMPUTER INTERFACE TYPES 9

Invasive BCIs : Invasive BCIs in Humans, Semi-Invasive BCIs : ECoG BCIs in Humans, BCIs Based on Peripheral Nerve Signals - Noninvasive BCIs : Electroencephalographic (EEG) BCIs, Oscillatory Potentials and ERD, Slow Cortical Potentials, Movement-Related Potentials, Stimulus-Evoked, BCIs Based on Cognitive Tasks - Other Noninvasive BCIs: fMRI, MEG, and fNIR.

UNIT - III BCI SIGNAL PROCESSING 9

Spike Sorting, Frequency Domain Analysis : Fourier Analysis, DFT, FFT, Spectral Features - Wavelet Analysis - Time Domain Analysis - Autoregressive (AR) Modeling, Bayesian Filtering, Kalman Filtering, Particle Filtering - Artifact Reduction Techniques:Thresholding, Band-Stop and Notch Filtering, Linear Modeling, Principal Component Analysis (PCA), Independent Component Analysis (ICA).

UNIT - IV MACHINE LEARNING METHODS FOR BCI 9

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis.

UNIT - V APPLICATIONS AND ETHICS 9

Medical Applications : Sensory restoration, Motor restoration, Cognitive restoration, Brain controlled wheelchairs — Non-Medical Applications : Web Browsing and Navigating Virtual Worlds, Lie Detection and Applications in Law, Monitoring Alertness, Security, Identiication, and Authentication - Ethics of Brain-Computer Interfacing : Medical, Health, and Safety Issues, BCI Security and Privacy, Legal Issues.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify and describe the types and components of brain-computer interfaces (bcis).

CO2 Differentiate between invasive and non-invasive techniques for brain activity monitoring and stimulation.

CO3 Analyse various types of bci signals and their corresponding monitoring methods.

CO4 Develop signal processing techniques for bci, such as fourier analysis and artifact reduction methods.

CO5 Utilize machine learning techniques for classifying and analyzing bci data.

CO6 Evaluate the applications of bcis in various domains and discuss the ethical implications associated with bci technology

TEXT BOOKS:

1. Rajesh.P.N.Rao, “Brain-Computer Interfacing: An Introduction”, Cambridge University Press, First edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, —Brain Computer Interfaces: Principles and practicell, Oxford University Press, USA, Edition 1, January 2015

REFERENCE BOOKS:

1. Christoph Guger, Brendan Z. Allison, and Junichi Ushiba, "Brain-Computer Interface Research: A State-of-the-Art Summary" Springer, 2021
2. Aboul Ella Hassanien, Ahmad Taher Azar (eds.),"Brain-Computer Interfaces: Current Trends and Applications" Springer International Publishing, 2015
3. Damien Coyle, "Brain-Computer Interfaces: Lab Experiments to Real-World Applications" Academic Press. 2016.
4. Ella Hassianien, A &Azar.A.T (Editors), “Brain-Computer Interfaces Current Trends and Applications”, Springer, 2015.

WEB REFERENCES: (Only accessible Links)

1. https://www.coursera.org/learn/neural-networks-deep-learning
2. https://spectrum.ieee.org/
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/neurohacking
2. https://www.coursera.org/learn/neurohacking
3. https://www.coursera.org/learn/dsp
4. https://www.khanacademy.org/math/statistics-probability
5. https://www.coursera.org/learn/neural-engineering

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2		2	3	2	2				2	2	3	1	2
CO2	2	2	2	2	2	2				2	2	2	1	2
CO3	3	2	3	3	2	2				2	3	2	2	3
CO4	3	2	3	3	2					2	3	3	3	2
CO5	3	3	3	3	2					3	3	3	2	3
CO6	2	2	2	3	3	3				3	2	3	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

VERTICAL II IoT ARCHITECTURE AND APPLICATIONS

23EC1908	WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the concept about Wireless networks, protocol stack and standards.
- To articulate and analyze the network layer solutions for Wireless networks.
- To acquire fundamentals of 3G Services, its protocols and applications.
- To attain in depth knowledge on internetworking of WLAN and WWAN.
- To explore about evolution of 4G Networks, its architecture and applications.
- To Interpret the concept about IoT wireless network.

UNIT - I WIRELESS LAN 9

Introduction, WLAN technologies: IEEE802.11: System architecture, protocol architecture, 802.11b, 802.11a, Hiper LAN: WATM, BRAN, HiperLAN2, Bluetooth: Architecture, WPAN, IEEE 802.15.4, Wireless USB, Zigbee, 6LoWPAN, Wireless HART.

UNIT - II MOBILE NETWORK LAYER 9

Introduction, Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet, Mobile IP session initiation protocol, mobile ad-hoc network: Routing: Destination Sequence distance vector, IoT: CoAP.

UNIT - III 3G AND INTERNETWORKING BETWEEN WLANS AND WWANS 9

Overview of UTMS Terrestrial Radio access network, UMTS Core network Architecture: 3GPP Architecture, User equipment, CDMA2000 overview, Radio and Network components, Network structure, Radio Network, Internetworking Between WLAN And WWAN-Interworking objectives and requirements, Schemes to connect WLANS and 3G Networks, Internetworking Architecture for WLAN and GPRS.

UNIT - IV 4G & BEYOND 9

Introduction, 4G vision, 4G features and challenges, Applications of 4G, 4G Technologies: Multicarrier Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO.

UNIT - V WIRELESS NETWORKS FOR IoT 9

Evolution of wireless technologies, Challenges and opportunities in wireless IoT, Requirements for IoT wireless networks. Overview of IoT architecture, IoT use cases and applications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the key concepts of wireless networks, standards, technologies and their basic operations.

CO2 Explain the network layer solutions for wireless networks.

CO3 Attain the fundamentals of 3G Services, its protocols and applications and also acquainted with in depth knowledge on internetworking of WLAN and WWAN

CO4 Acquire knowledge about evolution of 4G Networks, its architecture and applications.
CO5 Explore with the fundamentals of IoT wireless networks.
CO6 Interpret IoT cases and applications.

TEXT BOOKS:

1. Jochen Schiller, “Mobile Communication”, Second Edition, Pearson Education 2012.
2. Vijay Garg, “Wireless Communications and networking”, First Edition, Elsevier 2007.
3. The Wireless Internet of Things, by Daniel Chew, IEEE press, Wiely -2019.

REFERENCE BOOKS:

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband‖, Second Edition, Academic Press, 2008.
2. Anurag Kumar, D.Manjunath, Joy kuri, “Wireless Networking”, First Edition, Elsevier 2011.
3. Simon Haykin, Michael Moher, David Koilpillai, Modern Wireless Communications‖, First Edition, Pearson Education 2013.

WEB REFERENCES: (Only accessible Links)

1. https://onlinecourses.nptel.ac.in/noc21_ee66/preview
2. https://nptel.ac.in/courses/106106243

ONLINE COURSES / RESOURCES:

1. https://learningnetworkstore.cisco.com/on-demand-e-learning/implementing-cisco-enterprise-wireless-networks-enwlsi-v2.0/CSCU-LP-ENWLSI-V2-028372.html
2. https://learn.microsoft.com/en-us/training/modules/configure-wireless-network-connectivity/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	1	1	1	1	3	2	1
CO2	2	2	2	2	1	1	1	1	1	1	1	3	2	1
CO3	3	2	2	2	1	1	1	1	1	1	1	1	3	2
CO4	3	3	3	2	1	1	1	1	1	1	1	1	3	3
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	3
CO6	2	2	2	2	1	1	1	1	1	1	1	1	2	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1909	IoT ARCHITECTURES AND PROTOCOLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the foundational elements and design principles of IoT and M2M architectures.
- To attain state-of-the-art IoT architectures and design constraints.
- To acquire concepts of IoT data link layer and network layer protocols.
- To manage concepts of transport and session layer protocols in IoT.
- To Explore service layer protocols in IoT.
- To Explain security mechanisms in IoT.

UNIT - I IoT OVERVIEW 9

IoT-An Architectural Overview, Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT - II REFERENCE ARCHITECTURE 9

IoT Architecture, State of the Art, Introduction, State of the art, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

UNIT - III IoT DATA LINK LAYER & NETWORK LAYER PROTOCOLS 9

PHY/MAC Layer: 3GPP MTC, IEEE 802.11, IEEE 802.15, WirelessHART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7, Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

UNIT - IV TRANSPORT & SESSION LAYER PROTOCOLS 9

Transport Layer: TCP, MPTCP, UDP, DCCP, SCTP,TLS, DTLS, Session Layer:HTTP, CoAP, XMPP, AMQP, MQTT.

UNIT - V SERVICE LAYER PROTOCOLS & SECURITY 9

Service Layer: oneM2M, ETSI M2M, OMA, BBF, Security in IoT Protocols: MAC 802.15.4 , 6LoWPAN, RPL, Application Layer.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand comprehensive IoT architectures integrating devices, networking, data management, and analytics.

CO2 Explore IoT architectures considering functional, informational, and deployment views.

CO3 Analyze and apply various PHY/MAC and network layer protocols like 6LoWPAN, Zigbee, and IPv6 in IoT systems.

CO4 Implement and evaluate transport and session layer protocols.
CO5 Analyze and implement service layer protocols.
CO6 Examine security protocols for MAC, 6LoWPAN, and application layers.

TEXT BOOKS:

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 2019, 1st Edition, Wiley Publications, USA.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
3. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer

REFERENCE BOOKS:

1. Bahga, Arshdeep, and Vijay Madisetti. Internet of Things: A Hands-on Approach, 2014,1st Edition, Universities press, India.
2. Vlasios Tsiatsis, Jan Holler, Catherine Mulligan, Stamatis Karnourskos and David Boyle. Internet of Things: Technologies and Applications for a New Age of Intelligence, 2018, 2nd Edition, Academic Press, USA.
3. Vermesan, Ovidiu, and Peter Friess, eds. Internet of things-from research and innovation to market deployment, 1st edition, Aalborg: River publishers, 2014.

WEB REFERENCES: (Only accessible Links)

1. https://learn.microsoft.com/en-us/azure/IoT/
2. https://IoT-analytics.com/
3. https://www.ibm.com/topics/internet-of-things

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	1	1	1	1	3	1	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2	3	1
CO3	3	2	2	2	1	1	1	1	1	1	1	1	3	2
CO4	3	3	3	2	1	1	1	1	1	1	1	1	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	3	3
CO6	2	2	2	2	1	1	1	1	1	1	1	1	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1910	IoT SECURITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To elaborate Security concepts of IoT
- To understand the security requirements in IoT
- To learn the fundamentals of cryptographic in IoT
- To interpret the working of embedded devices in the IoT
- To familiarize with IoT protocols in security
- To estimate security issues for various applications using case studies

UNIT - I INTRODUCTION 9

Introduction to IoT Security, Vulnerabilities, Attacks and Countermeasures, Information Assurance, Attack types, New security threats and vulnerabilities, Fault Trees and CPS. Threat Modeling, Attack, Defense, and Network Robustness of Internet of Things, A Solution, Based Analysis of Attack Vectors on Smart Home Systems.

UNIT - II SECURITY MANAGEMENT & CRYPTOLOGY 9

Building security in to design and development, Safety and security design, Security Management & Cryptology, Security Controls, Authentication, Confidentiality, Integrity; Access Control, Key Management, Communication and messaging Protocols, Cipher, Symmetric Key Algorithms, Public Private Key Cryptography; Attacks, Dictionary and Brute Force, Lookup Tables, Reverse Look Tables, Rainbow Tables, Hashing, MDS, SHA256. SHA 512, Ripe MD, WI, Data Mining.

UNIT - III EMBEDDED DEVICES 9

Attack Surface and Threat Assessment, Embedded Devices, UART, SPI, I2C, JTAG, Attacks, Software and cloud components, Firmware devices, Web and Mobile Applications.

UNIT - IV IoT PROTOCOLS 9

IoT Protocol Built-in Security Features, Transport Layer, COAP, UDP, TCP, MQTT, SSL/TLS, DTLS, LIGHT WEIGHT M2M, XMPP, Zigbee, LoRa, BLE, Kerberos, Cloud security for IoT.

UNIT - V IoT APPLICATIONS 9

Case Studies and Discussion: Smart Agriculture, Cities, Grid, Healthcare, Smart Homes, smart street lighting, Smart building, Smart parking, smart irrigation, Supply Chain, and Transportation, Application of Security Concepts to Create IoT system.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the security requirements in IoT Architecture
CO2 Classify the security management in IoT.
CO3 Explain the different cryptographic techniques in IoT Security.
CO4 Express various Attacks & Threat for embedded devices related to IoT.
CO5 Analyze IoT protocols.
CO6 Interpret IoT applications in several fields.

TEXT BOOKS:

1. Brian Russell, Drew Van Duren, “Practical Internet of Things Security”, Packt Publishing Limited, 2nd Edition,2018.
2. Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations,” CRC Press (Taylor & Francis Group), 2016, ISBN:978-1-4987- 23190.
3. Sunil Cheruvu, Anil Kumar, Ned Smith, David M. Wheeler, “Demystifying Internet of Things Security”, 2020.

REFERENCE BOOKS:

1. Shancang Li and Li Da Xu, “Securing the Internet of Things”, Elsevier, 2017.
2. Sridipta Misra, Muthucumaru Maheswaran, Salman Hashmi, “Security Challenges and Approaches in Internet of Things,” Springer, 2016.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things — A Hands-on approach,” VPT Publishers, 2014, ISBN: 978-0996025515.

WEB REFERENCES: (Only accessible Links)

1. https://www.avsystem.com/blog/IoT-protocols-and-standards/
2. https://www.jigsawacademy.com/top-uses-of-IoT/
3. https://www.ibm.com/topics/internet-of-things

ONLINE COURSES / RESOURCES:

1. https://www.cybrary.it/course/IoT-security/
2. https://www.udemy.com/course/hacking-IoT/
3. https://www.edx.org/course/cybersecurity-and-privacy-in-the-IoT
4. https://www.netacad.com/courses/cybersecurity/IoT-security

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
CO2	3	3	3	3	1	1	1	1	1	1	1	2	3	1
CO3	2	2	2	2	1	1	1	1	1	1	1	1	3	2
CO4	3	3	3	2	1	1	1	1	1	1	1	1	3	2
CO5	3	2	2	2	1	1	1	1	1	1	1	1	3	3
CO6	3	2	2	2	1	1	1	1	1	1	1	1	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1911	DATA ANALYTICS FOR IoT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn the concepts of big data analytics.
- To get exposure on IoT cloud analytics environment.
- To be familiar with general strategies on IoT analytics.
- To examine on social impact of multimedia.
- To identify applications that makes use of multimedia Big Data and IoT.
- To interpret Future Directions and Challenges of IoT.

UNIT - I INTRODUCTION TO TECHNOLOGICAL DEVELOPMENTS 9

Defining IoT Analytics and Challenges- Defining IoT analytics, IoT analytics challenges, Business value concerns, IoT Devices and Networking Protocols, IoT devices, Networking basics, IoT networking connectivity protocols, Analyzing data, IoT Analytics for the Cloud, Building elastic analytics, Designing for scale, Cloud security and analytics, The AWS, Microsoft Azure, The ThingWorx overview.

UNIT - II CLOUD ANALYTICS ENVIRONMENT 9

The AWS Cloud Formation, The AWS Virtual Private Cloud (VPC), terminate and clean up the Environment, data processing for analytics, big data technology to storage, Apache Spark for data processing, Handling change, Exploring and visualizing data, Techniques to understand data quality Techniques to understand data quality, R and RStudio.

UNIT - III GENERAL STRATEGIES ON EXTRACTING VALUE FROM DATASETS 9

Decorating Your Data, Communicating with Others Visualization and Dashboarding, Applying Geospatial Analytics to IoT Data, Data Science for IoT Analytics, Machine learning (ML), Deep learning.

UNIT - IV SOCIETAL IMPACT OF MULTIMEDIA BIG DATA 9

Multimedia Social Big Data Mining, Process Model, SWOT Analysis, Techniques for Social Big Data Analytics, Advertisement Prediction, MMBD Sharing on Data Analytics Platform , Legal/Regulatory Issues.

UNIT - V APPLICATION ENVIRONMENTS 9

Big Data Computing for IoT Applications-Precision Agriculture, Machine Learning in Improving Learning Environment, Network-Based Applications of Multimedia Big Data Computing, Recent Trends in IoT, Based Analytics and Big Data, Future Directions and Challenges of Internet of Things.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the Concepts of big data and IoT.
CO2 Explore cloud based IoT analytic environment.
CO3 Apply various Big data strategies.
CO4 Analyse social impact of multimedia big data.
CO5 Design IoT-based precision agriculture systems.
CO6 Design smart IoT systems with big data.

TEXT BOOKS:

1. Andrew Minteer, “Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices”, Packt Publishing, first edition, July 2017.
2. Sudeep Tanwar, Sudhanshu Tyagi, Neeraj Kumar, “Multimedia Big Data Computing for IoT Applications:Concepts, Paradigms and Solutions”, Springer, 2020.

REFERENCE BOOKS:

1. John Soldatos, “Building Blocks for IoT Analytics”, River Publishers Series In Signal, Image and Speech Processing, 2017.
2. Nilanjan Dey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy, “Internet of Things and Big Data Analytics Toward Next-Generation Intelligence”, Springer International Publishing, 2018.
3. Stackowiak, R., Licht, A., Mantha, V., Nagode, L.,” Big Data and The Internet of Things Enterprise Information Architecture for A New Age”, Apress, 2015.

WEB REFERENCES: (Only accessible Links)

1. https://www.udemy.com/course/IoT-data-analytics/
2. https://www.cognixia.com/course/IoT-analytics/
3. https://www.jigsawacademy.com/IoT-analyst-certification/

ONLINE COURSES / RESOURCES:

1. https://www.classcentral.com/course/edx-IoT-data-analytics-and-storage-12664
2. https://www.educba.com/IoT-analytics/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	1	1	1	1	3	1	2
CO2	1	1	1	1	1	1	1	1	1	1	1	1	2	2
CO3	3	2	2	2	1	1	1	1	1	1	1	1	3	2
CO4	3	3	3	2	1	1	1	1	1	1	1	1	3	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	3	3
CO6	2	2	2	2	1	1	1	1	1	1	1	1	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1912	IoT FOR INDUSTRY AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basics of sensors used for various applications
- To develop the concept of signal conditioning circuits and implementation
- To construct the role IoT sensors for automotive industries
- To Explain about the functioning of IoT based sensors in healthcare industry
- To Enhance knowledge on unmanned Arial vehicle
- To Interpret Role of AI and Big Data Analytics in UAV

UNIT - I SENSORS & TRANSDUCERS 9

Introduction to IoT Sensors, Temperature sensors, Proximity sensor, Pressure sensor, Water quality sensor, Chemical sensor, Gas sensor, Smoke sensor, IR sensors, Level sensors, Image sensors, motion sensor, Humidity sensor, Ultrasonic Sensor, MQ2 Sensor, Digital switch, Electro Mechanical switches.

UNIT - II SIGNAL CONDITION CIRCUITS 9

Design of Signal conditioning circuit, Wheatstone Bridge, Deferential and Instrumentation amplifiers, Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors, Thermocouples, Piezoelectric Sensors, Photovoltaic Sensors, Thermistor, RTD, Load cell, Torque, Strain gauge, Force Sensor, Accelerometer, Digital and Intelligent Sensors.

UNIT - III INTERNET OF THINGS IN AUTOMOTIVE INDUSTRIES 9

Role of IoT automotive industries, interfacing of digital and analog sensors in automotive industries, Biometric car door opening, accident monitoring, Engine management system, driver management system, real time vehicle tracking system, 5G advanced driver assistance systems (ADAS), Augmented road sign information, In-vehicle Infotainment and Telematics, Automotive Maintenance System, Truck's performance statistics like fuel and mileage, Tracking traffic conditions on the road.

UNIT - IV INTERNET OF THINGS FOR THE HEALTHCARE INDUSTRY 9

Emerging Technologies in Smart Healthcare, Fog Computing in Healthcare, Technologies Used in Software Defined Networking (SDN) and HealthCare, WSN and IoT Based Smart Surveillance Systems for Patients, Security and Privacy Issues in Smart Healthcare System, IoMT, Based Smart Remote Monitoring System.

UNIT - V IoT FOR UNMANNED AERIAL VEHICLES 9

Introduction, Battery and Energy Management, Energy Efficient Communication Methods, Unmanned Aerial Vehicle (UAV) for Security Intelligence, Role of AI and Big Data Analytics in UAV, Blockchain, Based Solutions for Various Security Issues.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand sensors and transducers used in industry.
CO2 Explain about signal conditioning circuits.
CO3 Apply IoT design concept on automotive industry.
CO4 Analyse used of IoT technology in health care industry.
CO5 Design unmanned aerial vehicles.

CO6 Design energy-efficient communication systems

TEXT BOOKS:

1. A.K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation ”, Dhanpat Rai & Co. (P) Limited, 2015.
2. Ramon pallas-areny, John G. Webster, sensors and signal Conditioning, A Wiley-Interscience Publication, , 2001
3. IoT-Enabled Smart Healthcare Systems, Services and Applications by Shalli Rani, Maheswar Rajagopal, Neeraj Kumar, Syed Hassan Ahmed Shah, John.Wiley & Sons, Inc, 2022.

