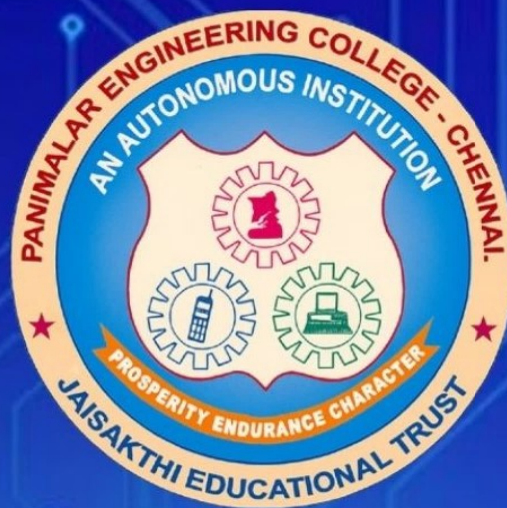


# PANIMALAR ENGINEERING COLLEGE

## B.E - ELECTRONICS AND COMMUNICATION ENGINEERING



**CURRICULUM & SYLLABUS**

**REGULATION 2023**

**FOR THE STUDENT ADMITTED FROM 2025-26**



# B.E - ELECTRONICS AND COMMUNICATION ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

Curriculum and Syllabi- Regulation 2023



## Vision

To provide world-class quality education and excel in 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

**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.



# B.E - ELECTRONICS AND COMMUNICATION ENGINEERING



## Program Outcome

**PO1 - Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization 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.

**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.

**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.

**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.

**PO6 - The Engineer and The World:** Analyse 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.

**PO7 - Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**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 independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.



## Program Specific Outcome

**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 from 2025-26)

Semester I							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
1.	23MA1101	Matrices and Calculus	BS	3/1/0	4	4	60/40
2.	23ES1106	Programming in C	ES	3/0/0	3	3	60/40
<b>Theory Cum Practical Courses</b>							
3.	23HS1103	Communicative English and Language Skills I	HS	2/0/2	4	3	50/50
4.	23PH1103	Engineering Physics	BS	2/0/2	4	3	50/50
<b>Laboratory Courses</b>							
5.	23ES1113	Programming in C Laboratory	ES	0/0/4	4	2	40/60
6.	23ES1115	Computer Aided Engineering Graphics	ES	2/0/2	4	2	60/40
<b>Mandatory Course</b>							
7.	23TA1101	தமிழ் மரபு/ Heritage of Tamils	HS	1/0/0	1	1	60/40
8.	23HS1104	Interpersonal Communication Skills I	EEC	0/0/2	2	0	0/100
9.	23HS1105	Quantitative Aptitude Practices I	EEC	0/0/1	1	0	0/100
<b>TOTAL</b>					<b>27</b>	<b>18</b>	

Semester II							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
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.	23ES1206	Programming in Python	ES	3/0/0	3	3	60/40
<b>Theory Cum Practical Courses</b>							
4.	23HS1203	Communicative English and Language Skills II	HS	2/0/2	4	3	50/50
5.	23ES1204	Basic Electrical Circuits and Engineering	ES	3/0/2	5	4	50/50
<b>Laboratory Courses</b>							
6.	23EC1212	Circuits and Devices Laboratory	PC	0/0/4	4	2	40/60
7.	23ES1215	Programming in Python Laboratory	ES	0/0/4	4	2	40/60
<b>Mandatory Courses</b>							
8.	23TA1201	தமிழரும் தொழில்நுட்பமும்/ Tamil and Technology	HS	1/0/0	1	1	60/40
9.	23ES1212	Technical Skill Practices I	EEC	2/0/0	2	0	0/100
10.	23HS1204	Interpersonal Communication Skills II	EEC	0/0/2	2	0	0/100
11.	23HS1205	Quantitative Aptitude Practices II	EEC	0/0/1	1	0	0/100
12.		Mandatory Course I	MC	2/0/0	2	0	0/100
<b>TOTAL</b>					<b>35</b>	<b>22</b>	

Semester III							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
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
<b>Laboratory Courses</b>							
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	0	0/100
<b>Mandatory Courses</b>							
9.	23HS1301	Skills for Career Building and Development I	EEC	0/0/2	2	0	0/100
10.	23HS1302	Quantitative Aptitude Practices III	EEC	0/0/1	1	0	0/100
<b>TOTAL</b>					<b>29</b>	<b>20</b>	

Semester IV							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
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
<b>Laboratory Courses</b>							
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	0	0/100
<b>Mandatory Courses</b>							
11.	23HS1401	Skills for Career Building and Development II	EEC	0/0/2	2	0	0/100
12.	23HS1402	Quantitative Aptitude Practices IV	EEC	0/0/1	1	0	0/100
<b>TOTAL</b>					<b>36</b>	<b>25</b>	