REFERENCE BOOKS:

1. Jerry Luecke, Analog and Digital Circuits for Electronic Control System Applications, Elsevier Inc., 2005
2. Chimata, Raghuveer, Singh, Rajesh, Singh, Bhupendra, Internet of Things in Automotive Industries and Road Safety, River Publishers, 2018.
3. Shalli Rani, Maheswar Rajagopal, Neeraj Kumar, Syed Hassan Ahmed Shah, IoT-Enabled Smart Healthcare Systems, Services and Applications, Wiley, 2022.
4. IoT in Automotive Industry: https://www.biz4intellia.com/blog/IoT-applications-in-automotive-industry/

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1. https://www.coursera.org/lecture/internet-of-things-history/IoT-automotive-0vJj5
2. https://www.coursera.org/lecture/network-transformation-101/IoT-verticals-connected-car-odaAf
3. https://www.udemy.com/course/fundamentals-of-connected-car-technology/
4. https://www.udemy.com/course/IoT-based-emergency-health-care-system/
5. https://cmpd.doctorasyou.com/courses/continuum-digital-education/internet-of-medical-things-in-healthcare-11/

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2. https://nptel.ac.in/courses/106105195

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	1	1	1	1	1	3	1	2
CO2	2	2	1	1	1	1	1	1	1	1	1	3	2	2
CO3	3	2	2	2	1	1	1	1	1	1	1	2	3	3
CO4	3	3	3	2	1	1	1	1	1	1	1	2	2	3
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	3
CO6	3	3	3	3	1	1	1	1	1	1	1	2	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1913	IoT FOR SMART CITIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To impart knowledge on the infrastructure, sensor technologies and networking technologies of Internet of Things.
- To analyze, design and develop solutions for Internet of Things.
- To explore the real-life aspects of Internet of Things.
- To analyze, design and develop IoT solutions.
- To explore the entrepreneurial aspect of the Internet of Things.
- To Interpret smart grid and renewable energy solutions.

UNIT - I IoT FOR SMART CITIES 9

Introduction, Characteristics of Smart Cities, IoT, Based Solutions for Smart Cities, Smart Home, Transport and Traffic Management, Challenges, Smart City Planning and Management, The Fundamentals of Smart Infrastructure, Role of Machine Learning and Deep Learning in Internet of Things enabled Smart Cities.

UNIT - II TECHNOLOGIES FOR INTERNET OF THINGS 9

Introduction, Communication Technologies for IoT Networks, Recent Protocols for IoT, Overview OF Secure IoT Architectures, IoT-Based Services for Smart Cities, Cellular Mobile Networks, Cloud Internet of Things, Study of Communication Technologies: Intelligent Traffic System, Disaster Management, Implementation and Comparison of MQTT, WebSocket, and HTTP Protocols for Smart Room IoT Application in Node-RED.

UNIT - III AI FOR SMART CITIES 9

Overview of Artificial Intelligence, Machine Learning and deep learning algorithms for smart cities, case study: smart street lighting, Smart building, Smart parking, smart irrigation, smart waste and storm water management, Vehicle Payload Monitoring System.

UNIT - IV SECURITY AND PRIVACY IN SMART CITY 9

Privacy and Social Values in Smart Cities, Information Security in the Smart City, IoT Security Challenges, Blockchain Technology for IoT, Case Studies: Smart Homes, Food Supply Chain Traceability System, smart street lighting, Smart building, Smart parking, smart irrigation, Security and Privacy Threats in IoT, Enabled Smart Cities.

UNIT - V TRANSPORTATION SYSTEM IN SMART CITY 9

Traffic Management for Smart Cities , Sensors , Electric Vehicles in Smart Cities, EV Charging Techniques, Renewable Energy, Smart Distribution Systems, Smart Grid, Traffic Control System for Smart City using Image Processing, An Interactive Analysis Platform for Bus Movement: A Case Study of One of the World's Largest Annual Gathering.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Relate the necessity of infrastructural development for smart cities.
CO2 Explain the components of infrastructure plan for smart city.
CO3 Choose AI based intelligent system in smart city.
CO4 Analyze water resources systems for smart city.

CO5 Construct and work in the smart city projects.
CO6 Develop and evaluate smart grid and renewable energy solutions.

TEXT BOOKS:

1. Waleed Ejaz, Alagan Anpalagan, Internet of Things for Smart Cities: Technologies, Big Data and Security, 1st ed. Springer International Publishing, 2019.
2. Stimmel, Carol L, Building smart cities: analytics, ICT, and design thinking, Taylor & Francis, 2016.
3. Joel J. P. C. Rodrigues, Parul Agarwal, Kavita Khann, IoT for Sustainable Smart Cities and Society, 2022.

REFERENCE BOOKS:

1. Vincenzo Piuri, Rabindra Nath Shaw, Ankush Ghosh, Rabiul Islam, AI and IoT for Smart City Applications, Springer, 2022.
2. Artificial Intelligence, Machine Learning, and Deep Learning, Oswald Campesato, Mercury Learning and Information, 2020.
3. Al-Turjman, Fadi, Intelligence in IoT-enabled smart cities, CRC Press, 2019.
4. Arpan Kumar Kar, M P Gupta, P. Vigneswara Ilavarasan, Yogesh K. Dwivedi, Advances in smart cities : smarter people, governance and solutions CRC Press, 2017.
5. Understanding IoT Security: https://IoT-analytics.com/understanding-IoT-security-part-1-IoT-security-architecture/
6. Hammi, B., Khatoun, R., Zeadally, S., Fayad, A., & Khoukhi, L. IoT technologies for smart cities, 2018.

WEB REFERENCES: (Only accessible Links)

1. https://www.coursera.org/lecture/network-transformation-101/IoT-verticals-smart-cities-and-utilities-wN2aQ
2. https://www.futurelearn.com/info/courses/gettingstartedwiththeIoT/0/steps/149743
3. https://www.snap4city.org/drupal/node/577

ONLINE COURSES / RESOURCES:

1. https://academy.itu.int/training-courses/full-catalogue/acquiring-5g-IoT-services-smart-cities-smart-villages
2. https://www.udemy.com/course/introduction-to-smart-cities-technologies-bim-gis-IoT-ai/
3. https://telecomstechacademy.com/course/smart-cities-101-online-academy/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	1	1	1	1	3	2	2
CO2	3	3	3	3	1	1	1	1	1	1	1	3	2	2
CO3	3	2	2	2	1	1	1	1	1	1	1	2	3	2
CO4	3	3	3	2	1	1	1	1	1	1	1	2	3	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	3	3
CO6	3	3	3	3	1	1	1	1	1	1	1	1	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1914	IoT AND EDGE COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To discuss the fundamental concepts of IoT and Edge computing
- To examine the concept of communication and information theory.
- To Explore edge routing and networking layers.
- To Illustrate the fog topologies in IoT
- To Analyze IoT data analytics and machine learning comparison
- To depict the security issues of protocols in IoT

UNIT - I IoT AND EDGE COMPUTING 9

IoT- History, definition, IoT Architecture and Core IoT Modules, Sensing devices: Thermocouples & Temperature sensing, Thermistors, PIR, LiDAR, MEMS, Vision systems, High performance IoT endpoints, Energy sources and power management.

UNIT - II COMMUNICATIONS AND INFORMATION THEORY 9

Communication theory, Information Theory, The radio spectrum, Non-IP Based WPAN, IP-Based WPAN and WLAN, Long-Range Communication Systems and Edge to Cloud Protocols.

UNIT - III EDGE COMPUTING 9

Edge purpose and definition, Edge hardware architectures, Operating systems, Edge platforms, Edge Routing and Networking, Edge to Cloud Protocols, Edge Analytics, Edge Use Cases and Industry Applications.

UNIT - IV CLOUD AND FOG TOPOLOGIES 9

Cloud services model, Public, private, and hybrid cloud, Constraints of cloud architectures for IoT, Fog computing- Open Fog reference architecture, Fog topologies, Data Analytics and Machine Learning- Basic data analytics, Machine learning- Convolutional neural networks, Recurrent neural networks, IoT data analytics and machine learning comparison.

UNIT - V IoT AND EDGE SECURITY 9

Cybersecurity- Attack and threat terms, definitions of different cyber defense mechanisms and technologies, Anatomy of IoT cyber-attacks, Physical and hardware security, Cryptography, Blockchain and cryptocurrencies in IoT, Consortiums and Communities.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the evolving IoT Standards.
CO2 Explain the functions of communication and information theory in IoT.
CO3 Practice the concept of edge computing protocols.
CO4 Determine Constraints of cloud architectures for IoT
CO5 Analyze the purpose of machine learning in IoT.
CO6 Construct hardware security for IoT applications.

TEXT BOOKS:

1. Perry Lea, IoT and Edge Computing for Architects Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition ,Packt Publishing, 2020.
2. Geng, Hwaiyu. "Internet of Things and Data Analytics in the Cloud with Innovation and Sustainability." The Internet of Things & Data Analytics Handbook, 2017.

REFERENCE BOOKS:

1. K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy, Edge Computing Fundamentals, Advances and Applications,CRC Press, 2021.
2. Rajkumar Buyya, Satish Narayana Srirama , Fog and Edge Computing: Principles and Paradigms , wiley publication, 2019.
3. David Jensen, “Beginning Azure IoT EdgeComputing: Extending the Cloud to the Intelligent Edge, Microsoft Azure.
4. Li, H., Ota, K., & Dong, M. Learning IoT in edge: Deep learning for the Internet of Things with edge computing, 2018.
5. Singh, J., Bello, Y., Hussein, A. R., Erbad, A., & Mohamed, A. Hierarchical security paradigm for IoT multiaccess edge computing, 2020.

WEB REFERENCES: (Only accessible Links)

1. https://www.cognixia.com/course/edge-computing-training/

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/introduction-to-edge-computing
2. https://www.coursera.org/lecture/IoT-wireless-cloud-computing/5-10-edge-computing-pOK8T

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	1	1	1	3	1	2
CO2	2	2	2	2	1	1	1	1	1	1	1	2	3	2
CO3	3	2	2	2	1	1	1	1	1	1	1	1	3	2
CO4	3	3	3	2	1	1	1	1	1	1	1	2	3	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	3	3
CO6	1	1	1	1	1	1	1	1	1	1	1	1	2	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

VERTICAL III SIGNAL PROCESSING

23EC1915	DSP ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basic principles and architectural features of programmable DSPs
- To learn TMS320C5x DSP's Architecture, On-chip peripherals and Instruction set
- To explore the real-time programming skills throughTMS320C6X DSP Processor
- To apply Fast Fourier Transform (FFT) in filter design using advanced DSP processor
- To compare the features and functionalities of various ADSP processors
- To discover theoretical knowledge and technical skills of Advanced DSP Processors

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

Introduction to Programmable DSPs, Architectural Features of PDSPs - Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals, Applications of Programmable DSPs.

UNIT II TMS320C5X PROCESSOR 9

Architecture of C5X Processor – Addressing modes – Assembly language Instructions – Pipeline structure, On-chip Peripherals — Block Diagram of DSP starter kit (DSK) — Software Tools, DSK on-board peripherals, Application Programs for processing real time signals.

UNIT III TMS320C6X PROCESSOR 9

Architecture of the C6x Processor - Instruction Set — Addressing modes, Assembler directives, Onchip peripherals, DSP Development System: DSP Starter Kit - Code Composer Studio — Support Files — Introduction to AIC23 codec and other on-board peripherals, Real-Time Programming Examples for Signals and Noise generation, Frequency analysis, Filter design.

UNIT IV ADSP PROCESSORS 9

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions — Application programs –Filter design, FFT calculation.

UNIT V ADVANCED PROCESSORS 9

Study of TI's advanced processors - TMS320C674x and TMS320C55x DSPs, ADSP's Blackfin And Sigma DSP Processors, NXP's DSP56Fxx Family of DSP Processors, Comparison of the features of TI, ADSP and NXP DSP family processors.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic principles and architectural features of programmable DSPs

CO2 Describe the architecture, on-chip peripherals, and instruction set of the TMS320C5x DSP.

CO3 Execute real-time programs using the TMS320C6X DSP

CO4 Develop programs that effectively utilize FFT for signal processing applications.
CO5 Distinguish the architectural features, addressing modes, and functionalities of various ADSP processors, including the ADSP-21XX and ADSP-210XX series.
CO6 Analyze technical skills required to utilize ADSP processors in real-world applications.

TEXT BOOKS:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, Cengage Learning India Private Limited, Delhi 2012.
2. B. Venkataramani and M. Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.

REFERENCE BOOKS:

1. RulphChassaing and Donald Reay, Digital Signal Processing and Applications with the C6713 and C6416 DSK, John Wiley & Sons, Inc., Publication, 2012 (Reprint).
2. User guides Texas Instruments, Analog Devices and NXP.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3	1	1
CO2	3	2										2	3	1
CO3	3	2	1									1	3	2
CO4	3	3	3			1						1	3	2
CO5	3	2	1									1	3	3
CO6	3	3	3			1						1	2	3

<table>
<tr><td colspan="2">Assessment
(40% weightage)
(Theory Component)</td><td colspan="2">Assessment
(60% weightage)
(Laboratory Component)</td><td>End Semester Examination</td></tr>
<tr><td>Individual Assignment / Case Study / Seminar / Mini Project</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record</td><td>Test</td><td>Written Examination</td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td rowspan="2">100</td></tr>
<tr><td colspan="4">100</td></tr>
<tr><td colspan="4">40 %</td><td>60 %</td></tr>
</table>

23EC1916	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the concept of random processes.
- To explore the notion of ergodicity in random processes and its implications.
- To learn about filtering techniques applied to random processes.
- To extend proficiency in spectrum estimation methods.
- To illustrate the principles and applications of optimum filters.
- To discover the knowledge of adaptive filters, their properties, and algorithms.

UNIT I **DISCRETE TIME RANDOM PROCESSES** **9**

Random variables - ensemble averages a review, random processes — ensemble averages, autocorrelation and autocovariance matrices, ergodic random process, white noise, filter ingrandom processes, spectral factorization, special types of random processes - AR, MA, ARMA

UNIT II **SPECTRUM ESTIMATION** **9**

Bias and consistency, Non-parametric methods - Periodogram, modified-Periodogram– performance analysis, Bartlett's method, Welch's method, Blackman-Tukey method, Performance comparison, Parametric methods - autoregressive (AR) spectrum estimation-autocorrelation method, Prony's method, solution using Levinson Durbin recursion.

UNIT III **OPTIMUM FILTERS** **9**

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications -filtering, linear prediction, IIR Wiener filter - causal and non-causal filters, Recursive estimators - discrete Kalman filter.

UNIT IV **ADAPTIVE FILTERS** **9**

Principles and properties of adaptive filters - FIR adaptive filters. Adaptive algorithms– steepest descent algorithm, the LMS algorithm — convergence, Applications of adaptive filtering — noise cancellation, channel equalization.

UNIT V **MULTIRESOLUTION ANALYSIS** **9**

Short-time Fourier Transform - Heisenberg uncertainty principle, Principles of multi-resolution analysis - sub-band coding, the continuous and discrete wavelet transform– properties, Applications of wavelet transform - noise reduction, image compression

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the concept of random processes through ensemble averages, autocorrelation, and auto covariance matrices.

CO2 Apply spectral estimation techniques, both non-parametric and parametric.

CO3 Design optimum filters using Wiener filter theory, including FIR and IIR Wiener filters.

CO4 Demonstrate adaptive filtering principles, properties and algorithms for noise cancellation and channel equalization applications.

CO5 Analyze signals using multi-resolution techniques.

CO6 Evaluate the performance of various spectral estimation and filtering techniques in real-world scenarios.

TEXT BOOKS:

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc.New York, Indian reprint 2008.

2. P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc.1993..

REFERENCE BOOKS:

1. John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing –Principles, Algorithms & Applications”, Fourth Edition, Pearson Education /Prentice Hall, 2007.

2. Sophoncles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2									3	1	2
CO2	3	3	3									2	3	2
CO3	3	3	3	2								1	3	3
CO4	3	3	3	2								1	3	3
CO5	3	2	3	1								1	2	3
CO6	3	3	3	2								1	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1917	DIGITAL IMAGE AND VIDEO PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce the digital image fundamentals.
- To get exposed to simple image enhancement techniques in Spatial and frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods.
- To explain the basics of video processing.

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Steps in Digital Image Processing - Components - Elements of Visual Perception - Image Sensing and Acquisition - Image Sampling and Quantization - Relationships between pixels -Color image fundamentals - RGB, HSI models.

UNIT II IMAGE ENHANCEMENT 9

Spatial Domain- Gray level transformations - Histogram processing - Basics of Spatial Filtering- Smoothing and Sharpening Spatial Filtering, Frequency Domain- Introduction to Fourier Transform- Smoothing and Sharpening frequency domain filters - Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III IMAGE RESTORATION AND SEGMENTATION 9

Image Restoration - degradation model, Properties, Noise models - Mean Filters - Order Statistics - Adaptive filters - Band reject Filters - Band pass Filters - Notch Filters - Optimum Notch Filtering - Inverse Filtering - Wiener filtering, Segmentation- Edge detection, Edge linking via Hough transform - Thresholding - Region based segmentation -Region growing - Region splitting and merging -Segmentation by morphological watersheds.

UNIT IV IMAGE COMPRESSION AND RECOGNITION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors - Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

UNIT V FUNDAMENTALS OF VIDEO PROCESSING 9

Analog video, Digital Video, Time varying Image Formation models- 3D motion models, Geometric Image formation, Photometric Image formation, sampling of video signals, filtering operations.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.

CO2 Compare the images using smoothing, sharpening and enhancement techniques.

CO3 Apply the restoration concepts and filtering techniques.

CO4 Analyze segmentation and features extraction concepts on digital images.

CO5 Examine the various compression standards and recognition techniques.

CO6 Explain the basics of video processing.

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', Pearson, Third Edition, 2018.
2. Anil K. Jain, 'Fundamentals of Digital Image Processing', Pearson, 2015.
3. Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication",1st edition, PHI, 2022.

REFERENCE BOOKS:

1. Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2011.
3. D,E. Dudgeon and RM. Mersereau, 'Multidimensional Digital Signal Processing', Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2002.
5. Milan Sonka et al 'Image processing, analysis and machine vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
6. M. Tekalp ,"Digital video Processing", Prentice Hall International, 2015.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1									3	2	2
CO2	3	3	1									3	2	2
CO3	3	3	2									3	2	1
CO4	3	3	2									1	3	2
CO5	3	3	1									1	3	3
CO6	3	3	1									1	2	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1918	BIOSIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn specific wave shapes and features of various biomedical signals.
- To know the optimal filtering techniques and adaptive filters for Noise removal.
- To focus on the removal of specific artifacts such as maternal-fetal ECG interference and muscle contraction noise.
- To learn pattern classification techniques for biosignals, including supervised and unsupervised methods.
- To apply wavelet transform and time-frequency representation (TFR) to biomedical signal processing.
- To develop Practical Applications using advanced signal processing techniques for biomedical signals.

UNIT I BIOSIGNAL WAVE SHAPES 9

Introduction to Biomedical signals - overview and characteristics of ECG, ,EMG, EEG, EGG, PCG, Carotid pulse, EOG, VMG,VAG, and Otto acoustic emission signals

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9

Noise sources in biomedical signals-Review of optimal filtering-adaptive filters- LMS&RLS Adaptive filters-Removal of Artifacts in ECG-Maternal-Fetal ECG-Muscle contraction interference-use of adaptive filters for segmentation in ECG and PCG Signals

UNIT III REMOVAL OF ARTIFACTS 9

Noise sources in biomedical signals-Review of optimal filtering-adaptive filters- LMS&RLS Adaptive filters-Removal of Artifacts in ECG-Maternal-Fetal ECG-Muscle contraction interference-use of adaptive filters for segmentation in ECG and PCG Signals

UNIT IV BIOSIGNAL PATTERN CLASSIFICATION 9

Pattern classification as applied to Biosignals-supervised pattern classification unsupervised pattern classification-Probabilistic models and statistical training and test steps-Neural networks-measures of diagnostic accuracy and cost-Reliability of classifiers and decisions.

UNIT V TIME FREQUENCY ANALYSIS OF BIOSIGNALS 9

Application of wavelet transform-Time Frequency representation, spectrogram, wigner distribution, Time scale representation, scalogram -ECG Characterization- wavelet networks-data reduction techniques -data compression of ECG and EEG signals.

TOTAL :45 PERIODS

COURSE OUTCOME

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

CO1 Understand Biosignal wave shapes including ECG, EMG, EEG, EGG, PCG, Carotid pulse, EOG, VMG, VAG, and otoacoustic emissions.

CO2 Learn time series analysis and spectral estimation identify and mitigate noise sources in biomedical signals.

CO3 Effectively use adaptive filters to remove artifacts from biomedical signals.

CO4 Utilize probabilistic models, neural networks, and statistical methods to improve diagnostic accuracy and decision reliability.

CO5 Apply wavelet transform and TFR representation to characterize ECG signals.

CO6 Enhance the reliability and accuracy of biomedical signal processing systems in real-world scenarios.

TEXT BOOKS:

1. Arnon-Cohen, “Bio-Medical Signal Processing,” Vol I&II, CRC Press. 1995
2. Vallaru Rao and Hayagriva Rao, “C++, Neural Networks and fuzzy logic, BPS Publication, New Delhi, 1996.
3. Raguveer M.Rao and ajith S.Bopardikar, Wavelet Transform – Introduction to Theory and its Applications, Pearson Education, India 2000 (Unit V).

REFERENCE BOOKS:

1. Rangaraj. M.Rangayyan, “Biomedical Signal Analysis-A Case Study Approach,” IEEE Press- John Wiley & Sons Inc, New York-2002.
2. W.J.Tompkins, “Biomedical Digital signal processing,” Prentice Hall, New Jersey-1993.
3. D.C. Reddy, “Biomedical Signal Processing- principles and techniques”, Tata McGraw-Hill, Edition-2005.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3	1	2
CO2	3	2										3	2	1
CO3	3	2	2									2	3	1
CO4	3	2	2									1	3	2
CO5	3	2										1	3	3
CO6	3	2										1	2	3

<table>
<tr><td colspan="2">Assessment
(40% weightage)
(Theory Component)</td><td colspan="2">Assessment
(60% weightage)
(Laboratory Component)</td><td>End Semester Examination</td></tr>
<tr><td>Individual Assignment / Case Study / Seminar / Mini Project</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record</td><td>Test</td><td>Written Examination</td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td rowspan="2">100</td></tr>
<tr><td colspan="4">100</td></tr>
<tr><td colspan="4">40 %</td><td>60 %</td></tr>
</table>

23EC1919	SPEECH PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the speech signal characteristics and analysis.
- To learn the various speech analysis techniques and Speech models.
- To illustrate the speech compression coding techniques.
- To identify the speech recognition techniques.
- To apply speech enhancement techniques.
- To explore speech synthesis techniques.

UNIT I SPEECH SIGNAL CHARACTERISTICS AND ANALYSIS 9

Speech production process - speech sounds and features- Phonetic Representation of Speech- representing speech in time and frequency domains - Short-Time Analysis of Speech - Short- Time Energy and Zero-Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception

UNIT II SPEECH COMPRESSION CODING TECHNIQUES 9

Need for speech coding, Waveform coding of speech — PCM, Adaptive PCM, DPCM, ADPCM, Delta Modulation, Adaptive Delta Modulation, G.726 Standard for ADPCM, Parametric Speech Coding – Channel Vocoders, Linear Prediction Based Vocoders, Code Excited Linear Prediction (CELP) based Vocoders, Sinusoidal speech coding techniques, Hybrid coder, Transform domain coding of speech

UNIT III SPEECH RECOGNITION 9

LPC for speech recognition- Hidden Markov Model (HMM)- training procedure for HMM-subword unit model based on HMM- language models for large vocabulary speech recognition — Overall recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition- Speech recognition in Adverse Environment.

UNIT IV SPEECH ENHANCEMENT 9

Classes of Speech Enhancement Algorithms, Spectral-Subtractive Algorithms - Multiband Spectral Subtraction, MMSE Spectral Subtraction Algorithm, Spectral Subtraction Based on Perceptual Properties, Wiener Filtering - Wiener Filters in the Time Domain, Wiener Filters in the Frequency Domain, Wiener Filters for Noise Reduction, Maximum-Likelihood Estimators, Bayesian Estimators, MMSE and Log-MMSE Estimator, Subspace Algorithms.

UNIT V TEXT TO SPEECH SYNTHESIS 9

Text to speech synthesis(TTS)-Concatenative-Unit selection synthesis , Diphone synthesis, Domain-specific synthesis- HMM-based synthesis and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of Prosody,TTS Application.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Compute and interpret speech spectrum and Mel-Frequency Cepstrum Coefficients (MFCC).

CO2 Realize various speech coding techniques such as PCM, DPCM, ADPCM, and delta modulation.

CO3 Implement language models for large vocabulary speech recognition, and handle Context-dependent subword units.

CO4 Develop systems for text-dependent and text-independent speaker recognition, and apply them in various scenarios.

CO5 Enhance the intelligibility and naturalness of synthesized speech through effective use of prosody and sub-word units.

CO6 Integrate advanced speech processing techniques into real-world systems for improved performance and usability.

TEXT BOOKS:

1. L. R. Rabiner and R. W. Schafer, “Introduction to Digital Signal Processing,Foundations and Trends in Signal Processing”, Vol. 1, Nos. 1–2 (2007) 1–194.
2. Philipos C. Loizou, Speech Enhancement Theory and Practice, Second Edition, CRC Press, Inc., United States, 2013.

REFERENCE BOOKS:

1. Lawrence Rabiner, Biiing - Hwang Juang and B.Yegnanarayana “Fundamentals of Speech Recognition”, Pearson Education, 2009.
2. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999.
3. Donglos O shanhnessy “Speech Communication: Human and Machine”, 2nd Ed. University press 2001.
4. Nilanjan Dey, “Applied Speech Processing Algorithms: Algorithms and Case Studies”, Academic Press,2021.

WEB REFERENCES:

1. https://www.ibm.com/topics/speech-recognition
2. https://speechprocessingbook.aalto.fi/

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/117/105/117105145/
2. https://www.udemy.com/course/digital-speech-processing/
3. https://speech.zone/courses/speech-processing/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1								1	3	2	2
CO2	3	3	1								1	3	2	2
CO3	3	3	1								1	1	3	2
CO4	3	3	1								1	2	3	2
CO5	3	3	1								1	1	3	3
CO6	3	3	2								1	1	2	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1920	COMPUTER VISION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To review image processing techniques for computer vision
- To understand shape and region analysis.
- To identify Hough Transform and its applications to detect lines, circles, ellipses
- To explore three-dimensional image analysis techniques
- To interpret 3D motion analysis.
- To implement computer vision algorithms in real time applications.

UNIT I IMAGE PROCESSING FOUNDATIONS 9

Review of image processing techniques — classical filtering operations — Thresholding techniques — edge detection techniques — corner and interest point detection — mathematical morphology – texture

UNIT II SHAPES AND REGIONS 9

Binary shape analysis — connectedness — object labeling and counting — size filtering — distance functions — skeletons and thinning — deformable shape analysis — boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moments

UNIT III HOUGH TRANSFORM 9

Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection — accurate center location — speed problem — ellipse detection — Case study: Human Iris location — hole detection — generalized Hough Transform (GHT) — spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation.

UNIT IV 3D VISION AND MOTION 9

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation — volumetric representations — 3D object recognition — 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion.

UNIT V COMPUTER VISION APPLICATIONS 9

Application: Photo album — Face detection — Face recognition — Eigen faces — Active appearance and 3D shape models of faces Application: Surveillance — foreground- background separation — particle filters — Chamfer matching, tracking, and occlusion — combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Implement fundamental image processing techniques required for computer vision.
CO2 Perform shape analysis.
CO3 Apply Hough Transform for line, circle, and ellipse detections.
CO4 Apply 3D vision techniques.
CO5 Implement motion related techniques.
CO6 Develop applications using computer vision techniques.

TEXT BOOKS:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer- Texts in Computer Science, Second Edition, 2022.
2. D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, Second Edition, 2015.

REFERENCE BOOKS:

1. D. L. Baggio et al., “Mastering OpenCV with Practical Computer Vision Projects”, Packt Publishing, 2012.
2. E. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
3. Jan Erik Solem, “Programming Computer Vision with Python: Tools and algorithms for analyzing images”, O'Reilly Media, 2012.
4. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition, Academic Press, 2012.
5. R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
6. Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3	1	2
CO2	3	2										3	2	2
CO3	3	3	3				1					1	3	2
CO4	3	3	3				1					1	3	2
CO5	3	3	3				1					1	3	3
CO6	3	3	3				1					1	2	3

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**40**	**60**	**100**
100				
40 %				**60 %**

23EC1921	UNDERWATER IMAGING SYSTEMS AND IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To study the fundamental components of optical imaging.
- To learn the basics of optical image processing techniques.
- To understand the challenges involved in underwater imaging.
- To explore the fundamentals of Ocean Acoustics.
- To distinguish the various sonar signal processing techniques.
- To elucidate the different types of SONAR Systems and applications.

UNIT I FUNDAMENTAL COMPONENTS OF OPTICAL IMAGE PROCESSING SYSTEM 9

Fundamentals and application of image processing, Human and Computer Vision, Introduction on Digital Camera-Focal length, Aperture, Shutter Speed, Spatial Resolution, Underwater lights and its importance, Halogen, LED, Colour Temperature, lumens, Beam angle, Image File format- JPEG, PNG, TIFF, BMP,GIF.

UNIT II OPTICAL IMAGE PROCESSING 9

Image Formation, Digitization, Sampling and Quantization, Geometric Transformation, Interpolation, Image Reconstruction, Spatial Filtering, Histogram, Binary Image, Color Fundamentals, Color transformations, Color Interpolation, Morphology, Image segmentation, Pattern Recognition, Challenges involved in underwater optical imaging.

UNIT III FUNDAMENTALS OF UNDERWATER ACOUSTICS 9

Acoustic waves, Acoustic pressure, Velocity and density, Frequency and wavelength, Intensity and power, Logarithmic notation- Decibels, absolute references and levels, Source Level, Basics of propagation losses, Target Strength, Back scattering, Acoustic noise, Multiple paths, Doppler effect, Time characteristics of echoes, Active and passive sonar equations, Underwater electro acoustic transducers- projectors and hydrophones, General Structure of SONAR systems

UNIT IV SONAR SIGNAL PROCESSING 9

Spatial signals-Signals in space and time, Co-ordinate systems, Propagating waves, Wave number- frequency space, Finite continuous apertures, Spatial sampling, Directivity, Beam forming, Time and frequency domain beam forming, Array gain,Angular resolution, Transmitting signals Narrowband Vs Chirp, Matched filtering, Range resolution, Time Varying Gain (TVG), Signal intensity to image conversion

UNIT V DIFFERENT TYPES OF SONAR SYSTEMS 9

Passive and active sonars, Single beam echo sounder, Multi beam echo sounder, Sub-bottom profiler, Sediment profiler, Side scan sonar, Synthetic aperture sonar, Forward looking sonar.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the fundamentals for underwater imaging systems.
CO2 Apply the Optical Image Processing Techniques.
CO3 Comprehend the Fundamentals of Underwater Acoustics and ambient noise.
CO4 Implement Sonar Signal Processing Techniques.
CO5 Evaluate Different Types of Sonar Systems.
CO6 Create Solutions for Challenges in Underwater Optical and Acoustic Imaging.

TEXT BOOKS:

1. Jähne, Bernd," Digital Image Processing." 7th ed., Springer, 2022.

2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB, Third Edition, Gatesmark Publishing,2020.

3. P.K. Thiruvikraman,"A Course on Digital Image processing with MATLAB,First Edition, IOP Publishing,2020.

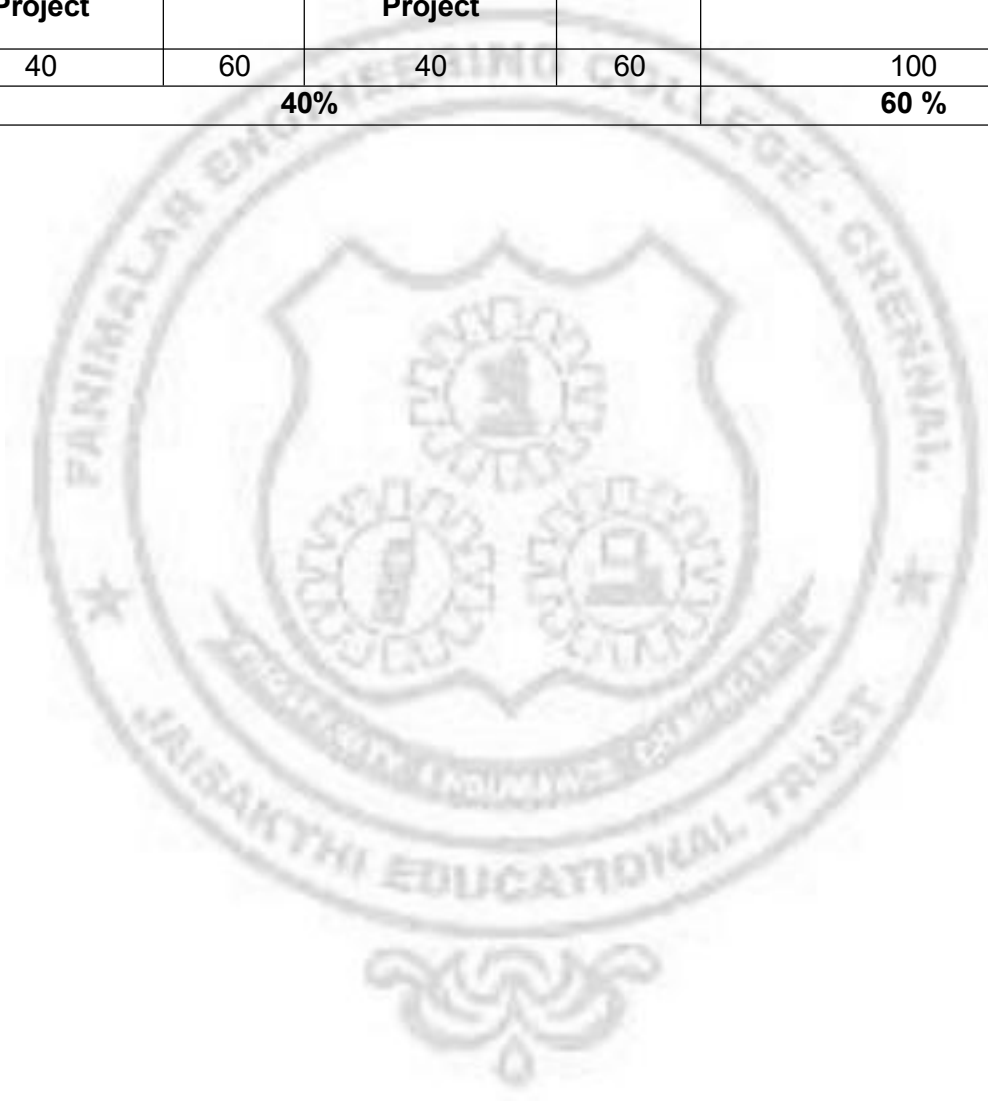
REFERENCE BOOKS:

1. Tinku & Ajoy K. Ray,"Image Processing principles & Applications, First Edition, WileyInterscience,2005.
2. Xavier Lurton,"An Introduction to Underwater Acoustics (Principles and applications), Second Edition, Springer,2010.
3. Don H. Johnson and Dan E. Dudgeon,"Array Signal Processing: Concepts and Techniques, First Edition, Prentice Hall,1993
4. Harry L. Van Trees,"Optimum Array Processing, First Edition, Wiley Interscience,2002
5. Richard O. Nielsen,"Sonar Signal Processing, First Edition, Artech House,1991

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2					1					3	1	2
CO2	3	3	3				1					2	3	1
CO3	3	3	1				1					2	3	2
CO4	3	3	3				1					2	2	3
CO5	3	2	3				1					1	3	3
CO6	3	3	3				1					1	2	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %



VERTICAL IV ADVANCED COMMUNICATION TECHNOLOGY

23EC1922	COGNITIVE RADIO NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the concepts of cognitive radio.
- To familiarize with the Architecture of Cognitive Radio.
- To learn spectrum sensing and dynamic spectrum access.
- To acquaint the fundamentals of MAC & Network Layer Design in Cognitive Radio.
- Apply cognitive radio for Internet of Things and M2M technologies..

UNIT I INTRODUCTION TO SOFTWARE DEFINED RADIO AND COGNITIVE RADIO 9

Evolution of Software Defined Radio(SDR) – Definitions – SDR Functions and Components – Cognitive Radio (CR) – Goals – Benefits – Definitions – CR Transceiver – Relations with other Radios — Issues–Enabling Technologies — Radio Frequency Spectrum and Regulations – Cognitive Radio Bands.

UNIT II COGNITIVE RADIO ARCHITECTURE 9

Cognitive Radio – Functions – Components and Design Rules – Cognition Cycle – Orient, Plan, Decide and Act Phases — Inference Hierarchy — Architecture Maps — Building the Cognitive Radio Architecture on Software defined Radio Architecture – Overview of IEEE
802.22 standard for Broadband Wireless Access in TV Bands – TV White Space(TVWS).

UNIT III SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS 9

Introduction – Primary User Detection Techniques – Energy Detection, Feature Detection, Matched Filtering, Cooperative Detection – Bayesian Approach, Neyman Pearson Fusion Rule for Spectrum Sensing – Optimum Spectrum Sensing – Kullback Leibler Divergence and other approaches – Fundamental Trade offs in Spectrum Sensing – Spectrum Sharing Models of Dynamic Spectrum Access – Unlicensed and Licensed Spectrum Sharing.

UNIT IV MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO NETWORKS 9

MAC for Cognitive Radio Networks — Multichannel MAC — Slotted ALOHA — CSMA — Network Layer Design — Routing in Cognitive Radio Networks, Flow Control and Error Control Techniques – IEEE 802.22 MAC Layer.

UNIT V ADVANCEMENTS IN COGNITIVE RADIO NETWORKS 9

Cognitive Radio Networks for Internet of Things — Features and applications — Enabling technologies and protocols – M2M technologies – Data Storage and Analysis Techniques – Requirement and Challenges of IoT – Energy efficiency – MIMO Cognitive Radio Networks – Power allocation algorithms- Cognitive Digital Home.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the concepts of cognitive radio.
CO2 Interpret the Architecture of Cognitive Radio.
CO3 Summarize spectrum sensing techniques and dynamic spectrum access.
CO4 Compare MAC and network layer design for cognitive radio.
CO5 Apply cognitive radio for Internet of Things and M2M technologies.

TEXT BOOKS:

1. Alexander M. Wyglinski, MaziarNekovee, Thomas Hou, “Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2. Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006.

REFERENCE BOOKS:

1. Wei Zhang, “ Handbook of Cognitive Radio”, Springer Nature Singapore Pte Ltd. 2019.
2. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017.
3. Ezio Biglieri, Andrea J.Goldsmith, Larry J.Greenstein, Narayan B. Mandyam and H.Vincent Poor, “Principles of Cognitive Radio”, Cambridge University Press 2013.
4. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
5. Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.

WEB REFERENCES: (Only accessible Links)

1. https://www.wipro.com/engineering/cognitive-radio/
2. .https://www.techtarget.com/searchnetworking/definition/cognitive-radio
3. https://ietresearch.onlinelibrary.wiley.com/doi/full/10.1049/cmu2.12200
4. https://www.sciencedirect.com/topics/engineering/cognitive-radio
5. https://www.cdac.in/index.aspx?id=product_details&productId=SoftwareDefinedRadio (SDR))

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee22/
2. https://www.udemy.com/course/cognitive-radio-networks
3. https://www.sanfoundry.com/cognitive-radio-certification/

CO-PO MAPPING

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

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1923	HIGH SPEED ACCESS TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the various Access Technologies
- To understand the functions of Digital Subscriber Lines
- To comprehend operation of Cable Modem
- To explore various Fiber Access Technologies
- To comprehend the concepts of BroadBand Access
- To Analye with the concepts of services offered by wireless networks.

UNIT - I REVIEW OF ACCESS TECHNOLOGIES 9

Introduction to Access Technologies, Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless

UNIT - II DIGITAL SUBSCRIBER LINES 9

Asymmetric Digital subscriber lines (ADSL) — Rate Adaptive subscriber line (RADSL)- ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL)- very high bit rate DSL (VDSL)- Standards for XDSL & Comparison.

UNIT - III CABLE MODEM 9

Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.

UNIT - IV FIBER ACCESS TECHNOLOGIES 9

Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison.

UNIT - V BROAD BAND WIRELESS 9

Fixed Wireless, Direct Broadcast Satellite (DBS), Multi-channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Describe the various Access Technologies
CO2 Identify the functions of Digital Subscriber Lines
CO3 Apply operation of Cable Modem
CO4 Explore various Fibre Access Technologies
CO5 Apply the concepts of Broadband Access
CO6 Analyze the various services offered by wireless networks

TEXT BOOKS:

1. Laurence Cahill. "Broadband Access Networks: Technologies and Deployments" , CRC Press, 2021
2. "Broadband Access: Wireline and Wireless - Alternatives for Internet Services" Wiley Publishers, 2014
3. Niel Ransom and Albert A. Azzam, “Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS, McGraw Hill 2002

REFERENCE BOOKS:

1. Gilbert Held, “Next Generation Modems: A Professional Guide to DSL and cable modems”, John Wiley & sons.

2. William Webb, “Introduction to Wireless Local Loop broadband and narrow band system”, Artech House, 2000.

3. Martin P. Clarke, “Wireless Access Network: Fixed Wireless Access and WLL network Design and operation”, John Wiley & Sons 2000.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	1				1	2	3	2	1
CO2	3	3	3	2	1	3				2	2	3	2	1
CO3	3	2	2	3	3	1				2	2	3	2	2
CO4	3	3	3	2	1	3				1	2	3	2	2
CO5	3	2	2	3	3	1				1	1	3	2	2
CO6	3	3	3	2	1	3				2	1	3	2	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1924	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To explore the research issues and challenges in implementing cooperative communications in OFDM and MIMO cellular relay networks.
- To give thorough understanding about the trade-offs involved in designing green radio networks and the importance of energy efficiency.
- To provide an insight on radio resource optimization and adaptive resource allocation techniques in relay-based cooperative networks.
- To understand the concept of base station power management techniques and energy-saving techniques.
- To investigate access techniques for green radio networks
- To gain practical insights into green radio networks through green radio test-beds and standardization activities.

UNIT - I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9

Network architectures and research issues in cooperative cellular wireless networks; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes.

UNIT - II COOPERATIVE TECHNIQUES 9

Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE-Advanced.

UNIT - III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9

Distributed space-time block codes ; Collaborative relaying in downlink cellular systems ; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

UNIT - IV GREEN RADIO NETWORKS 9

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations, Power-management for base stations in smart grid environment, Cooperative multi cell processing techniques for energy-efficient cellular wireless communications.

UNIT - V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks; Energy performance in TDD-CDMA multihop cellular networks; Resource allocation for green communication in relay-based cellular networks; Green Radio Test-Beds and Standardization Activities.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand Network Architectures and Research Issues.

CO2 Evaluate Cooperative Communications in LTE-Advanced.

CO3 Analyze Relay-Based Cooperative Cellular Networks.
CO4 Design and Optimize Energy Performance in various scenarios.
CO5 Utilize green radio test-beds and participate in standardization activities.
CO6 Implement Access Techniques for Green Radio Networks.

TEXT BOOKS:

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava , "Cooperative Cellular Wireless Networks",Cambridge University Press, 2011.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), "Green Radio Communication Networks", Cambridge University Press, 2012.

REFERENCE BOOKS:

1. F. Richard Yu, Yu, Zhang and Victor C. M. Leung "Green Communications and Networking", CRC press, 2012.
2. Ramjee Prasad and Shingo Ohmori, Dina Simunic, "Towards Green ICT", River Publishers, 2010.
3. Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2						3	2	1
CO2	3	2	3	2	3	3						3	2	1
CO3	3	2	3	1	2	3						3	2	2
CO4	2	3	3	2	2	1						3	2	2
CO5	3	3	3	2	1	2						3	2	2
CO6	3	3	3	2	2	2						3	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1925	MASSIVE MIMO NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To gain knowledge about massive MIMO networks.
- To understand the massive MIMO propagation channels.
- To learn about channel estimation in single cell massive MIMO systems.
- To comprehend the channel estimation in multicell massive MIMO systems.
- To grasp the concepts of massive MIMO deployment in the context of single cell deployment.
- To illustrate the concepts of massive MIMO deployment in the context of multicell deployment.