Semester V							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
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
<b>Laboratory Courses</b>							
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	0	0/100
<b>TOTAL</b>					<b>32</b>	<b>24</b>	

Semester VI							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
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
<b>Laboratory Courses</b>							
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	0	0/100
<b>Mandatory Course</b>							
10.		Mandatory Course II	MC	2/0/0	2	0	0/100
<b>TOTAL</b>					<b>30</b>	<b>22</b>	

Semester VII							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
<b>Theory Courses</b>							
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.	23HS1701	Climate Change and Sustainability	HS	1/0/0	1	1	0/100
5.		Professional Elective III	PE	3/0/0	3	3	60/40
6.		Professional Elective IV	PE	3/0/0	3	3	60/40
<b>Laboratory Courses</b>							
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
<b>Employment Enhancement Course</b>							
10.	23EC1714	Industrial Training/Internship#	EEC	-	-	2	0/100
<b>TOTAL</b>					<b>26</b>	<b>23</b>	

#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
<b>Theory Courses</b>							
1.		Professional Elective V	PE	3/0/0	3	3	60/40
2.		Professional Elective VI	PE	3/0/0	3	3	60/40
<b>Laboratory Course</b>							
1.	23EC1811	Project Work	EEC	0/0/16	16	8	40/60
<b>TOTAL</b>					<b>22</b>	<b>14</b>	

**Total No. of Credits: 168**



## 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

**VERTICAL I BIOMEDICAL TECHNOLOGIES**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1901	Biomedical Instrumentation	PE	3	3	0	0	3
2.	23EC1902	Diagnostic and Therapeutic Equipments	PE	3	3	0	0	3
3.	23EC1903	Wearable Devices	PE	3	3	0	0	3
4.	23EC1904	Body Area Networks and its Applications	PE	3	3	0	0	3
5.	23EC1905	Telemedicine and Telehealth	PE	3	3	0	0	3
6.	23EC1906	Medical Image Analysis	PE	3	3	0	0	3
7.	23EC1907	Brain Computer Interface	PE	3	3	0	0	3

**VERTICAL II IOT ARCHITECTURE AND APPLICATIONS**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1908	Wireless Networks	PE	3	3	0	0	3
2.	23EC1909	IoT Architectures and Protocols	PE	3	3	0	0	3
3.	23EC1910	IoT Security	PE	3	3	0	0	3
4.	23EC1911	Data Analytics for IoT	PE	3	3	0	0	3
5.	23EC1912	IoT for Industry Automation	PE	3	3	0	0	3
6.	23EC1913	IoT for Smart Cities	PE	3	3	0	0	3
7.	23EC1914	IoT and Edge Computing	PE	3	3	0	0	3

**VERTICAL III SIGNAL PROCESSING**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1915	DSP Architecture and Programming	PE	3	3	0	0	3
2.	23EC1916	Advanced Digital Signal Processing	PE	3	3	0	0	3
3.	23EC1917	Digital Image and Video Processing	PE	3	3	0	0	3
4.	23EC1918	Biosignal Processing	PE	3	3	0	0	3
5.	23EC1919	Speech Processing	PE	3	3	0	0	3
6.	23EC1920	Computer Vision	PE	3	3	0	0	3
7.	23EC1921	Underwater Imaging Systems and Image Processing	PE	3	3	0	0	3

**VERTICAL IV ADVANCED COMMUNICATION TECHNOLOGY**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1922	Cognitive Radio Networks	PE	3	3	0	0	3
2.	23EC1923	High Speed Access Technologies	PE	3	3	0	0	3
3.	23EC1924	Advanced Wireless Communication Techniques	PE	3	3	0	0	3
4.	23EC1925	Massive MIMO Networks	PE	3	3	0	0	3
5.	23EC1926	Artificial Intelligence and Machine Learning for Communication Engineers	PE	3	3	0	0	3
6.	23EC1927	Machine Learning for Future Wireless Communication	PE	3	3	0	0	3
7.	23EC1928	Terahertz Communication	PE	3	3	0	0	3

**VERTICAL V VLSI DESIGN AND TESTING**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1929	ASIC Design	PE	3	3	0	0	3
2.	23EC1930	CAD for VLSI Design	PE	3	3	0	0	3
3.	23EC1931	System Verilog	PE	3	3	0	0	3
4.	23EC1932	Low-Power IC Design	PE	3	3	0	0	3
5.	23EC1933	VLSI Testing and Design for Testability	PE	3	3	0	0	3
6.	23EC1934	System On Chip	PE	3	3	0	0	3
7.	23EC1935	Network On Chip	PE	3	3	0	0	3