UNIT I MASSIVE MIMO NETWORKS 9

Introduction, , Correlated Rayleigh Fading, System Model for Uplink and Downlink, Basic Impact of Spatial Channel Correlation, Channel Hardening and Favourable Propagation, Local Scattering Spatial Correlation Model

UNIT II MASSIVE MIMO PROPAGATION CHANNEL 9

Favorable Propagation and Deterministic Channels-Capacity Upper Bound-Distance from Favorable Propagation-Favorable Propagation and Linear Processing-Singular Values and Favorable Propagation, Favorable Propagation and Random Channels-Independent Rayleigh Fading-Uniformly Random Line-of-Sight (UR-LoS)-Independent Rayleigh Fading versus UR-LoS - Finite-Dimensional Channels

UNIT III SINGLE-CELL SYSTEMS 9

Uplink Pilots and Channel Estimation - Orthogonal Pilots- De-Spreading of the Received Pilot Signal-MMSE Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission-Linear Precoding-Zero-Forcing-Maximum-Ratio, Discussion-Interpretation of the Effective SINR Expressions-Implications for Power Control-Scaling Laws and Upper Bounds on the SINR - Near-Optimality of Linear Processing when M >> K - Net Spectral Efficiency - Limiting Factors: Number of Antennas and Mobility

UNIT IV MULTI-CELL SYSTEMS 9

Uplink Pilots and Channel Estimation, Uplink Data Transmission - Zero-Forcing - Maximum-Ratio, Downlink Data Transmission -Zero-Forcing - Maximum-Ratio, Discussion -Asymptotic Limits with Infinite Numbers of Base Station Antennas - The Effects of Pilot Contamination - Non-Synchronous Pilot Interference

UNIT V CELL DEPLOYMENT IN MIMO 9

Single-Cell Deployment Example: Fixed Broadband Access in Rural Area, Multi-Cell Deployment: Preliminaries and Algorithms, Multi-Cell Deployment Examples: Mobile Access - Dense Urban

TOTAL :45 PERIODS

COURSE OUTCOME

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

CO1 Understand the massive MIMO networks.

CO2 Analyze massive MIMO propagation channels and their capacity bounds.

CO3 Examine channel estimation techniques for single cell system.

CO4 Interpret channel estimation techniques for multi cell system.

CO5 Explain the concepts underlying the deployment of single cell massive MIMO systems.

CO6 Describe the concepts underlying the deployment of multicell massive MIMO systems.

TEXT BOOKS:

1. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press 2016.
2. Emil Bjornson, Jakob Hoydis and Luca Sanguinetti (2017), “Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency”, Foundations and Trends, Now, 2017.

REFERENCE BOOKS:

1) Long Zhao, Hui Zhao, Kan Zheng, “Wei Xiang Massive MIMO in 5G Networks: Selected Applications”, Springer 2018.
2) Leibo Liu, Guiqiang Peng, Shaojun Wei, “Massive MIMO Detection Algorithm and VLSI Architecture”, Springer 2019.
3) Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai, “mmWave Massive MIMO A Paradigm for 5G”, Elsevier, 2017.

WEB REFERENCES: (Only accessible Links)

1. https://telcomaglobal.com/p/massive-mimo-mmwave-training-course-certification
2. https://www.coursera.org/learn/foundations-of-advanced-wireless-communication

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee65/preview
2. https://nptel.ac.in/courses/117104115

CO PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	1	3	2	1
CO2	3	3	2	-	-	-	-	-	-	-	1	3	1	1
CO3	3	3	2	-	-	-	-	-	-	-	1	3	2	2
CO4	3	3	2	-	-	-	-	-	-	-	1	3	2	2
CO5	3	3	2	-	-	-	-	-	-	-	1	3	2	2
CO6	3	3	2	-	-	-	-	-	-	-	1	3		2

23EC1926	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR COMMUNICATION ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- Study uninformed and heuristic search techniques.
- Learn logical programming in AI
- Explain Machine Learning and supervised learning algorithms for regression problems
- Interpret supervised learning algorithms for classification problems
- Relate between ensembling and unsupervised learning algorithms
- Interpret deep learning techniques using neural networks

UNIT - I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

Meaning and definition of artificial intelligence, Physical Symbol System Hypothesis, production systems, Characteristics of production systems; Breadth first search and depth first search techniques. Heuristic searchTechniques: Hill Climbing, Iterative deepening DFS, bidirectional search. Analysis of search methods. A*algorithm and their analysis. Introduction to Genetic Algorithm.

UNIT - II INTRODUCTION TO PROLOG 9

Introduction to Prolog. Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, inferencing, monotonic and non monotonic reasoning.

UNIT - III SUPERVISED LEARNING 9

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Probabilistic discriminative model - Logistic regression, Probabilistic generative model — Naive Bayes, Maximum margin classifier — Support vector machine, Decision Tree, Random forests

UNIT - IV ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING 9

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, FCM Instance Based Learning: KNN, Gaussian mixture models.

UNIT - V NEURAL NETWORKS 9

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization –stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) — ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand appropriate search algorithms for problem solving

CO2 Compare between first order and predicate logic

CO3 Classify supervised learning models for regression problems

CO4 Apply supervised learning models for classification problems

CO5 Construct ensembling and unsupervised models

CO6 Examine the complexity in deep learning neural network models

TEXT BOOKS:

1. Rich, Elaine. Artificial Intelligence 3rd Edition. India: Tata McGraw-Hill Publ., 2019.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.

REFERENCE BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence — A Modern Approach”, Fourth Edition, Pearson Education, 2021.
2. Joshi, Ameet V. Machine Learning and Artificial Intelligence. Switzerland: Springer International Publishing, 2022.
3. Bishop, Christopher M.. Pattern Recognition and Machine Learning. Sweden: MTM, 2023.
4. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education,2007
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016

WEB REFERENCES: (Only accessible Links)

1. https://www.edx.org/learn/artificial-intelligence
2. https://github.com/saneshashank/Reference-Links

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. https://archive.nptel.ac.in/courses/106/105/106105152/
3. https://onlinecourses.nptel.ac.in/noc22_cs24/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	2	2				1	2	3	3	1	1
CO2	3	2	2	2	3				2	2	3	3	11	1
CO3	3	2	3	3	2				2	3	3	3	2	2
CO4	3	2	3	3	3				2	3	3	3	2	2
CO5	3	2	3	3	3				2	3	3	3	2	2
CO6	3	2	3	3	3				2	3	3	3	2	2

23EC1927	MACHINE LEARNING FOR FUTURE WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand basic machine learning concepts and types of learning.
- To apply regression techniques and SVMs for network tasks.
- To use k-NN, Bayesian classifiers, and graphical models for communication system challenges.
- To develop algorithms for opportunistic spectrum access in millimeter wave networks.
- To optimize energy efficiency in wireless networks using machine learning techniques.
- To use machine learning for traffic prediction and energy-efficient routing in wireless sensor networks.

UNIT - I INTRODUCTION 9

Machine learning, Terminologies in machine learning, Types of machine learning: supervised, unsupervised, semi-supervised learning. Review of probability.

UNIT - II DISCRIMINATIVE MODELS 9

Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Prediction Model, probabilistic interpretation, Regularization, Logistic regression, multi class classification, Support Vector Machines- Large margin classifiers, Nonlinear SVM, kernel functions, SMO algorithm.

UNIT - III GENERATIVE MODELS 9

k-Nearest Neighbour Classification, Bayesian concept learning, Likelihood, Posterior predictive distribution, beta-binomial model, Naive Bayes classifiers, classifying documents using bag of words. Bayesian Statistics and Frequentist statistics. Directed graphical models (Bayes nets), Conditional independence, Inference.

UNIT - IV MACHINE LEARNING FOR SPECTRUM ACCESS AND SHARING 9

Online Learning Algorithms for Opportunistic Spectrum Access, Random and Deterministic Approaches, the Adaptive Sequencing Rules Approach, Structure of Transmission Epochs, Learning Algorithms for Channel Allocation, Machine learning for spectrum sharing in millimeter wave cellular networks.

UNIT - V MACHINE LEARNING IN ENERGY EFFICIENCY OPTIMIZATION 9

Self-Organizing Wireless Networks, Positioning of Unmanned Aerial Vehicles, Traffic Prediction, Mobility Prediction, Threshold-Based Optimization Energy-Efficient Routing Technique in Heterogeneous Wireless Sensor Network.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Apply relevant machine learning approaches to build supervised and unsupervised models to solve problems

CO2 Use probability and statistics concepts to prepare the training, testing and validation datasets for model-building

CO3 Apply advanced techniques to model the relationship between a dependent variable and one or more independent variables
CO4 Design machine learning algorithms for spectrum, access and sharing
CO5 Apply machine learning algorithms for optimizing energy efficiency
CO6 Apply machine learning for traffic forecasting and efficient routing in sensor networks.

TEXT BOOKS:

1 Alex Smola and SVN. Viswanathan, "Introduction to Machine Learning", Cambridge University Press, 2008
2. Fa-Long Luo," Machine Learning for Future Wireless Communications", John Wiley and Sons, 2020
3. Ruisi He, Z Ding, "Applications of Machine Learning in Wireless Communications", IET Telecommunication series 81.

REFERENCE BOOKS:

1. 1. K. K. Singh, A. Singh, K. Cengiz, Dac-Nhuong Le, "Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks", Wiley 2020
2. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
3. E. Alpaydin, "Introduction to Machine Learning", PHI, 2005.
4. Tom Mitchell, "Machine Learning", McGraw Hill, 1997
5. Kevin P. Murphy, "Machine Learning, a probabilistic perspective", The MIT Press Cambridge, Massachusetts, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	-	-	1	3	1	1
CO2	3	3	2	1	1	-	-	-	-	-	1	3	1	1
CO3	3	3	2	1	1	-	-	-	-	-	1	3	2	2
CO4	3	3	2	1	1	-	-	-	-	-	1	3	2	2
CO5	2	2	2	1	1	-	-	-	-	-	1	3	2	2
CO6	2	2	2	1	1	-	-	-	-	-	1	3	2	2

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1928	TERAHERTZ COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To know the principles of Terahertz principles
- To study THz sources for a given for different applications.
- To Determine THz detectors for a given applications.
- To Analyze suitability of THz imaging and spectroscopy systems.
- To Apply THZ systems knowledge for different Industrial and communication applications.

UNIT - I TERAHERTZ OVERVIEW AND PRINCIPLES 9

Electromagnetic Radiation and Propagation Fundamentals, Terahertz Principles, Towards Terahertz communication systems, Key technological issues for Terahertz technology, Fundamental limits, Terahertz technology Applications and opportunities.

UNIT - II TERAHERTZ SOURCES 9

The development of Terahertz sources, Terahertz sources based on Schottky diode frequency multipliers, Free Electron based Tera Hertz sources, Compact Tunable Terahertz Sources very short wave length Vacuum Electronic devices, Photo mixing Tunable Terahertz sources, Terahertz magnetic response from artificial material, Continuous wave THz radiation generation through non linear processes

UNIT - III THz DETECTORS> 9

Pyroelecrtic detectors, gallium doped Germanium photoconductive detector, Bolometer detectors, composite Germanium Bolometer, unturned Indium Antimode, Go lay Cell detectors, Terahertz Electronic components, Travelling Wave Terahertz detector, Tunable Plasma Wave-HEMT THz Detector, Terahertz detector on a single chip, Quantum dot Photo detector, Multiband Terahertz detection and imaging devices, Integrated Terahertz Imager based on quantum dots, CNT based QD frequency tunable THz detector

UNIT - IV LOW COHERENCE THz SIGNAL SOURCES AND APPLICATIONS AND THz CHEMICAL SPECTROSCOPY 9

Introduction, Schemes for Noise generation, Characterization of noise signals,Imaging,2D imaging, Tomographic imaging, spectroscopy, amplifier characterization,THZ TDS overview, Application: Terahertz spectroscopic imaging, overview, measurement system, Application:chemical mapping of pharmaceuticals in medicine and chemical mapping of pharmaceuticals cocrystals.

UNIT - V INDUSTRIAL AND WIRELESS COMMUNICATIONS APPLICATIONS OF TERAHERTZ WAVES 9

Different kinds of Terahertz systems, Polymer Industry, Polymeric compounds, Paper Industry, Food Industry, Pharmaceuticals Industry, crops Industry, why the terahertz waves for communication, Application scene of terahertz communication, current technologies, frequency dispersion, Ray shadowing by moving persons.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify THz principles and components.
CO2 Select THz sources for a given for different applications.
CO3 Determine THz detectors for a given for different applications.
CO4 Analyze suitability of THz imaging and spectroscopy systems for different applications.
CO5 Apply THZ systems knowledge for different Industrial and communication applications.

TEXT BOOKS:

1. Saim Ghafoor, Mubashir Husain Rehmani, Alan Davy, ``Next Generation Wireless Terahertz Communication Networks'', CRC Press, 2021
2. Ho-Jin Song,Tadao Nagatsuma, "Handbook of Terahertz Technologies, Devices and applications", Pan Stanford Publishing Pte. Ltd. 2015,
3. Ali Rostami, Hassan Rasooli, Hamed Baghban, "Terahertz Technology: Fundamentals and applications," New York, Springer, 2011

REFERENCE BOOKS:

1. E. Bjorson, J. Hoydis, and L. Sanguinetti, Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency, now Publishers, 2018
2. Ho-Jin Song,Tadao Nagatsuma, "Handbook of Terahertz Technologies, Devices and applications", Pan Stanford Publishing Pte. Ltd. 2015
3. RE Miles,P Harisson, D Lippens "Terahertz Sources and Systems ",Springer Science+Business media, BV 2000

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2							3	1	1
CO2	3	3	3	2	2							3	1	1
CO3	3	3	2	2	2							3	1	2
CO4	3	3	3	3	2							3	2	2
CO5	3	2	3	3	2							3	2	2
CO6	3	3	3	3	2							3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

VERTICAL V VLSI DESIGN AND TESTING

23EC1929	ASIC DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of ASIC and its design methods.
- To gain knowledge on programmable ASICs.
- To demonstrate advanced FPGA architectures.
- To explore the physical design of ASIC.
- To analyse various routing algorithms for design optimisation.
- To comprehend System on Chip design.

UNIT I INTRODUCTION TO ASIC 9

Types of ASICs - Design Flow - CMOS Transistors - Combinational Logic Cell – Sequential Logic Cell - Data Path Logic Cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical Effort.

UNIT II PROGRAMMABLE ASIC 9

Anti Fuse - Static RAM - EPROM and EEPROM Technology - ACTEL ACT- Xilinx LCA — ALTERA FLEX - ALTERA MAX DC & AC Inputs and Outputs - Clock & Power Inputs - Xilinx I/O Blocks.

UNIT III PROGRAMMABLE ASIC ARCHITECTURE 9

Architecture and Configuration of ARTIX / Cyclone and KINTEX Ultra Scale / STRATIX FPGA — Micro-Blaze / NIOS Based Embedded Systems — Signal Probing Techniques.

UNIT IV LOGIC SYNTHESIS, PLACEMENT AND ROUTING 9

Logic Synthesis - Floor Planning Goals and objectives, Measurement of Delay in Floor Planning, Floor Planning Tools, I/O and Power Planning, Clock Planning, Placement Algorithms. Routing: Global Routing, Detailed Routing, Special Routing.

UNIT V SYSTEM ON CHIP DESIGN 9

SoC Design Flow, Platform-Based and IP Based SoC Designs, Basic Concepts of Bus Based Communication Architectures, High Performance Filters using Delta Sigma Modulators, Applications: Digital Camera, SDRAM, High Speed Data standards.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the fundamentals of ASIC and its design methods.
CO2 Comprehend programmable ASICs
CO3 Assess recent FPGA architectures.
CO4 Apply the algorithms for Floor Planning and Placement of Cells.
CO5 Analyze Routing Algorithms for Optimization of Length and Speed.
CO6 Develop applications using System on Chip design.

TEXT BOOKS:

1. M.J.S.Smith, "Application Specific Integrated Circuits", Addison - Wesley Longman. Inc., Eleventh Impression 2011
2. Steve Kilts,"Advanced FPGA Design", Wiley Inter-Science,2006.

REFERENCE BOOKS:

1. Wayne Wolf , "FPGA-Based System Design", Prentice Hall PTR, 2009.
2. Farzad Nekoogar and Faranak Nekoogar, "From ASICs to SOCs: A Practical Approach ", Prentice Hall PTR, 2003.
3. Roger Woods, John Mcallister, Dr. Ying Yi, Gaye Lightbod,"FPGA-Based Implementation of Signal Processing Systems", Wiley, 2008.

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1. https://www.einfochips.com/blog/asic-design-flow-in-vlsi-engineering-services-a-quick-guide/
2. https://www.system-to-asic.com/blog/what-is-asic-design/
3. https://www.ansys.com/en-in/simulation-topics/what-is-asic-design
4. https://www.chipverify.com/verilog/asic-soc-chip-design-flow

ONLINE COURSES / RESOURCES:

1. ASIC Bootcamp for VLSI Engineer:STA Basic Concepts
   https://www.udemy.com/course/asic-bootcamp-sta-basic-concepts/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2					1		3	3	1	3
CO2	3	3	3	3	3				1		3	3	1	3
CO3	3	3	3	3	3				1		3	3	2	2
CO4	3	3	3	3	3				1		3	3	3	2
CO5	3	3	3	3	3				1		3	3	3	3
CO6	3	3	3	3	3				1		3	3	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

243C1930	CAD FOR VLSI DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce VLSI design methodologies and design styles.
- To demonstrate data structures and algorithms required for VLSI design.
- To apply algorithms for partitioning and placement.
- To analyze algorithms for floor planning and routing.
- To explain different modelling in VLSI design
- To formulate modelling simulation and synthesis for VLSI design

UNIT I INTRODUCTION TO VLSI DESIGN CYCLE 9

Introduction to VLSI Design Methodologies - VLSI Design Cycle -New Trends in VLSI Design Cycle - Physical Design Cycle-New Trends in Physical Design Cycle -Design Styles- Review of VLSI Design Automation Tools- System Packaging styles.

UNIT II DATA STRUCTURES AND BASIC ALGORITHMS 9

Introduction - Computational Complexity - Examples of graph Algorithms-Depth first search, Breadth first search, Dijkstra's shortest path algorithm, Prim's Algorithm for minimum spanning trees, Tractable and Intractable Problems - Combinatorial optimization problems, decision problems, complexity classes, NP-completeness and NP-hardness, General Purpose Methods for Combinatorial Optimization — Dynamic Programming, integer linear programming.

UNIT III LAYOUT, PARTITIONING AND PLACEMENT 9

Layout Compaction - Problem Formulation, Algorithms for Constraint Graph Compaction - Partitioning -Classification, Group migration algorithms, Simulated annealing and evolution, Placement - classification, simulation based and partitioning based, Placement Algorithms, Performance driven placement.

UNIT IV FLOORPLANNING AND ROUTING 9

Floor planning - Problem Formulation - Floor Planning Algorithms-Constraint based, Integer Programming based, Hierarchical tree based, Pin assignment - General pin assignment, Channel pin assignment, Routing - Area Routing, Channel Routing, Global Routing, Detailed Routing.

UNIT V MODELLING, SIMULATION AND SYNTHESIS 9

Simulation - Gate Level modelling and simulation, Switch level modelling and simulation Logic Synthesis and verification - Binary Decision Diagrams, Two-level logic synthesis -High Level Synthesis - Hardware models, Internal representation of the input algorithm, Allocation, Assignment and Scheduling.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Recall various VLSI design methodologies

CO2 Relate different data structures and algorithms required for VLSI design.
CO3 Apply algorithms for partitioning and placement.
CO4 Analyze algorithms for floor planning and routing.
CO5 Evaluate different modelling in VLSI design
CO6 Develop simulation and synthesis of VLSI design

TEXT BOOKS:

1. Sabih H. Gerez, "Algorithms for VLSI Design Automation", Second Edition, Wiley-India, 2017.
2. Naveed a. Sherwani, "Algorithms for VLSI Physical Design Automation", 3rd Edition, Springer, 2017.

REFERENCE BOOKS:

1. Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu"VLSI Physical Design: From Graph Partitioning to Timing Closure" Springer International Publishing,2022
2. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, "Handbook of Algorithms for Physical Design Automation", CRC Press, 2nd Edition, 2019.
3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2014

WEB REFERENCES: (Only accessible Links)

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/106/106/106106089

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	1	1			1	1		3	2	1	1
CO2	3	3	3	3	3			1	1		3	3	1	3
CO3	3	3	3	3	3			1	2		3	3	2	2
CO4	3	3	3	3	3			1	2		3	3	3	2
CO5	3	2	2	2	3			1	2		3	3	3	2
CO6	3	3	3	3	3			1	2		3	3	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1931	SYSTEM VERILOG	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To recognize the verification guidelines

- To classify datatypes in system Verilog
- To execute routines and connect the test bench & design
- To implement the basic Object Oriented Programming
- To examine randomization in System Verilog
- To plan communication and Functional Coverage

UNIT I Verification guidelines and Data Types 9

Verification guidelines: Verification Process, Basic Test bench functionality, directed testing, Methodology basics, Constrained-Random stimulus, Functional coverage, Test bench components, Layered test bench, Building layered test bench, Simulation environment phases, Maximum code reuse, Test bench performance.

Data types: Built-in data types, Fixed-size arrays, Dynamic arrays, Queues, Associative Arrays, linked lists, Array methods, choosing a storage type, creating new types with typedef, creating user-defined structures, Type conversion, Enumerated types, Constants, strings, expression width.

UNIT II Routines and Connecting the test bench & design 9

Procedural statements and routines: Procedural statements, tasks, functions and void Functions, Routine arguments, returning from routine, local data storage, Time values. Connecting the test bench and design: Separating the test bench and design, Interface constructs, Stimulus timing, Interface driving and sampling, connecting it all together, Top- level scope, Program — Module interactions, System Verilog assertions.

UNIT III Basic OOP 9

Introduction, first class, define a class, OOP (Object Oriented Programming) terminology, creating new objects, Object de-allocation, Using objects, Static variables vs. Global variables, Class methods, Defining methods outside of the class, Scoping rules, Using one class inside another, Understanding dynamic objects, Copying objects, Public vs. private, Straying off course, building a test bench.

CO-PO MAPPING

UNIT IV Randomization 9

Introduction, randomization, Randomization in System Verilog, Constraint details, solution probabilities, Controlling multiple constraint blocks, Valid constraints, In-line constraints, The pre_randomize and post_randomize functions, Constraints tips and techniques, common randomization problems.

UNIT V Interprocess communication and Functional Coverage 9

Interprocess Communication, Events, Semaphores, Mailboxes, Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, Anatomy of a Cover Group, Triggering a Cover Group, Data Sampling, Cross Coverage, Generic Cover Groups, Coverage Options, Analyzing Coverage Data, Measuring Coverage Statistics During Simulation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Recognize the concepts of verification methodologies and data types.
CO2 Summarize the concepts of data types.
CO3 Execute procedural statements, routines and assertions.
CO4 Apply Object Oriented Programming concepts.
CO5 Evaluate randomization in System Verilog.
CO6 Develop the concepts of functional coverage.

TEXT BOOKS:

1. System Verilog for Verification — A guide to learning the Test bench language features Chris Spear Springer Publications Third Edition, 2012.

REFERENCE BOOKS:

1. System Verilog Assertions and Functional Coverage: Guide to Language, Methodology and Applications, by Ashok B. Mehta, Springer; 2014 edition.
2. Formal Verification: An Essential Toolkit for Modern VLSI Design 1st Edition by Erik Seligman, Tom Schubert, M V Achutha Kiran Kumar, Morgan Kaufmann; 2015.
3. System Verilog for Design- A guide to using system Verilog for Hardware design and modelling Stuart Sutherland, Simon Davidmann, Peter Flake Springer Publications Second Edition, 2006

WEB REFERENCES: (Only accessible Links)

1. https://www.chipverify.com/tutorials/systemverilog

ONLINE COURSES / RESOURCES:

1. https://www.cadence.com/en_US/home/training/all-courses/82143.html
2. https://www.udemy.com/course/soc-verification-systemverilog/
3. https://www.nielit.gov.in/calicut/course-calendar?coursecode=VL800

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2			2						3	2	1	2
CO2	3	2			2						3	2	1	2
CO3	3	3	3		2				2		3	2	2	2
CO4	3	2	2		2				2		3	3	3	2
CO5	3	2		2	3						3	3	2	2
CO6	3	2	3	2	3					2	3	3	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1932	LOW POWER IC DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To Understand various sources of power in an IC.
- To interpret the power reduction techniques based on technology independent and technology dependent methods
- To Apply suitable techniques to reduce the power dissipation.
- To gain knowledge about advanced techniques for low power IC design.
- To estimate power dissipation at various levels in IC design.
- To develop algorithms for low power dissipation.

UNIT I POWER DISSIPATION IN CMOS 9

Hierarchy of Limits of Power - Sources of Power Consumption - Physics of Power Dissipation in CMOS FET Devices -The MIS Structure- Long channel MOSFET-Submicron MOSFET- Gate induced Drain leakage - Basic Principle of Low Power Design.

UNIT II POWER OPTIMIZATION 9

Logic Level Power Optimization - Circuit Level Low Power Design - Gate Level Low Power Design -Architecture Level Low Power Design - VLSI Subsystem Design of Adders, Multipliers, PLL, Low Power Design.

UNIT III DESIGN OF LOW POWER CMOS CIRCUITS 9

Computer Arithmetic Techniques for Low Power System - Reducing Power Consumption in Combinational Logic, Sequential Logic, Memories - Low Power Clock - Advanced Techniques - Special Techniques, Adiabatic Techniques.

UNIT IV POWER ESTIMATION 9

Power Estimation Techniques, Circuit Level, Gate Level, Architecture Level, Behavioral Level, Logic Power Estimation - Simulation Power Analysis -Probabilistic Power Analysis-Real Delay gate power estimation.

UNIT V SOFTWARE DESIGN FOR LOW POWER CMOS CIRCUIT 9

Synthesis for Low Power - Behavioral Level Transform -Algorithms for Low Power - BUS switching activity instruction level power analysis -Software Design for Low Power-Software power optimization S to Match computational resources.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

CO1 Understand power dissipation in MOS circuits.
CO2 Summarize power optimization at various abstraction levels.
CO3 List out the low power techniques for VLSI circuits.
CO4 Apply advanced techniques for low power IC design

CO5 Evaluate power estimation at various levels in IC design
CO6 Develop software algorithms to reduce power dissipation.

TEXT BOOKS:

1. J.Rabaey, “Low Power Design Essentials (Integrated Circuits and Systems)”, Springer, 2017.
2. Kaushik Roy and S.C.Prasad,”Low Power CMOS VLSI Circuit Design”, Wiley, 2009.

REFERENCE BOOKS:

1. J.B.Kulo and J.H Lou,”Low Voltage CMOS VLSI Circuits”, Wiley 1999.
2. James B.Kulo, Shih-Chia Lin, “Low Voltage SOI CMOS VLSI Devices and Circuits”, John Wiley and Sons, Inc. 2001.
3. Dimitrios Soudris,Christians Pignet,Costas Goutis,“Designing CMOS Circuits for Low Power”,Kluwer,2002
4. Yeap Gary K, “Practical low power digital VLSI design”, Springer Science & Business Media, 2012.
5. Abdelatif Bellaouar, Mohamed.I.Elmasry, “Low power digital VLSI design: circuits and systems”, Springer Science and Business Media, 2012.
6. Ajit Pal, Low Power VLSI Circuits and Systems, Springer 2015.

WEB REFERENCES:

1. https://link.springer.com/chapter/10.1007/978-1-4419-8546-0_1

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/106/105/106105034/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3						2	1		3	2	1	2
CO2	3	3		2				2	1		3	2	2	2
CO3	3	3	2	2	2				1		3	2	2	2
CO4	2	3	3	2	2				1		3	3	3	2
CO5	2	2	3	2	2	2		2	1		3	3	2	3
CO6	2	2	3	2	2	3		2	1		3	3	3	3

23EC1933	VLSI TESTING AND DESIGN FOR TESTABILITY	L	T	P	C
		3	0	0	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

COURSE OBJECTIVES

- To learn basics of testing and fault modeling.
- To understand test generation for combinational logic circuits.

- To comprehend test generation for sequential logic circuits.
- To apply various design approaches for testability.
- To develop test pattern generation and algorithms.
- To analyse various fault diagnosis in VLSI circuits.

UNIT I TESTING AND FAULT MODELING 9

Introduction to testing - Faults in Digital Circuits - Modeling of faults - Logical Fault Models - Fault detection - Fault Location - Fault dominance - Logic simulation - Types of simulation - Delay models - Gate Level Event - driven simulation.

UNIT II TEST GENERATION 9

Test generation for combinational logic circuits –Test generation techniques for combinational circuits- Testable combinational logic circuit design - Test generation for sequential circuits - design of testable sequential circuits.

UNIT III DESIGN FOR TESTABILITY 9

Design for Testability - Ad-hoc design - generic scan based design - classical scan based design, Isolated Serial Scan, Non serial Scan- system level DFT approaches. System-Level Busses -System-Level Scan Paths- Boundary Scan Standards.

UNIT IV SELF TEST AND TEST ALGORITHMS 9

Built-In self-test - BIST Design Rules -test pattern generation for BIST - Circular BIST - BIST Architectures - Testable Memory Design - Test Algorithms - Test generation for Embedded RAMs

UNIT V FAULT DIAGNOSIS 9

Logical Level Diagnosis - Diagnosis by UUT reduction - Fault Diagnosis for Combinational Circuits - Self-checking design - System Level Diagnosis.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Understand the concept of testing and fault in VLSI digital circuits.

CO2 Apply test generation techniques for combinational logic circuits.

CO3 Make use of test generation techniques for sequential logic circuits.

CO4 Perform Built in self-test and generate test pattern.

CO5 Analyse fault diagnosis in VLSI circuits.

CO6 Develop VLSI testing methods and system level applications.

TEXT BOOKS

1. A.L.Crouch,"Design Test for Digital IC's and Embedded Core Systems", Prentice Hall International, 2007.
2. M. Abramovici, M.A.Breuer and A.D. Friedman,"Digital systems and Testable Design", Jaico Publishing House, 2001.

REFERENCE BOOKS

1. Lala, Parag K., "An Introduction to Logic Circuit Testing", United States: Morgan & Claypool Publishers, 2022.
2. M.L.Bushnell and V.D.Agrawal,"Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits", Kluwer Academic Publishers, 2013.
3. P.K. Lala,"Digital Circuit Testing and Testability", Academic Press, 2002.

WEB REFERENCES: (Only accessible Links)

1. https://www.cerc.utexas.edu/~jaa/vlsi/lectures/20-2.pdf
2. http://smdpc2sd.gov.in/downloads/IEP/IEP%205/IEP_C2SD_2017_HR.pdf

ONLINE COURSES / RESOURCES

1. https://www.maven-silicon.com/advanced-vlsi-design-and-dft-course
2. https://chip edge.com/design-for-test-course

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	3	1	1					1	3	1	2
CO2	3	2	3	3	1	1					1	3	1	2
CO3	3	2	3	3	1	1					1	3	2	2
CO4	3	2	3	3	1	1					1	3	3	2
CO5	3	2	3	3	1	1					1	3	2	3
CO6	3	2	3	3	1	1					1	3	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1934	SYSTEM ON CHIP	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of System Processor architecture
- To gain knowledge on design concepts underlying system on chip.
- To select processors for SoCs.
- To design SOC memory systems.
- To explore various interconnect architectures and SOC customization.
- To develop FPGA based embedded processor.

UNIT I SYSTEM ARCHITECTURE 9

Components of the system processor architectures-Memory and addressing system level - interconnection- SoC design requirements and specifications-design integration- design complexity cycle time, die area and cost, ideal and practical scaling, area-time-power trade off in processor design, Configurability.

UNIT II PROCESSOR SELECTION FOR SOCs 9

Overview -soft processors, processor core selection. Basic concepts, instruction set, branches, interrupts and exceptions, Basic elements in instruction handling - Minimizing pipeline delays -reducing the cost of branches -Robust Processors, Vector processors, VLIW processors, Superscalar processors.

UNIT III MEMORY DESIGN 9

SoC external memory, SoC internal memory, Scratch pads and cache-memory cache organization and write policies-strategies for line replacement at miss time - split I and D caches-multilevel caches-SoC memory systems-board based memory systems-simple processor/memory interaction.

UNIT IV INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION 9

Bus architectures - SoC standard buses AMBA, Core Connect-Processor customization approaches -Reconfigurable technologies-mapping designs onto reconfigurable devices - FPGA based design-Architecture of FPGA, FPGA interconnect technology, FPGA memory, Floor plan and routing.

UNIT V FPGA BASED EMBEDDED PROCESSOR 9

Hardware software task partitioning-FPGA fabric Immersed Processors-Soft Processors and Hard Processors -Tool flow for Hardware/Software Co-design Interfacing Processor with memory and peripherals -Types of On-chip interfaces - Wishbone interface, Avalon Switch Matrix, OPB Bus Interface, creating a Customized Microcontroller — FPGA based Signal Interfacing and Conditioning.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Summarize the fundamentals of System Processor architecture.
CO2 Comprehend the design concepts underlying System on chip.
CO3 Select suitable processors for SoCs.
CO4 Design SOC memory systems.
CO5 Analyze interconnect architectures and SoC customization.
CO6 Develop FPGA based embedded processors using SoC concepts.

TEXT BOOKS:

1. Flynn, MJ, Luk, W, "Computer System Design: System-on-Chip", Wiley India Pvt. Ltd, 2011.
2. Steve Furber, "Arm System-On-Chip Architecture", 2/E. India, Pearson Education, 2001.

REFERENCE BOOKS:

1. Wayne Wolf, "Modern VLSI Design -System- on-Chip Design", Prentice Hall, 3rd Edition, 2008.
2. Wayne Wolf, "Modern VLSI Design – IP based Design", Prentice Hall, 4th Edition, 2008.

WEB REFERENCES: (Only accessible Links)

1. https://www.ansys.com/en-in/blog/what-is-system-on-a-chip
2. https://www.geeksforgeeks.org/architecture-of-soc/
3. https://www.synopsys.com/blogs/chip-design/system-on-chip.html
4. https://www.arm.com/glossary/soc-development

ONLINE COURSES / RESOURCES:

1. System on Chip Design using VIVADO and ZYBO Z7-10
   https://www.udemy.com/topic/soc/
2. Lab Workshop on ARM-based SoC Design
   https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-arm-based-soc-design/?v=c86ee0d9d7ed

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2					1		3	3	1	2
CO2	3	3	3	3	3	2			1		3	3	1	2
CO3	3	3	3	3	3	2			1		3	3	2	2
CO4	3	3	3	3	3	2			1		3	3	3	2
CO5	3	3	3	3	3	2			1		3	3	2	3
CO6	3	3	3	3	3	2			1		3	3	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1935	NETWORK ON CHIP	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Understand the concept of Network on Chip (NoC)
- To demonstrate router architecture designs
- To gain knowledge on routing algorithms
- To study the concepts testing of NoC architectures
- To explain fault tolerance algorithms for NoC
- To elaborate three dimensional integration of NoC

UNIT I INTODUCTION TO NoC 9

Introduction to NOC — OSI Layer roles in NoC - Benefits and challenges of adopting NoCs Interconnection Networks in Network-on-Chip - Network Topologies, Switching Techniques, Routing Strategies, Flow Control Protocol, Quality-of-Service Support.

UNIT II ARCHITECTURE DESIGN OF NoC 9

Switching Techniques and Packet Format - Asynchronous FIFO Design -GALS Style of Communication - Wormhole Router Architecture Design - VC Router Architecture Design - Adaptive Router Architecture Design

UNIT III ROUTING ALGORITHMS 9

Packet routing-QOS, Congestion control and Flow control — Router Design — Network Link Design – Efficient and Deadlock-Free Tree-Based Multicast Routing Methods - Path-Based Multicast Routing for 2D and 3D Mesh Networks- Fault-Tolerant Routing Algorithms - Reliable and Adaptive Routing Algorithms

UNIT IV TESTING OF NoC ARCHITECTURES 9

Introduction — Testing Communication fabric- NoC Links, NoC Switches, Test Data Transport, Test Transport Time Minimization, Testing Cores-Core Wrapper Design, ILP Formulation, PSO based Strategy

UNIT V THREE-DIMENSIONAL INTEGRATION OF NoC 9

Three-Dimensional Networks-on-Chips Architectures. — A Novel Dimensionally-Decomposed Router for on-Chip Communication in 3D Architectures - Resource Allocation for QoS on-Chip Communication – Networks-on-Chip Protocols- On-Chip Processor Traffic Modelling for Networks-on-Chip

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Recall the fundamental definitions and principles related to NoC.

CO2 Interpret the reliability and robustness of fault tolerance strategies in NoC.

CO3 Choose appropriate routing algorithms in practical NoC applications.

CO4 Analyze different testing approaches for NoC to ensure their effectiveness.
CO5 Evaluate the reliability and robustness of fault tolerance strategies in NoC.
CO6 Develop innovative 3D integration designs for NoC.

TEXT BOOKS:

1. Jerger, Natalie Enright., Krishna, Tushar., Peh, Li-Shiuan. On-Chip Networks, Second Edition. Poland: Springer International Publishing, 2022.
2. Kundu, Santanu., Chattopadhyay, Santanu. Network-on-Chip: The Next Generation of System-on-Chip Integration. United States: CRC Press, 2018.

REFERENCE BOOKS:

1. Fayezgebali, Haythamelmiligi, Hqhahedwatheq E1-Kharashi "Networks-On-Chips Theory and Practice CRC Press,2017
2. Palesi, Maurizio, Daneshtalab, Masoud "Routing Algorithms in Networks-On-Chip" 2014.
3. Tatas, Konstantinos., Siozios, Kostas., Soudris, Dimitrios., Jantsch, Axel. Designing 2D and 3D Network-on-Chip Architectures. Springer New York, 2016

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2			1	1		3	3	1	1
CO2	3	3	3	3	2			1	1		3	3	1	1
CO3	3	3	3	2	3			1	2		3	3	2	2
CO4	3	3	2	3	3			1	2		3	3	3	2
CO5	3	3	3	3	2			1	2		3	3	2	3
CO6	3	3	3	3	3			1	2		3	3	3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

VERTICAL VI RF TECHNOLOGIES

23EC1936	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic concepts of Electromagnetic Interference.
- To get the knowledge on the EMI Coupling mechanism.
- To understand ways of mitigating EMI by using shielding, grounding & Filtering.
- To Explain the concept of EMC design for circuits and PCBs
- To know the EMI test methods & types
- To describe the existing standards for Electromagnetic Compatibility.

UNIT I INTRODUCTION TO EMI/EMC 9

EMI-EMC definitions; Sources and Victims of EMI; Conducted and Radiated EMI Emission and Susceptibility; frequency spectrum conservation, Case Histories; Radiation Hazards to humans, ESD Phenomena and effects.

UNIT II EMI COUPLING MECHANISM 9

Conducted, radiated and transient coupling; Common ground impedance coupling; Common mode and ground loop coupling; Differential mode coupling; Near field cable to cable coupling; Field to cable coupling; Automotive transient, Power mains and Power supply coupling.

UNIT III EMI CONTROL METHODS 9

Shielding- Practical examples; EMI Filters - Filter types and operation- Characteristics of filter-Installation and evaluation; Grounding- examples; Bonding; Isolation transformer; Transient suppressors; Opto-isolator, EMI Suppression Cables.

UNIT IV EMC DESIGN FOR CIRCUITS AND PCBs 9

Noise from Relays and Switches; Nonlinearities in Circuits; Cross talk in transmission line and cross talk control; Component selection and mounting; PCB trace impedance; Routing; Power distribution decoupling; Zoning; Grounding; VIAs; Terminations

UNIT V EMI TEST METHOD AND STANDARDS 9

TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Line impedance stabilization networks; EMI Rx and spectrum analyser; Open area test sites: OATS measurements, measurement precautions. Feed through Capacitor, Current Probe, Civilian standards - CISPR, FCC, IEC, EN; Military standards- MIL461E/462.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1** Understand the basic concepts of EMI/EMC.
- **CO2** Know various EMI coupling principles.
- **CO3** Describe the various mitigation techniques
- **CO4** Recognize EMC design for circuits and PCBs
- **CO5** Propose a suitable EMI test methods
- **CO6** Describe the various EMC Standards and methods to measure them

TEXT BOOKS

1. V. Prasad Kodali, "Engineering Electromagnetic compatibility: Principles, measurements and computer models", 2nd Edition, March 2010.
2. Henry W.Ott., "Noise Reduction Techniques in Electronic Systems", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.

REFERENCE BOOKS

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Third Edition, Indian Edition, 2023.
2. Bemhard Keiser, "Principles of Electromagnetic Compatibility", 3rd Ed, Artech house,Norwood, 1986.
3. Don R. J.White Consultant Incorporate, "Handbook of EMI/EMC", Vol I-V, 1988.
4. C.R.Paul, "Introduction to Electromagnetic Compatibility" , John Wiley and Sons, Inc,1992.

WEB REFERENCES

1. https://byjus.com/jee/electromagnetic-spectrum-and-electromagnetic-waves/
2. https://www.sciencedirect.com/topics/neuroscience/electromagnetic-radiation

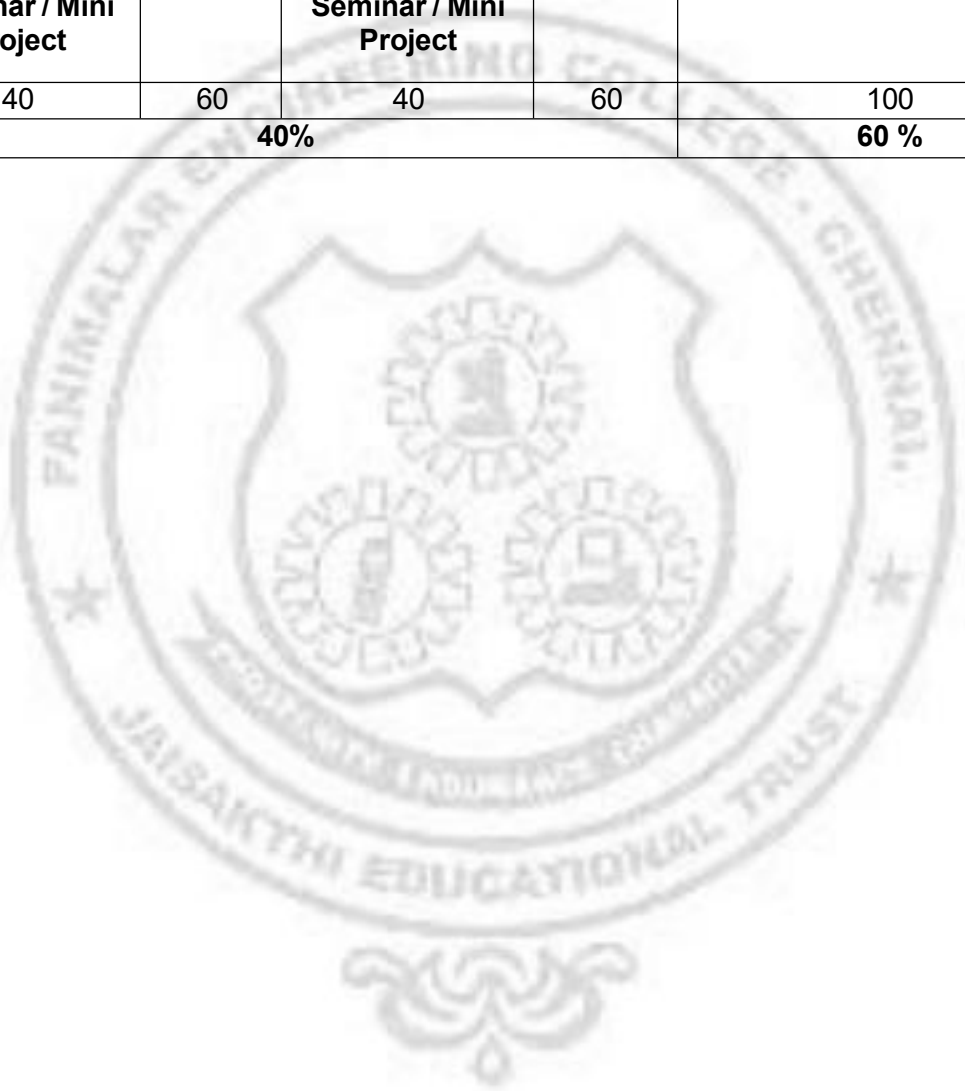
ONLINE COURSES / RESOURCES

1. https://byjus.com/physics/electromagnetic-radiation/
2. https://www.sciencedirect.com/topics/neuroscience/electromagnetic-radiation

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	1	3	2	1
CO2	3	2	1	1	1	1	1	1	1	1	1	3	2	1
CO3	3	2	1	1	1	1	1	1	1	1	1	3	2	1
CO4	3	2	1	1	1	1	1	1	1	1	1	3	2	1
CO5	3	2	1	1	1	1	1	1	1	1	1	3	2	1
CO6	2	2	1	1	1	1	1	1	1	1	1	3	2	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %



23EC1937	RFID SYSTEM AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To discuss the fundamentals of near field and far field RFID communications.
- To articulate the standards and protocols used in RFID systems.
- To describe the operating principles of RFID tag and reader.
- To explore the security aspects of RFID systems.
- To impart knowledge on system architecture of RFID systems.
- To illustrate the industrial and scientific applications of RFID systems.

UNIT I INTRODUCTION TO RFID 9

RFID Principles: Near-field based RFID – Properties of Magnetic field – Far-field based RFID – Properties of Backscatter RF Systems – Modulation techniques – Frequency based property comparison of RFID Systems.

UNIT II RFID STANDARDS AND PROTOCOLS 9

RFID Industry standards: EPC global — ISO15693 Vicinity cards and RFID — ISO14443 Proximity cards and RFID – The NFC forum – Reading collocated RFID tags: Query Tree protocol – Query Slot protocol.

UNIT III OPERATING PRINCIPLES 9

RFID Tag components: RFID tag types – the 1-Bit Transponder and Chipless Tags — RFID readers and middleware component — Communication fundamentals: Coupling, Data encoding, multi-path effect – Tag, Reader and sensor communication.

UNIT IV DATA INTEGRITY AND SECURITY 9

Checksum procedure – Parity checking – LRC procedure – CRC procedure - Multi-access procedures — Attacks on RFID Systems — Protection by Cryptographic measures - Mutual Symmetrical Authentication - Authentication using Derived Keys - Encrypted Data Transfer.

UNIT V RFID ENABLED SENSORS AND APPLICATIONS 9

RFID enabled Sensors: Antenna design challenges – IC design – Integration of sensors and RFID — Power consumption and Link budget. Applications: Contactless smart cards — Access control — Electronic passport — Industrial Automation – Medical applications – Challenges and opportunities.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Classify RFID systems based on frequency, architecture and performance.

CO2 Comprehend the standards and protocols used in RFID systems.

CO3 Illustrate the operation of various components of RFID systems.

CO4 Explore the privacy and security issues in RFID Systems.

CO5 Interpret the concepts of RFID system architecture.

CO6 Analyze the construction and applications of RFID enabled sensor.

TEXT BOOKS:

1. Klaus Finkenzeller, RFID Handbook, 3rd Edition, Wiley, 2010.
2. Amin Rida, Li Yang, Manos M. Tentzeris, RFID Enabled Sensor Design and Applications, Artech House, 2010.

REFERENCE BOOKS:

1. Syed Ahson, Mohammad Ilyas, RFID Handbook, CRC Press, 2008.
2. Paris Kitsos, Security in RFID and Sensor Networks, CRC Press, 2016.
3. Roy Want, RFID Explained, Springer 2022.

WEB REFERENCES: (Only accessible Links)

1. https://www.rfidjournal.com/
2. https://www.academia.edu/

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/radio-frequency-identification-rfid/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	1	1	3	2	1
CO2	3	2	1	1	2	1	1	1	1	1	1	3	2	1
CO3	3	2	1	1	2	1	1	1	1	1	1	3	2	1
CO4	3	2	1	1	2	1	1	1	1	1	1	3	2	1
CO5	3	2	1	1	2	1	1	1	1	1	1	3	2	1
CO6	3	2	1	1	2	1	1	1	1	1	1	3	2	1

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

23EC1938	RF MEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basic principles of RF MEMS.
- To impart the knowledge on MEMS switches.
- To understand the concepts on MEMS Inductors and Capacitors.
- To describe the operation of various micro-machined RF filters.
- To summarize micro-machined phase shifters.
- To familiarize the performance of micromachined antenna.

UNIT I INTRODUCTION OF RF MEMS 9

MEMS, Micro-fabrications for MEMS, Electromechanical transducers, Microsensing for MEMS, piezoresistive sensing, capacitive sensing, piezoelectric sensing, resonant sensing and surface acoustic wave sensors, Materials for MEMS, metal and metal alloys, polymers.

UNIT II RF MEMS SWITCHES AND MICRO RELAYS 9

Switch parameters, Basics of switching, Switches for RF and microwave applications, Actuation mechanisms for MEMS devices, Bistable micro relays and micro-actuators, Dynamics of the switch operation, MEMS switch design, modeling and evaluation, MEMS switch design considerations.

UNIT III MEMS INDUCTORS AND CAPACITORS 9

MEMS inductors, Self-inductance and mutual inductance, Micro-machined inductors, Effect of inductor layout, Reduction of stray capacitance of planar inductors, Approaches for improving the quality factor, Types of Inductors.

MEMS capacitors, MEMS gap tuning capacitors, MEMS area tuning capacitors, Dielectric tunable capacitors.

UNIT IV MICROMACHINED RF FILTERS AND PHASE SHIFTERS 9

Modeling of mechanical filters, modeling of resonator, mechanical coupling components, general consideration for mechanical filters, Micromechanical filters, Micro-machined filters for millimeter wave frequencies.

MEMS phase shifters, switched delay line phase shifters, distributed MEMS phase shifters, polymer, Distributed parallel plate capacitor, Inter-digital capacitor phase shifters.

UNIT V MICROMACHINED ANTENNA 9

Microstrip antenna, Characteristics and design parameters, micromachining techniques to improve antenna performance, micromachining as a fabrication process of small antenna, micro-machined reconfigurable antenna.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic principles of RF MEMS.
CO2 Inferring the operation of RF MEMS switches and micro relays.
CO3 Explain the concepts on MEMS Inductors and Capacitors.
CO4 Comprehend the working operation of various micro-machined RF filters.
CO5 Examine the operation of micro-machined phase shifters.
CO6 Explore the understanding of micro-machined antenna.

TEXT BOOKS:

1. Vijay K. Varadan, Vinoy.K.J and Jose.K .A, “RF MEMS and their Applications”, Reprint, John Wiley & Sons, 2003.
2. Gabriel M. Rebeiz, “RF MEMS: Theory, Design, and Technology”, Wiley, 2003.

REFERENCE BOOKS:

1. Hector J. De Los Santos, “Introduction to Micro-electro mechanical Microwave Systems”, 2nd Edition, Artech House, 2004.
2. Nadim Maluf, Kirt Williams, "Introduction to Micro electromechanical Systems Engineering", Artech House, 2004.
3. Jacopo Iannacci, “Practical Guide to RF-MEMS”, John Wiley & Sons, 2013.
4. Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, 2018, CRC Press.(Unit I)
5. SK Koul & S Dey, “Micromachined Circuits and Devices”, Springer Singapore, 2022 (Unit II, IV, V)
6. Naser Pour Aryan, “Design and Modeling of Inductors, Capacitors and Coplanar Waveguides at Tens of GHz Frequencies”, Springer International Publishing AG, 2014. (Unit III).

WEB REFERENCES: (Only accessible Links)

1. https://link.springer.com/article/
2. https://www.researchgate.net/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117105082

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	1	1	1	1	1	2	2	1
CO2	2	2	2	1	1	1	1	1	1	1	1	2	2	1
CO3	2	2	2	1	1	1	1	1	1	1	1	2	2	1
CO4	2	2	2	1	1	1	1	1	1	1	1	2	2	1
CO5	2	2	2	1	1	1	1	1	1	1	1	2	2	1
CO6	3	2	2	1	1	1	1	1	1	1	1	2	2	1

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

23EC1939	SMART ANTENNAS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basic principles of smart antennas.
- To study insight on various DOA estimation techniques.
- To explore the basics on beamforming and its algorithm.
- To gain knowledge on integration of smart antennas and its processing methods
- To explore the concept of space time processing.
- To impart knowledge on the types of antenna arrays with its beamforming.

UNIT - I INTRODUCTION TO SMART ANTENNAS 9

Need for Smart Antennas, Overview, Smart Antenna Configurations, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.

UNIT - II DOA ESTIMATION FUNDAMENTALS 9

Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Auto-covariance Matrices, Conventional DOA Estimation Methods - Conventional Beamforming Method - Capon's Minimum Variance Method, Subspace Approach to DOA Estimation - MUSIC Algorithm - ESPRIT Algorithm, Uniqueness of DOA Estimates.

UNIT - III BEAMFORMING ALGORITHMS 9

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

UNIT - IV SPACE–TIME PROCESSING 9

Discrete Space–Time Channel and Signal Models, Space–Time Beamforming, Intersymbol and Co-Channel Suppression, Space–Time Processing for DS-CDMA, Capacity and Data Rates in MIMO Systems.

UNIT - V ADAPTIVE ARRAYS 9

Spatial covariance matrix, multi-beam arrays, Scanning arrays, switched beam beamformers, Fully adaptive beamformers - Temporal reference beamforming, spatial reference beamforming, Blind beamforming algorithms — DILFAST and SCORE algorithm.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic principles of smart antennas.

CO2 Explain various DOA estimation techniques.

CO3 Develop the Beamforming techniques and its algorithm.

CO4 Analyse the importance of integration of smart antennas using various algorithms.

CO5 Explain the concept of space time processing.

CO6 Infer the types of antenna arrays with its beam forming algorithms.

TEXT BOOKS:

1. Constantine A. Balanis & Panayiotis I. Loannides, “Introduction to Smart Antennas”, Morgan & Claypool Publishers’ series, 2007.
2. Steven Shichang Gao, “Low-cost Smart Antennas”, Wiley, 2019.

REFERENCE BOOKS:

1. Praveen kumar malik, “Smart antenna-Recent trends in design and applications”, Bentham books, 2021.
2. Lal Chand Godara, “Smart Antennas”, CRC Press, LLC-20. 3. Ben Allen, M. Ghavami, “Adaptive Array Systems: Fundamentals and Applications’, John Wiley & Sons, Ltd, 2005.

WEB REFERENCES: (Only accessible Links)

1. https://ocw.mit.edu/courses/6-661-receivers-antennas-and-signals-spring-2003/
2. https://ieeexplore.ieee.org/xpl/conhome/8727163/proceeding

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117107035
2. https://telcomaglobal.com/p/smart-antennas-and-beamforming

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	1	3	2	1
CO2	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO3	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO4	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO5	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO6	3	2	1	1	1	1	1	1	1	1	1	3	2	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1940	RF SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of RF devices.
- To know the basics of impedance matching.
- To understand the various transceiver architectures & Specifications.
- To understand the fundamentals of LNA & Power amplifiers.
- To know the basic techniques needed to design RF Filters.
- To understand the different types of Oscillators and Mixers.

UNIT - I RF DEVICES & IMPEDANCE MATCHING 9

Active RF components: Semiconductor basics in RF, bipolar junction transistors, RF field effect transistors, High electron mobility transistors, Impedance matching networks-Matching using discrete components and stub tuning.

UNIT - II TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 9

Noise: Thermal, shot, flicker, popcorn noise. Transceiver Specifications: Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes.

UNIT - III LNA & POWER AMPLIFIER 9

Low Noise Amplifiers: Power match and Noise match, Single ended and Differential schemes. Power Amplifiers: General model — Class A, AB, B, C, D, E and F amplifiers, Linearization Techniques.

UNIT - IV RF FILTER 9

Basic resonators and Filter configuration - Filter Types and Parameters- Low-Pass Filter-High-Pass Filter-Bandpass and Bandstop Filters - Insertion Loss, special filter realization-Butterworth-Type Filter- Chebyshev-Type Filters.

UNIT - V OSCILLATOR & MIXER 9

Basic oscillator model, Negative Resistance Oscillator, Quartz Oscillators, High frequency oscillator configuration- Dielectric Resonator Oscillators - YIG-Tuned Oscillator - Gum Element Oscillator, Basic characteristics of mixers - Single-Ended Mixer Design - Single-Balanced Mixer - Double-Balanced Mixer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic concepts of various RF devices.
CO2 Explain the design of various impedance matching networks.
CO3 Describe the characteristics of different transceiver architectures & Specifications.
CO4 Explore the concepts of LNA & Power amplifiers.
CO5 Interpret the design and implementation of RF filters.
CO6 Explain the basic concepts of RF Oscillator and Mixer.

TEXT BOOKS:

1. Reinhold Ludwig and Pavel Bretshko, “RF Circuit design Theory and Applications”, Pearson Education, Inc., 2006.
2. B.Razavi, “RF Microelectronics”, Pearson Education, second edition, 2012

REFERENCE BOOKS:

1. David. M. Pozar, “Microwave Engineering”, International Adaptation, 4th Edition, John Wiley & Sons, 2021.
2. T. Lee, “Design of CMOS RF Integrated Circuits”, Cambridge, 2004.

WEB REFERENCES: (Only accessible Links)

1. https://resources.pcb.cadence.com/blog/2022-an-overview-of-rf-circuit-design-basics

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_ee75/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	1	1	1	1	1	3	2	1
CO2	3	3	3	2	1	1	1	1	1	1	1	3	2	1
CO3	3	3	3	2	1	1	1	1	1	1	1	3	2	1
CO4	3	3	3	2	1	1	1	1	1	1	1	3	2	1
CO5	3	3	3	2	1	1	1	1	1	1	1	3	2	1
CO6	3	3	3	2	1	1	1	1	1	1	1	3	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1941	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the signal propagation on transmission lines.
- To explore multi-conductor transmission lines.
- To know the insights on non-ideal effects.
- To introduce power considerations and system design.
- To explain the clock distribution
- To understand clock oscillators.

UNIT - I SIGNAL PROPAGATION ON TRANSMISSION LINES 9

Transmission line equations, wave solution, wave vs. circuits, wave propagation, reflection, and bounce diagrams Reactive terminations — L, C, static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT - II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk in stripline and microstrip,Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossless models.

UNIT - III NON-IDEAL EFFECTS 9

Non-ideal signal return paths — gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses — Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors.

UNIT - IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling, Logic families, power consumption, and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter, inter-symbol interference, Bit-error rate, Timing analysis

UNIT - V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Controlling cross talk on clock lines, Delay Adjustments, Differential distribution, cancelling parasitic capacitance of clock repeater, Decoupling of clock receivers, Clock jitter.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Identify sources affecting the speed of digital circuits.
CO2 Characterize and model multi-conductor transmission line.
CO3 Identify methods to improve the signal transmission characteristics

CO4 Analyze non-ideal effects of transmission line
CO5 Analyze clock distribution system
CO6 Interpret clock oscillators

TEXT BOOKS:

1. H. W. Johnson and M. Graham, “High-Speed Digital Design: A Handbook of Black Magic”, Prentice Hall, 1993.
2. S. Hall, G. Hall, and J. McCall, “High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices”, Wiley-Interscience, 2000.

REFERENCE BOOKS:

1. Douglas Brooks, “Signal Integrity Issues and Printed Circuit Board Design”, Prentice Hall PTR, 2003.
2. Eric Bogatin, “Signal and Power Integrity — Simplified”, Prentice Hall PTR, third edition 2018.
3. Stephen H. Hall Howard L. Heck, Advanced Signal Integrity for High-Speed Digital Designs, John Wiley & Sons, 2009.
4. Signal Integrity: From High-Speed to Radiofrequency Applications (Digital Signal and Image Processing), 1st Edition, Wiley-ISTE; 2014.

WEB REFERENCES: (Only accessible Links)

1. https://resources.pcb.cadence.com/blog/2019-signal-integrity-design-considerations-for-high-speed-design

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_ee67/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	1	1	1	1	1	**3**	**2**	**1**
CO2	3	3	3	2	1	1	1	1	1	1	1	**3**	**2**	**1**
CO3	3	3	3	2	1	1	1	1	1	1	1	**3**	**2**	**1**
CO4	3	3	3	2	1	1	1	1	1	1	1	**3**	**2**	**1**
CO5	3	3	3	2	1	1	1	1	1	1	1	**3**	**2**	**1**
CO6	3	3	3	2	1	1	1	1	1	1	1	**3**	**2**	**1**

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1942	COMPUTATIONAL ELECTROMAGNETICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the need and basics of computational electromagnetic theory.
- To familiarize various types of problems in electromagnetics.
- To develop analytical and numerical skill on electromagnetics.
- To explore the concepts and analysis approaches of MoM and FDTD methods.
- To impart knowledge on various types of analytical and numerical techniques to solve boundary value problems.
- To comprehend the applications of computational electromagnetic theory.

UNIT I INTRODUCTION 9

Review of Electromagnetic Theory - Electromagnetic fields - Magnetostatic fields Maxwell's equations - Electro thermal formulation - Classification of EM problems.

UNIT II THE FINITE DIFFERENCE METHOD 9

Finite Differencing Formulas - One-Dimensional Analysis - Two-Dimensional Analysis - Yee's FDTD Scheme - Absorbing Boundary Conditions - Modeling of Dispersive Media - Wave Excitation and Far-Field Calculation.

UNIT III THE FINITE ELEMENT METHOD 9

Introduction to the Finite Element Method - Finite Element Analysis of Scalar Fields - Finite Element Analysis of Vector Fields - Finite Element Analysis in the time domain - Absorbing Boundary Conditions.

UNIT IV THE METHOD OF MOMENTS 9

Introduction to the Method of Moments - Two-Dimensional Analysis - Three-Dimensional Analysis - Analysis of Periodic Structures - Analysis of Microstrip Antennas and Circuits - The Moment Method in time domain.

UNIT V APPLICATIONS OF CEM 9

EBG structure analysis - EBG patch antenna - Surface wave antenna - PBG structures - Physical origin of PBG - Modes - PBG application in Waveguide, Cavity, Narrow Band Filter.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the need and basics of computational electromagnetic theory.

CO2 Explain various types of problems in electromagnetics.

CO3 Explore the various types of analytical and numerical techniques to solve problems in electromagnetics.

CO4 Interpret the concepts and analysis approaches of MoM and FDTD methods.

CO5 Apply various types of analytical and numerical techniques to solve boundary value problems related to electromagnetics.

CO6 Comprehend various applications of computational electromagnetic theory.

TEXT BOOKS:

1. Jian-Ming Jin, "Theory and computation of Electromagentic fields", Wiley — IEEE press, second edition 2015.
2. Peterson, Scott L Ray and Raj Mittra, "Computational Methods for Electromagnetics", IEEE Press Series on Electromagnetic Wave Theory, 1998.

REFERENCE BOOKS:

1. Nathan Ida, Joao P.A.Bastos, "Electromagnatics & Calculation of Fields", Springer- Verlag, London, 2012.
2. Fanyang & Yahya Rahmat Samii, "Electromagnetic Band Gap Structures in Antenna Engineering", The Cambridge RF & Microwave Engineering Series, 2009.
3. Mathew N.O.Sadiku, "Numerical Techniques in Electromagnetics with MATLAB", CRC Press, Bocaraton, 2009.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee105/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	1	1	**3**	**2**	**1**
CO2	3	2	1	1	1	1	1	1	1	1	1	**3**	**2**	**1**
CO3	3	2	1	1	2	1	1	1	1	1	1	**3**	**2**	**1**
CO4	3	2	1	1	2	1	1	1	1	1	1	**3**	**2**	**1**
CO5	3	2	1	1	2	1	1	1	1	1	1	**3**	**2**	**1**
CO6	3	2	1	1	2	1	1	1	1	1	1	**3**	**2**	**1**

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	
100				**100**
50 %				**50 %**

VERTICAL VII SENSOR SYSTEM TECHNOLOGY

23EC1943	PRINCIPLES OF SENSORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals of sensors and sensor sources.
- To study the concepts of Interferometric sensors and understand its characteristics.
- To design displacement and level sensors using different parameters.
- To analyze the performance of velocity and acceleration sensors.
- To examine the performance of temperature and acoustic sensors.
- To create analytical design and development solutions for sensors in the practical environments.

UNIT - I FUNDAMENTALS OF SENSOR SOURCES 9

Sensor Classification, Performance and Types, Error Analysis characteristics, Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.

UNIT - II INTERFEROMETRIC SENSORS 9

Intensity sensor, Microbending concept, Interferometers, Mach Zehnder, Michelson, FabryPerot and Sagnac, Phase sensor: Phase detection, Polarization maintaining fibers. Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.

UNIT - III DISPLACEMENT AND LEVEL SENSORS 9

Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magneto strictive sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor.

UNIT - IV VELOCITY AND ACCELERATION SENSORS 9

Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes.

UNIT - V TEMPERATURE AND ACOUSTIC SENSORS 9

Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. microflow sensor, coriolis mass flow and drag flow sensor. Temperature sensors- thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor. Acoustic sensors- microphones-resistive, capacitive, piezoelectric, fiber optic, solid state - electrect microphone.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Use concepts in common methods for converting a physical parameter into an electrical quantity.

CO2 Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc .,

CO3 Design and develop sensors using optical methods with desired properties.

CO4 Evaluate performance characteristics of different types of sensors.

CO5 Locate different type of sensors used in real life applications and paraphrase their importance.

CO6 Create analytical design and development solutions for sensors.

TEXT BOOKS:

1. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York
2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.

REFERENCE BOOKS:

1. Gerd Keiser,”Optical Fiber Communications”, 2012, 4th edition, McGraw-Hill Science, Delhi.
2. John G Webster, “Measurement, Instrumentation and sensor Handbook”, 2014, 2nd edition, CRC Press, Florida.
3. Eric Udd and W.B. Spillman, “Fiber optic sensors: An introduction for engineers and scientists”, 2013, 2nd edition, Wiley, New Jersey.
4. Bahaa E. A. Saleh and Malvin Carl Teich, “Fundamentals of photonics”, 2012, 1st edition, John Wiley, New York

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	3	2				3	3	1	1
CO2	3	2	2	3	3	3	2				3	3	1	1
CO3	3	2	2	3	3	3	2				3	3	1	1
CO4	3	2	2	3	3	3	3				3	3	1	1
CO5	3	2	2	3	3	3	3				3	3	1	1
CO6	3	2	2	3	3	3	3				3	3	1	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1944	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basic laws and phenomena of operation of sensors and transducers.
- To relate the basic laws of behaviour and characterization of thermal sensors.
- To comprehensively analyze and interpret the parameters of radiation sensors.
- To explain the Standards for Smart Sensor Interfaces.
- To determine the various functionalities of actuators.
- To develop an appropriate system design of actuators.

UNIT - I **SENSORS AND TRANSDUCERS** **9**

Sensors and Transducers: Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Resistance Strain Gauge, Semiconductor Strain Gauges, Capacitive Sensors, Electrostatic Transducer, Ultrasonic Sensors.

UNIT - II **THERMAL SENSORS** **9**

Thermal Sensors: Introduction, Gas thermometric Sensors, Thermal Expansion Type Thermometric Sensors, Acoustic Temperature Sensor, Dielectric Constant and Refractive Index Thermo-sensors, Nuclear Thermometer, Thermo-EMF Sensors, Thermal Radiation Sensors, Quartz Crystal Thermo-electric Sensors, Spectroscopic Thermometry, Noise Thermometry.

UNIT - III **RADIATION SENSORS** **9**

Basic Characteristics — Types of Photosensistors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors. Electro Analytical Sensors: Introduction — The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Sensor Electrodes.

UNIT - IV **SMART SENSORS** **9**

Primary Sensors, Excitation, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, the Automation. Sensors Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors.

UNIT - V **ACTUATORS** **9**

Pneumatic and Hydraulic Actuation Systems- Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Learn the fundamental physical and technical basics of sensors and actuators.

CO2 Analyze basic laws and phenomena that define behaviour of sensors and actuators.

CO3 To identify the behaviour of radiation sensors under various conditions.

CO4 Apply the Smart Sensor Interface in various applications.

CO5 Examine sensors and actuators for various applications.

CO6 Construct various premises, approaches, procedures and results related to sensors and actuators.

TEXT BOOKS:

1. D. Patranabis," Sensors and Actuators", 2nd Edition, PHI, 2013.
2. H. Janocha(Ed.), "Actuators-Basics and Applications", Springer, 2013.

REFERENCE BOOKS:

1. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2nd edition, CRC Press, Florida, 2014.
2. Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", Wiley, New Jersey, 2nd edition ,2013.
3. Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 1st edition, John Wiley, New York,2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	3	2			3	3	**2**	**2**	**2**
CO2	3	2	2	3	3	3	2			3	3	**2**	**2**	**2**
CO3	3	2	2	3	3	3	2			3	3	**2**	**2**	**2**
CO4	3	2	2	3	3	3	3			3	3	**2**	**2**	**2**
CO5	3	2	2	3	3	3	3			3	3	**2**	**2**	**2**
CO6	3	2	2	3	3	3	3			3	3	**2**	**2**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1945	FLEXIBLE AND WEARABLE SENSORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To provide the overview of flexible electronics technology and the issues with materials processing for thin film electronics.
- To expose the students for the materials selection and patterning methods for thin film electronics development.
- To choose the materials and novel patterning methods for flexible electronics.
- To describe the attributes and future of wearable haptic devices.
- To expose the process involved in the conversion of conducting and semiconducting fibers to smart textiles.
- To discuss the design challenges, opportunities and the future of wearable devices.

UNIT I OVERVIEW OF FLEXIBLE ELECTRONICS TECHNOLOGY 9

History of flexible electronics - Materials for flexible electronics: degrees of flexibility, substrates, backplane electronics, front plane technologies, encapsulation - Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to Roll processing - Additive printing.

UNIT II AMORPHOUS AND NANO-CRYSTALLINE SILICON MATERIALS AND THIN FILM TRANSISTORS 9

Fundamental issues for low temperature processing - low temperature amorphous and nano crystalline silicon - characteristics of low temperature dielectric thin film deposition - low temperature silicon nitride and silicon oxide characteristics - Device structures and materials processing - Device performance - Contacts for the device - Device stability.

UNIT III MATERIALS AND NOVEL PATTERNING METHODS 9

Materials considerations for flexible electronics: Overview, Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials.

UNIT IV WEARABLE HAPTICS 9

World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable Challenges and opportunities - Future of wearables - Need for wearable haptic devices - Categories of wearable haptic and tactile display.

UNIT V WEARABLE BIO, CHEMICAL AND INERTIAL SENSORS 9

Introduction-Systems design - Challenges in chemical and biochemical sensing - Application areas -Wearable inertial sensors - obtained parameters from inertial sensors - Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Application in clinical practice and future scope.

TOTAL: 45 PERIODS

COURSE OUTCOME

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

- **CO1** Realize the technology developments in the flexible electronics technology.
- **CO2** Identify the suitable materials and its processing for the development of thin film electronics.
- **CO3** Design the pattern and develop with suitable patterning methods.
- **CO4** Learn about the attributes and features of wearables.
- **CO5** Acquire the design knowledge for developing wearable sensors for physical and chemical parameters.
- **CO6** Gain the competency in developing the applications for clinical practice.

TEXT BOOKS

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, “Sensor Technologies: Healthcare, Wellness and Environmental Applications”, 2013, 1st Edition , Apress Media LLC, New York.
2. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York

REFERENCE BOOKS

1. Edward Sazonov, Michael R. Newman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 2014, 1st Edition, Academic Press, Cambridge.
2. Kate Hartman, “Make: Wearable Electronics: Design, prototype, and wear your own interactive garments”, 2014, 1st Edition, Marker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 2015, 1st Edition, World Scientific Publishing Co, Singapore.
4. Yugang Sun, John A. Rogers, “Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies)”, 2011, 1st Edition, William Andrew, New York.

WEB REFERENCES

1. https://www.nature.com/articles/s41528-023-00261-4
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9775172/

ONLINE COURSES / RESOURCES

1. https://onlinecourses.nptel.ac.in/noc23_ee95/preview
2. https://archive.nptel.ac.in/courses/108/108/108108147/
3. https://www.coursera.org/learn/wearable-technologies

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	3					1	**3**	**2**	**1**
CO2	3	2	3	2	2	2					1	**3**	**2**	**1**
CO3	3	2	3	2	2	2					1	**3**	**2**	**1**
CO4	2	3	2	3	2	1					1	**2**	**3**	**1**
CO5	2	3	2	3	1	1					1	**2**	**3**	**1**
CO6	2	1	2	1	1	1					1	**2**	**1**	**1**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1946	MICROSYSTEMS AND HYBRID TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce the fundamental concepts of MEMS and Microsystems.
- To acquaint the students with various materials and material properties for Microsystem designing.
- To relate scaling effects in Microsystems for miniaturization procedures..
- To provide comprehensive understanding of various micromachining techniques and applications.
- To enhance the basics of thick film for sensor development.
- To evaluate the performances of sensors in real time environment using hybrid technologies.

UNIT - I **INTRODUCTION TO MEMS AND MICROSYSTEMS** **9**

MEMS and Microsystems, Miniaturization, Benefits of Microsystems, Typical MEMS and Microsystems products, microgears, micromotors, microturbines, micro optical componenets, Evolution of Micro fabrication and Applications.

UNIT - II **MATERIALS FOR MICROSYSTEMS** **9**

Silicon, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric materials, Polymers, Shape Memory Alloys, ferroelectric and rheological materials.

UNIT - III **SCALING EFFECTS IN MICROSYSTEMS** **9**

Introduction to Scaling, Scaling laws, Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electromagnetic, Electrostatic, magnetic, optical and Thermal domains. Scaling in Fluid mechanics

UNIT - IV **MICROMACHINING TECHNOLOGIES AND APPLICATIONS** **9**

Overview of silicon processes techniques, Photolithography, Ion Implantation, Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.

Details of application in actual systems, introduction to RF- MEMS, MOEMS, future of smart structures and MEMS leading to NEMS. Packaging, test and calibration of MEMS.

UNIT - V **HYBRID TECHNOLOGY** **9**

Thick-film and hybrid technology in sensor production. Basic materials, components, manufacturing Screen manufacturing, Screen printing, Parameters, Comparison: thick- vs. thinfilm technology Structure dimensions, Assembly and packaging Surface mount technology (SMT) Active and passive devices (SMD), Connection technologies, Packaging.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Identify and understand the fundamental concepts and background of MEMS and Microsystems.

CO2 Identify suitable materials for microsystems. and material properties for Microsystem designing.

CO3 Determine and compare the scaling effects in miniaturizing devices.

CO4 Recognize and interpret various micromachining techniques and design, analysis and applications of various MEMS devices micromachining tools and techniques.

CO5 Choose suitable materials for thick film and hybrid technologies for sensor development.

CO6 Incorporate micro-fabrication knowledge for developing various Micromachining devices using hybrid technology.

TEXT BOOKS:

1. Tai-Ran Hsu," MEMS and Microsystems-Design, Manufacture and nanoscale Engineering", 2nd Edition, John Wiley & Sons, 2020.
2. Alberto Corigliano, Raffaele Ardito, Claudia Com. Mechanics of Microsystems, John Wiley & Sons, 2018.

REFERENCE BOOKS:

1. Mahalick NP, "MEMS",1st ed., Tata McGraw Hill, New Delhi, 2017.
2. Wolfgang Menz, Jürgen Mohr, Oliver Paul, "Microsystem Technology",2nd ed.,Wiley, New York, 2011.
3. Banks H.T. Smith R.C. and Wang Y.Smart, 'Material Structures — Modeling, Estimation and Control', 1st ed., John Wiley & Sons, NewYork, 2011.
4. Massood Tabib – Arar, 'Microactuators – Electrical, Magnetic Thermal, Optical, Mechanical, Chemical and Smart structures',1st ed., Kluwer Academic publishers, New York, 2014.

WEB REFERENCES

1. https://www.sciencedirect.com/topics/computer-science/hybrid-integration

ONLINE COURSES / RESOURCES

1. https://nptel.ac.in/courses/117105082

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	3	2			3	3	**2**	**2**	**2**
CO2	3	2	2	3	3	3	2			3	3	**2**	**2**	**2**
CO3	3	2	2	3	3	3	2			3	3	**2**	**2**	**2**
CO4	3	2	2	3	3	3	3			3	3	**2**	**2**	**2**
CO5	3	2	2	3	3	3	3			3	3	**2**	**2**	**2**
CO6	3	2	2	3	3	3	3			3	3	**2**	**2**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1947	NANO MATERIALS AND SENSORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To provide an insight of nanomaterials and its synthesis.
- To study the different methods used for nano materials characterization.
- To illustrate the process involved in the fabrication of sensors using metallic nano particles and nanowires.
- To analyze the special materials like carbon nano tubes for sensor development.
- To examine the fabrication of sensors based on random array of carbon nanotubes.
- To evaluate the performance of sensors based on polymeric nanostructures.

UNIT - I INTRODUCTION TO NANOTECHNOLOGY 9

Definition of nanotechnology, main features of nanomaterials, types of nanostructures (0D, 1D, and 2D structures), synthesis of nano-materials and nano-composites, chemical/physical/electrical/optical properties of nanomaterials and composites.

UNIT - II CHARACTERIZATION OF NANOMATERIALS 9

Methods for characterizing the nano-materials: Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and spectroscopy, spectrometry based surface analysis techniques.

UNIT - III METAL NANOPARTICLES AND NANOWIRE BASED SENSORS 9

Definition of nanoparticles, features of nanoparticles, production of nanoparticles by physical approach and chemical approaches, Definition of nano wires, features of nano wires, fabrication of individual nanowire by top-down approaches and bottom -up approaches.

UNIT - IV CARBON NANOTUBES-BASED SENSORS 9

Definition of carbon nano tube, features of carbon nanotubes, synthesis of carbon nano tubes, fabrication and working principles of sensors based on individual carbon nanotube - fabrication and working principles of sensors based on random array of carbon nanotubes.

UNIT - V SENSORS BASED ON NANOSTRUCTURES OF POLYMERS 9

Working principle of sensors based on polymeric nanostructures - sensing mechanism and applications of nanomaterial, Nanopolymer based chemiresistors and field effect transistors of semi/conductive polymers.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Acquire an insight of nano materials and its synthesis.
CO2 Visualize the different methods being used for nano materials characterization.
CO3 Analyze the process involved in the fabrication of sensors using metallic nano particles and nano wires.
CO4 Discover different methods of synthesis of carbon nano tubes.
CO5 Illustrate the fabrication techniques of sensor based on carbon nanotubes.
CO6 Examine the developments in the nano polymers and its role in sensors.

TEXT BOOKS:

1. Suresh Kumar Kailasa, Chaudhery Mustansar Hussain, Handbook of Nano materials for Sensing Applications, Elsevier, 2021.
2. Dieter Vollath, "Nano materials: An Introduction to Synthesis, Properties and Applications", 2016, 2nd Edition, Wiley, New Jersey.

REFERENCE BOOKS:

1. Jyotishkumar Parameswaran Pillai, Nishar Hameed, Thomas Kurian, Yingfeng Yu, "Nano composite Materials Synthesis, Properties and Applications", CRC Press Taylor & Francis Group, 2017.
2. Martin Pumera, "Nano materials for Electrochemical Sensing and Biosensing", 1st Edition, Pan Stanford, 2014.
3. Guozhong Cao, "Nano structures & Nano materials: Synthesis, Properties & Applications", 2nd Edition, Imperial College Press, London, 2011.

WEB REFERENCES:

1. https://nanohub.org/
2. http://nanozone.org/
3. https://www.nature.com/subjects/nanosensors

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/courses?query=nanotechnology
2. https://www.edx.org/learn/nanotechnology

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3									1	**3**	**3**	**1**
CO2	3	3									1	**3**	**3**	**1**
CO3	3	3									1	**3**	**3**	**1**
CO4	3	3									1	**3**	**3**	**1**
CO5	3	3									1	**3**	**3**	**1**
CO6	3	3									1	**3**	**3**	**1**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1948	DATA ACQUISITION AND HARDWARE INTERFACES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

- To understand the fundamentals of data acquisition and signalling conditions.
- To explore high-speed data acquisition methods and real-time systems.
- To learn about embedded interfaces and advanced sensor networks.
- To understand the principles of multi-channel networks in data acquisition.
- To gain practical experience in designing and implementing advanced data acquisition systems.

UNIT I FUNDAMENTALS OF DATA ACQUISITION 9

Overview of data acquisition systems — Components of a data acquisition system — Importance and applications of data acquisition – Introduction to sensors and transducers — Basic concepts of analog and digital signals — Essentials of computer interfacing — Interface systems and bus.

UNIT II HIGH SPEED DATA ACQUISITION METHODS 9

Sampling theory for high-frequency signals – Nyquist rate and aliasing considerations – Serial data transmission methods and standards RS 232-C – Techniques for high-speed analog-to-digital conversion – Time-interleaved and parallel ADC architectures – Jitter reduction techniques.

UNIT III DATA INTERFACE STANDARDS AND SENSORS 9

RS232, RS422, RS485, GPIB, PXI, VME — Classification of sensors based on measurement parameters – Types of sensors – Selection criteria for sensors – Sensor characteristics.

UNIT IV DATA ACQUISITION OF MULTI CHANNEL NETWORKS 9

Data acquisition method with time-division channels — Data acquisition with space- division channels — Main errors of multi-channel data acquisition systems — Data transmission and error protection.

UNIT V DESIGN AND IMPLEMENTATION OF DATA ACQUISITION SYSTEMS 9

Overview of data acquisition hardware: DAQ boards and modules – Introduction to data acquisition software — Configuration and setup of data acquisition systems — Data acquisition programming with LabVIEW and MATLAB – Troubleshooting and debugging of data acquisition systems.

TOTAL: 45 PERIODS

COURSE OUTCOME

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

- **CO1** Elucidate the elements of data acquisition techniques
- **CO2** Explain the operation of high speed data acquisition systems and their importance in various applications
- **CO3** Remember the classification criteria for various types of sensors
- **CO4** Analyze the characteristics of sensor signals and determine appropriate signal conditioning techniques
- **CO5** Evaluate errors in multi-channel data acquisition networks
- **CO6** Apply data acquisition modules for troubleshooting and debugging

TEXT BOOKS

1. Maurizio Di Paolo Emilio, Data Acquisition Systems: From Fundamentals to Applied Design, 1st Edition, Springer Science and Business Media, 2017.
2. John Park, Practical Data Acquisition for Instrumentation and Control Systems, 3rd Edition, Elsevier, 2003.

REFERENCE BOOKS

1. Phillip A. Laplante and Seppo O. Ovaska, Real-Time Systems Design and Analysis, John Wiley and Sons, 4th Edition , 2015.
2. Jon S. Wilson, Sensor Technology Handbook, 1st Edition, Elsevier, 2004.
3. Robert H King, Introduction to Data Acquisition with LabVIEW, 2nd Edition, McGraw Hill, 2012.
4. Jacob Fraden, Hand Book of Modern Sensors: Physics, Designs and Applications, 3rd Edition, Springer, 2003.
5. Pallas Areny. R and Webster. J. G, Sensors and Signal conditioning, 2nd Edition, John Wiley and Sons, 2001.

WEB REFERENCES

1. https://www.ni.com/en/support/documentation/supplemental/10/data-acquisition-reference-design-for-labview.html
2. https://dewesoft.com/blog/what-is-data-acquisition.

ONLINE COURSES / RESOURCES

1. https://www.udemy.com/course/labjack-daq/?couponCode=LEADERSALE24B
2. https://in.mathworks.com/help/daq/getting-started-with-data-acquisition-toolbox.html
3. https://www.ni.com/en-in/shop/product/data-acquisition-using-ni-daqmx-and-labview-course.html
4. https://dewesoft.com/products
5. https://www.coursera.org/learn/introduction-to-hardware-and-operating-systems
6. https://www.linkedin.com/learning/data-acquisition-with-labview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	3						**3**	**2**	**2**
CO2	3	2	3	2	2	2						**3**	**2**	**3**
CO3	3	2	3	2	2	2						**3**	**2**	**3**
CO4	2	3	2	3	2	1						**2**	**3**	**2**
CO5	2	3	2	3	1	1						**2**	**3**	**2**
CO6	2	1	2	1	1	1						**2**	**1**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1949	WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals of wireless sensor networks.
- To interpret the knowledge in Adhoc and sensor networks with various sensor architectures.
- To explain the design goals and classification of MAC protocols for adhoc and sensor networks.
- To analyze the design goals and classification of Routing protocols for adhoc and sensor networks.
- To discuss the issues challenges involved in managing a sensor network.
- To examine the sensor networks application in critical real time scenarios.

UNIT - I **INTRODUCTION TO WIRELESS COMMUNICATION TECHNOLOGIES** **9**

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

UNIT - II **ADHOC SENSOR NETWORKS** **9**

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

UNIT - III **MAC PROTOCOL FOR WSN** **9**

outing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

UNIT - IV **ROUTING PROTOCOLS FOR WSN** **9**

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

UNIT - V **ENERGY MANAGEMENT IN WSN** **9**

QoS and Energy Management : Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Gain fundamental knowledge of wireless sensor networks.
CO2 Explain various sensor architectures of Adhoc and sensor networks.
CO3 Analyze issues in designing MAC protocols for adhoc and sensor networks.

CO4 Examine various types of routing protocols pertaining to deployment of sensor networks.

CO5 Interpret the issues and challenges in providing quality of service.

CO6 Develop solutions for sensor networks in real time applications.

TEXT BOOKS:

1. Ibrahiem M.M,. El Mary, Ramakrishnan S, "Wireless Sensor Networks From Theory to Applications", CRC Press, 2013.
2. Ian F. Akyilidz. Mehmet Can Vuran, John Wiley & Sons, 2010.

REFERENCE BOOKS:

1. Waltenegus Dargie, Christian Poellabauer,"Fundamentals of Wireless Sensor Networks Theory and Practisc",John Wiley & Sons, 2010.
2. Sudip Misra, Isaac Woungang, Subhas Chandra Misra, "Guide to Wireless Sensor Networks",Springer,2009.
3. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks: Technology, Protocol and Applications", Wiley Interscience,2007.

WEB REFERENCES:

1. https://link.springer.com/book/10.1007/978-3-030-58015-5
2. https://www.intechopen.com/chapters/38793

ONLINE COURSES / RESOURCES:

1. https://www.shiksha.com/online-courses/wireless-sensor-networks-certification
2. https://archive.nptel.ac.in/courses/106/105/106105160

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	SPO3
CO1	3	3										**3**	**3**	**1**
CO2	3	3										**3**	**3**	**1**
CO3	3	3										**3**	**3**	**1**
CO4	3	3										**3**	**3**	**1**
CO5	3	3										**3**	**3**	**1**
CO6	3	3										**3**	**3**	**1**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

VERTICALS VIII EMERGING TECHNOLOGIES

23EC1950	CRYPTOGRAPHY AND SECURITY PRACTICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals of networks security
- To learn the security architecture, threats and vulnerabilities.
- To explain the fundamental mathematical concepts related to Symmetric Key Cryptography.
- To examine the fundamental mathematical concepts related to Asymmetric Key Cryptography.
- To interpret the various types of data integrity and authentication schemes.
- To develop various Security Practices and System Security

UNIT I INTRODUCTION TO CRYPTOGRAPHY 9

Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies - Model of network security – Security attacks, services and mechanisms — OSI security architecture — Classical encryption techniques: substitution techniques, transposition techniques, steganography- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis

UNIT II SYMMETRIC KEY CRYPTOGRAPHY 9

MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures – Modular arithmetic-Euclid's algorithm- Congruence and matrices - Groups, Rings, Fields — Finite fields- SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis - Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard - RC4 – Key distribution.

UNIT III PUBLIC KEY CRYPTOGRAPHY 9

MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing – Factorization – Euler's totient function, Fermat's and Euler's Theorem - Chinese Remainder Theorem – Exponentiation and logarithm - ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange - ElGamal cryptosystem – Elliptic curve arithmetic-Elliptic curve cryptography.

UNIT IV MESSAGE AUTHENTICATION AND INTEGRITY 9

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA –Digital signature and authentication protocols – DSS- Entity Authentication: Biometrics, Passwords, Challenge Response protocols- Authentication applications - Kerberos, X.509.

UNIT V SECURITY PRACTICE AND SYSTEM SECURITY 9

Electronic Mail security – PGP, S/MIME – IP security – Web Security - SYSTEM SECURITY: Intruders – Malicious software – viruses – Firewalls. Security of Big Data Analytics, Cloud Computing, IoT and Smart Grids.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the concept of security needed in computers and networks along with various possible attacks.
CO2 Study the different cryptographic operations of symmetric cryptographic algorithms.
CO3 Compare the various cryptographic operations of public key cryptography.
CO4 Examine the various Authentication schemes to simulate different applications.
CO5 Understand various Security practices.
CO6 Examine types of System security.

TEXT BOOKS:

1. William Stallings, “Cryptography and Network Security - Principles and Practice”, Seventh Edition, Pearson Education, 2017.
2. Sarhan M. Musa, “Network Security and Cryptography”, ISBN:9781683928812, Mercury Learning and Information, 2022.

REFERENCE BOOKS:

1. C K Shyamala, N Harini and Dr. T R Padmanabhan, “Cryptography and Network Security”, Wiley India Pvt.Ltd.
2. Behrouz A. Foruzan, “Cryptography and Network Security”, Tata McGraw Hill 2007.
3. Charlie Kaufman, Radia Perlman, and Mike Speciner, “Network Security: PRIVATE Communication in a PUBLIC World”, Prentice Hall

WEB REFERENCES:

1. https://www.youtube.com/playlist?list=PLBlnK6fEyqRgJU3EsOYDTW7m6SUmW6kII

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_cs90/preview

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2							3	**2**	**1**	**1**
CO2	3	3	3	2							3	**2**	**1**	**1**
CO3	3	3	2	2							1	**2**	**2**	**2**
CO4	3	3	2	2							1	**3**	**2**	**2**
CO5	3	2	3	2							1	**3**	**2**	**2**
CO6	3	2	2	2							2	**3**	**1**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1951	BLOCK CHAIN TECHNOLOGIES AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals of Block chain.
- To explain the details of Bitcoin and its different components.
- To identify the consensus of Block chain.
- To infer the Ethereum development environment.
- To outline the applications of Block chain.
- To incorporate the privacy and security on Block chain.

UNIT I INTRODUCTION TO BLOCK CHAIN 9

Block chain history, basics, architectures, Types of block chain, Basic Cryptographic primitives used in Block chain –Secure- Collision Resistant hash functions - Digital signature - Public key cryptosystems — Zero knowledge proof systems - Need for Distributed Record Keeping - Modelling faults and adversaries- Byzantine Generals problem - Consensus algorithms and their scalability problems - Why Nakamoto Came up with Block chain based crypto currency.

UNIT II BITCOIN 9

Fundamentals, aspects of bitcoins, properties of bitcoins, Digital Keys and Addresses – Transactions, life cycle, data structure, types — Structure of the block chain — Mining — Bitcoin Networks and Payments – Wallets – Alternative coins – Smart Contracts – Definition — Recardian contracts.

UNIT III BITCOIN CONSENSUS 9

Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases, Design issues for Permissioned Blockchains, Execute contracts- Consensus models for permissioned blockchain-Distributed consensus in closed environment Paxos.

UNIT IV ETHEREUM 9

Setting up Ethereum development tools — Solidity language — Ethereum accounts, key pairs, working with Externally Owned Accounts (EOA), contract accounts – Smart contracts, structure, setting up and interaction, examples — Decentralised applications, implementation, case studies – Whisper protocol – Swarm architecture and concepts.

UNIT V APPLICATIONS 9

Applications of block chain in cyber security- integrity of information- E-Governance, Finance, Internet of things, Health and other contract enforcement mechanisms. Block chain Cryptography: Privacy and Security on Block chain.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the fundamentals of Block chain.
CO2 Explain the different steps in the use of Bit coins.
CO3 Summarize the basics of Bit coin consensus.
CO4 Analyze the Ethereum.
CO5 Inspect various applications of Block chain.
CO6 Examine the privacy and security details of Block chain

TEXT BOOKS:

1. Banafa, Ahmed. Blockchain Technology and Applications. Denmark: River Publishers, 2022.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, “Bitcoin and cryptocurrency technologies: a comprehensive introduction”, Princeton University Press,2016.

REFERENCE BOOKS:

1. S.Shukla,n M.Dhawan, S.Sharma, S. Venkatesan, “Blockchain Technology: Cryptocurrency and Applications”, Oxford University Press 2019.
2. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
3. Alex Leverington “Ethereum Programming”, Packt Publishing Limited, 2017.
4. Arshdeep Bahga and Vijay Madisetti, “Blockchain Applications : A Hands-On Approach”, 2017.

WEB REFERENCES: (Only accessible Links)

1. https://onlinecourses.nptel.ac.in/noc22_cs44/preview
2. https://onlinecourses.swayam2.ac.in/aic21_ge01/preview

ONLINE COURSES / RESOURCES:

1. https://www.simplilearn.com/tutorials/blockchain-tutorial/blockchain-technology
2. https://www.mygreatlearning.com/academy/learn-for-free/courses/blockchain-basics

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2								1	**3**	**1**	**1**
CO2	3	3	2								1	**3**	**1**	**1**
CO3	3	3	2								1	**3**	**1**	**2**
CO4	3	3	2								1	**3**	**2**	**2**
CO5	3	3	2								1	**3**	**2**	**2**
CO6	3	3	2								1	**3**	**2**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1952	DATA SCIENCE AND ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals of data science, covering the need, benefits, and uses.
- To discuss statistical methods for descriptive data analytics.
- To review statistical methods to visualize data for various applications.
- To apply t-tests, ANOVA, and chi-square tests to assess data and its statistical significance.
- To analyze and build predictive models from data
- To evaluate Python's suitability for data science tasks, including exploration, clustering, and dimensionality reduction using relevant libraries and IDEs.

UNIT I INTRODUCTION TO DATA SCIENCE 9

Need for data science – benefits and uses – facets of data – data science process – setting the research goal — retrieving data — cleansing, integrating, and transforming data — exploratory data analysis – build the models– presenting and building applications.

UNIT II DESCRIPTIVE ANALYTICS 9

Frequency distributions–Outliers–interpreting distributions–graphs–averages- describing variability — interquartile range — variability for qualitative and ranked data - Normal distributions – z-scores –correlation – scatter plots – regression – regression line – least squares regression line –standard error of estimate — interpretation of r2 — multiple regression equations – regression toward the mean.

UNIT III INFERENTIAL STATISTICS 9

Populations – samples – random sampling – Sampling distribution- standard error of the mean –Hypothesis testing– z-test procedure–decision rule–calculations– decisions– interpretations – one-tailed and two-tailed tests – Estimation – point estimate – confidence interval –level of confidence– effect of sample size.

UNIT IV ANALYSIS OF VARIANCE 9

t-test for one sample — sampling distribution of t — t-test procedure — t-test for two independent samples – p-value – statistical significance – t-test for two related samples. F- test – ANOVA – Two-factor experiments–three tests –two-factor ANOVA – Introduction to chi-square tests.

UNIT V PREDICTIVE ANALYTICS AND TOOL 9

Linear least squares–implementation–goodness of fit–testing a linear model– weighted resampling. Regression using Stats Models –Data Science Tool: Python-Basics of python for Data Science-Python Libraries- Exploration Data Analysis-Clustering with Python- Dimensionality Reduction-Python IDE for Data Science.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the key components and processes involved in data science.

CO2 Describe the proficiency in analyzing data distributions, interpreting variability, and performing regression analysis using statistical techniques

CO3 Estimate population parameters, conduct hypothesis testing, and determine confidence intervals using appropriate statistical methods

CO4 Explore inferential statistical concepts and techniques to draw conclusions about populations based on sample data.

CO5 Analyze the variance in the data.

CO6 Propose models for data analytics using Python.

TEXT BOOKS:

1. David Cielen, ArnoD.B.Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications,2016.
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
3. Jake Vander Plas, “Python Data Science Handbook”, O’Reilly,2016.

REFERENCE BOOKS:

1. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press,2014.
2. Sanjeev J. Wagh, Manisha S.Bhende, Anuradha D.Thakare, “Fundamentals of Data Science”, CRC Press,2022.
3. Chirag Shah, “A Hands-on Introduction to Data Science”, Cambridge University Press, 2020.
4. Vineet Raina, Srinath Krishnamurthy, “Building an Effective Data Science Practice: A Framework to Bootstrap and Manage a Successful Data Science Practice”, A press, 2021.

WEB REFERENCES: (Only accessible Links)

1. https://www.w3schools.com/datascience/ds_python.asp

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/106106179

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	1			1		1	**3**	**1**	**1**
CO2	3	3	2	1	2	1			1		1	**3**	**1**	**1**
CO3	3	3	2	1	2	1			1		1	**3**	**2**	**2**
CO4	3	3	2	1	2	1			1		1	**3**	**2**	**2**
CO5	3	3	2	1	2	1			1		1	**3**	**2**	**2**
CO6	3	3	2	1	2	1			1		1	**3**	**2**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1953	5G AND BEYOND COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To get acquainted with the fundamentals of 5G networks.
- To provide an insight on the processes associated with 5G architecture.
- To gain knowledge about 5G protocols.
- To instill knowledge on spectrum sharing and spectrum trading.
- To learn the security features in 5G networks.
- To study the introduction of the 6G system.

UNIT - I 5G CONCEPTS AND CHALLENGES 9

Fundamentals of 5G technologies, overview of 5G core network architecture,5G new radio and cloud technologies, Radio Access Technologies (RATs), EPC for 5G.

UNIT - II NETWORK ARCHITECTURE 9

5G architecture and core, network slicing, multi access edge computing(MEC)visualization of 5G components, end-to-end system architecture, service continuity, relation to EPC, and edge computing. 5G protocols: 5G NAS,NGAP, GTP-U, IPSec and GRE.

UNIT - III DYNAMIC SPECTRUM MANAGEMENT 9

Mobility management, Command and control, spectrum sharing and spectrum trading, cognitive radio based on 5G, millimeter waves.

UNIT - IV SECURITY IN 5G NETWORKS 9

Security features in 5G networks, network domain security, user domain security, flow based QoS framework, mitigating the threats in 5G.

UNIT - V 6G WIRELESS NETWORKS 9

Introduction to 6G communications and networks- 6G : vision, Applications, challenges and requirements- Next G applications and use cases-Bridging the digital divide-Enabling Technologies for 6G communications-AI Native Air Interface- Waveform and modulation Design of Terahertz Communications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the concepts of 5G networks.
CO2 Comprehend the 5G architecture
CO3 Learn the concepts of 5G protocols.
CO4 Analyze the dynamic spectrum management **CO5**
Familiarize the security aspects in 5G networks. **CO6**
Explore the concepts of 6G networks.

TEXT BOOKS:

1. Stephen Rommer, “5G Core networks: Powering Digitalization”, Academic Press, 2019.
2. SaroVelrajan, “An Introduction to 5G Wireless Networks : Technology, Concepts and Use cases”, First Edition, 2020.
3. Fundamentals of 6G Communications and Networking, Xingqin Lin, Jun Zhang, Yuanwei Liu, Joongheon Kim,Springer International Publishing AG , 2023.

REFERENCE BOOKS:

1. Jyrki.Penttinen,“5G Simplified: ABCs of Advanced Mobile Communications”, 1st edition, 2019.
2. Wan Lee Anthony,” 5G system Design: An end to end Perspective”, Springer Publications, 2019.
3. 6G Wireless Communications and Mobile Networking, Xianzhong Xie, Bo Rong, Michel Kadoch, benthambooks publisher, 2021.

CO PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2							3	2	1
CO2	3	3	3	2	2							3	2	1
CO3	3	3	2	2	2							3	2	2
CO4	3	3	3	3	2							3	2	2
CO5	3	2	3	3	2							3	2	3
CO6	3	3	3	3	2							3	2	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EC1954	SPACE COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To enable the student to become familiar with the basics of satellite orbits and launching.

- To understand the subsystems of satellite segment and earth segment.
- To interpret the basic link design for satellite.
- To illustrate various methods of satellite access.
- To examine with the applications of satellites.
- To enable the student to become familiar with the basics of satellite orbits and launching.

UNIT I **SATELLITE ORBITS** **9**

A brief History of Satellite Communication - Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non, Geo stationary orbits, Look Angle Determination, Limits of visibility , Eclipse, Sub satellite point ,Sun transit outage, Launching Procedures , launch vehicles and propulsion.

UNIT II **SPACE SEGMENT** **9**

Spacecraft Technology, Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and Command, Transponders, The Antenna Subsystem.

UNIT III **SATELLITE LINK DESIGN** **9**

Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse, PURE ALOHA, Satellite Packet Switching, Slotted Aloha, Packet Reservation, Tree Algorithm.

UNIT IV **SATELLITE ACCESS AND CODING METHODS** **9**

Analog , digital transmission system, Digital video Broadcast, multiple access: FDMA, Time Division Multiple Access(TDMA), Frame structure, Burst structure, Satellite Switched TDMA Onboard processing, CDMA, DAMA Assignment Methods, Satellite Broadcast Networks, IPV6 over Satellite Networks.

UNIT V **SATELLITE APPLICATIONS** **9**

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System, GPS Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS,DTH), Digital Video broadcasting

TOTAL :45 PERIODS

COURSE OUTCOME

On successful completion of the course student will be able to:

CO1 Understand the basics of satellite orbits and launching procedures.

CO2 Explain various subsystems of earth segment and space segment.

CO3 Outline the satellite Link design for transmission and reception of signals.

CO4 Interpret different multiple access technique end coding methods for satellite communication.

CO5 Explain the applications of Satellite Communications.

TEXT BOOKS:

1. Dennis Roddy, “Satellite Communication”, 4th Edition, Mc Graw Hill International, 2006.
2. Gerard Maral, Michel Bousquet, Zhilli Sun, “Satellite Communications systems, Techniques and technology”, Wiley, 2020.

REFERENCE BOOKS:

1. Wilbu L.Pritchard, Hendri G. Suyderhoud, Robert A.Nelson,“Satellite Communication Systems Engineering”, Prentice Hall/Pearson, 2007.
2. K. N Raja Rao,” Fundamental of Satellite Communications”, PHI, 2004.
3. Richharia, “Satellite Communication Systems,Design Principles”, Macmillan 2003.
4. Anil K. Maini, Varsha Agrawal, “Satellite Communications”, Wiley India Pvt. Ltd., 2015.
5. Timothy, Pratt, Charles, W.Bostain, JeremyE.Allnutt,"Satellite Communication”,2nd Edition, Wiley Publications,2002.

WEB REFERENCES: (Only accessible Links)

1. https://www.inmarsat.com/en/insights/corporate/2023/a,straightforward,introductio n,to, satellite,communications.html
2. https://www.itu.int/hub/2020/05/satellite,communications,an,essential,link,for,a,co nnec ted,world/
3. https://www.etsi.org/technologies/satellite
4. https://www.isro.gov.in/SatelliteCommunication.html
5. https://www.stationsatcom.com

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/courses?query=satellite
2. https://www.classcentral.com/tag/satellite,communications
3. https://nptel.ac.in/courses/117105131
4. https://onlinecourses.nptel.ac.in/noc24_ce56/preview

CO PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3								3	3	2	1
CO2	3	2	3								3	3	2	1
CO3	3	2	3								3	3	2	2
CO4	3	2	3								3	3	2	2
CO5	3	2	3								3	3	2	2
CO6	3	2	3								3	3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1955	HUMAN COMPUTER INTERACTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basics of human computer interaction.
- To interpret the methodologies for designing interactive systems.
- To analyze the user experience design.
- To examine the evaluation methodologies of design.
- To evaluate the interaction techniques for web platforms.
- To discuss the design issues for mobile platforms.

UNIT I HCI AND USABILITY 9

Context of Interaction–Ergonomics–Designing Interactive systems–Understanding Users–Cognition and cognitive frameworks–User Centered approaches, Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories.

UNIT II INTERACTION STYLES 9

HCI patterns, design frameworks, design methods, prototyping. Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation, Expressive Human and Command Languages, Communication and Collaboration.

UNIT III USER EXPERIENCE DESIGN 9

Frameworks for User Centric Computing, Computational models of users, Advancing the user experience, Timely user Experience, Empirical research, User-centric design evaluation Information search, Data Visualization.

UNIT IV COGNITIVE SYSTEMS AND EVALUATION OF HCI 9

Cognitive Models, Goals and Task Hierarchies, Communication and Collaboration models Task analysis, Dialog notations and design, Evaluation Techniques, Assessing user experience, Usability testing, Heuristic evaluation and walkthroughs, Analytics predictive models.

UNIT V HCI IN COLLABORATIVE APPLICATIONS 9

Designing websites, Social media, Collaborative environments, Agents and Avatars, Ubiquitous computing, Mobile Computing, Wearable Computing, Introduction to M2M, Drone and Autonomous vehicle interaction, Virtual and Augmented Reality.

TOTAL :45 PERIODS

COURSE OUTCOME(S)

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

CO1 Understand the concepts and theories related to human-computer interaction.
CO2 Infer user-centred design principles to create user interfaces.
CO3 Analyze user experience to enhance the interaction quality.
CO4 Utilize appropriate evaluation methods and techniques to assess the usability.
CO5 Explore various designs for web applications.
CO6 Summarize the basics of interaction with mobiles and machines.

TEXT BOOKS:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, Niklas Elmqvist "Designing the User Interface: Strategies for Effective Human-Computer Interaction", Sixth Edition, Pearson Education, 2017.
2. Jenny Preece, Helen Sharp, Yvonne Rogers, "Interaction Design: Beyond Human Computer Interaction", Wiley, 5th Edition, 2019.

REFERENCE BOOKS:

1. David Benyon, "Designing User Experience: A guide to HCI, UX and interaction design", 4th Edition, Pearson, 2018.
2. Samit Bhattacharya, "Human-Computer Interaction: User-Centric Computing for Design", McGraw-Hill India, 1st Edition, 2019.
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O"Reilly, 2009.
4. Cameron Banga, Josh Weinhold, "Essential Mobile Interaction Design: Perfecting Interface Design in Mobile Apps", Addison-Wesley Professional, 1st edition,2014.
5. Preece, J., Sharp, H., Rogers, Y., "Interaction Design: Beyond Human-Computer Interaction", Sixth Edition, Wiley, 2022.

WEB REFERENCES: (Only accessible Links)

1. https://link.springer.com/referenceworkentry/10.1007/978-0-387-39940-9_192

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1						3	2	1
CO2	3	2	1	1	3	1						3	2	1
CO3	3	2	2	1	3	1						3	1	2
CO4	3	1	2	2	1	1						3	1	2
CO5	3	1	3	3	3	2						3	2	2
CO6	2	1	2	3	3	1						3	2	2

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EC1956	VIRTUAL REALITY AND AUGMENTED REALITY	L	T	P	C
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COURSE OBJECTIVE:

- To learn the fundamental aspects and principles of VR and AR Technologies
- To know the internals of the hardware and software components involved in the development of VR and AR enabled applications.
- To identify the graphical processing units and their architectures.
- To examine VR and AR application development.
- To interpret the technologies involved in the development of VR and AR based applications
- To construct the fundamental aspects and principles of VR and AR Technologies

UNIT I INTRODUCTION TO VIRTUAL REALITY AND AUGMENTED REALITY 9

Introduction to Virtual Reality and Augmented Reality — Definition — Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies- Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces — Gesture Interfaces — Types of Gesture Input Devices — Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

UNIT II VR MODELING 9

Modeling — Geometric Modeling — Virtual Object Shape — Object Visual Appearance — Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies — Viewing the 3D World — Physical Modeling — Collision Detection — Surface Deformation — Force Computation — Force Smoothing and Mapping — Behavior Modeling – Model Management.

UNIT III VR PROGRAMMING 9

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3Dman Factors in VR.

UNIT IV APPLICATIONS OF VR 9

Hu – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR — VR Applications in Manufacturing — Applications of VR in Robotics — Information Visualization – VR in Business – VR in Entertainment – VR in Education. Need for Extended Reality (XR).

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UNIT V **AUGMENTED REALITY** **9**

Requirements and Characteristics- Spatial Display model, Visual display, Reality-Computer vision for AR-Marker tracking, Multiple-camera Infrared Tracking-Interaction-Modelling and Annotation Navigation-Wearable devices.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the basic concepts of VR and AR.

CO2 Study the tools related to VR and AR.

CO3 Identify the technologies related to VR and AR.

CO4 Examine the working principle of VR and AR related Sensor devices.

CO5 Interpret the various models using modeling techniques.

CO6 Develop VR and AR applications in different domains.

TEXT BOOKS:

1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VR experiences for mobile”, Packt Publisher, 2018.
2. Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, Addison Wesley, 2016.

REFERENCE BOOKS:

1. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
2. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design”, Morgan Kaufmann, 2003.
3. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
4. Bernhard Jung, Paul Grimm, Ralf Doerner, Wolfgang Brol, “Virtual and Augmented Reality (VR/AR) Foundations and Methods of Extended Realities (XR)”, Springer International Publishing, 2022

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	1						3	**3**	**1**	**2**
CO2	3	3	3	2	1						3	**3**	**1**	**2**
CO3	3	3	2	2	1						1	**3**	**1**	**2**
CO4	3	3	2	2	1						1	**3**	**1**	**2**
CO5	3	2	3	2	1						1	**3**	**1**	**2**
CO6	3	2	2	2	1						2	**3**	**1**	**2**

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**