**VERTICAL VI RF TECHNOLOGIES**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1936	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3
2.	23EC1937	RFID system and Applications	PE	3	3	0	0	3
3.	23EC1938	RF MEMS	PE	3	3	0	0	3
4.	23EC1939	Smart Antennas	PE	3	3	0	0	3
5.	23EC1940	RF System Design	PE	3	3	0	0	3
6.	23EC1941	Signal Integrity for High Speed Design	PE	3	3	0	0	3
7.	23EC1942	Computational Electromagnetics	PE	3	3	0	0	3

**VERTICAL VII SENSOR SYSTEM TECHNOLOGY**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1943	Principles of Sensors	PE	3	3	0	0	3
2.	23EC1944	Sensors and Actuators	PE	3	3	0	0	3
3.	23EC1945	Flexible and Wearable Sensors	PE	3	3	0	0	3
4.	23EC1946	Microsystems and Hybrid Technology	PE	3	3	0	0	3
5.	23EC1947	Nanomaterials and Sensors	PE	3	3	0	0	3
6.	23EC1948	Data Acquisition and Hardware interfaces	PE	3	3	0	0	3
7.	23EC1949	Wireless Sensor Networks	PE	3	3	0	0	3

**VERTICAL VIII EMERGING TECHNOLOGIES**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	23EC1950	Cryptography and Security Practices	PE	3	3	0	0	3
2.	23EC1951	Block chain Technologies and Applications	PE	3	3	0	0	3
3.	23EC1952	Data Science and Analytics	PE	3	3	0	0	3
4.	23EC1953	5G and Beyond Communication Networks	PE	3	3	0	0	3
5.	23EC1954	Space Communication	PE	3	3	0	0	3
6.	23EC1955	Human Computer Interaction	PE	3	3	0	0	3
7.	23EC1956	Virtual Reality and Augmented Reality	PE	3	3	0	0	3

### List of Open Electives I

S.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

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

### Credit Distribution

S. No	Subject Area	CREDITS PER SEMESTER								Total	Percentage (%)
	Semester	I	II	III	IV	V	VI	VII	VIII		
1.	HS	4	4	-	-	-	-	1	-	9	5.32
2.	BS	7	4	4	4	-	-	-	-	19	11.24
3.	ES	7	9	-	5	-	-	-	-	22	13.02
4.	PC	-	5	16	16	18	16	13	-	84	49.7
5.	PE	-	-	-	-	3	3	6	6	18	10.65
6.	OE	-	-	-	-	3	3	-	-	6	3.55
7.	EEC	-	0	0	0	0	0	3	8	11	6.51
8.	MC	-	0	0	-	-	-	-	-	0	0
<b>TOTAL</b>		<b>18</b>	<b>22</b>	<b>20</b>	<b>25</b>	<b>24</b>	<b>22</b>	<b>23</b>	<b>14</b>	<b>168</b>	<b>100</b>



## SEMESTER I

23MA1101	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4
SDGs Mapped: 4		Theory Course			

### COURSE OBJECTIVES:

- Matrix algebra can be readily applied to the structural properties of graphs from an algebraic point of view.
- 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.

#### 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 Periods: 60**

### COURSE OUTCOME(S):

Upon successful completion of the course student will be able to:

- CO1:** Find Eigen values and Eigen vectors, diagonalization of a matrix, symmetric matrices, positive definite matrices.
- 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

## TEXT BOOKS

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

## REFERENCE BOOKS

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

## ONLINE COURSES / RESOURCES

1. [https://onlinecourses.nptel.ac.in/noc21\\_ma60/preview](https://onlinecourses.nptel.ac.in/noc21_ma60/preview)
2. [https://onlinecourses.nptel.ac.in/noc21\\_ma58/preview](https://onlinecourses.nptel.ac.in/noc21_ma58/preview)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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
CO6	3	3	3	-	-	-	-	-	-	-	1	1	2	1

## SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

23ES1106	PROGRAMMING IN C	L	T	P	C
		3	0	0	3
SDGs Mapped: 4,8,9		Theory Course			

### COURSE OBJECTIVES:

- Syntax for C programming
- Develop C Programs using basic programming constructs
- Develop C programs using arrays and strings
- Develop applications in C using functions, pointers
- 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 – Go to 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 Periods: 45**

## 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:** Develop simple applications in C using basic constructs

**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. Pradip Dey, Manas Ghosh, —Fundamentals of Computing and Programming in C, First Edition, Oxford University Press, 2009
4. Anita Goel and Ajay Mittal, —Computer Fundamentals and Programming in C, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011
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](https://en.wikibooks.org/wiki/C_Programming)
6. <https://www.cprogramming.com/tutorial/c-tutorial.html?inl=hp>

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>



23HS1103	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS I	L	T	P	C
		2	0	2	3
SDGs Mapped: 4, 8, 9,17		Theory Cum Practical Course			

### COURSE OBJECTIVES:

- 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.

### 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.

ACTIVITY: Listening to self -introduction before the interview committee after listening modules.

### 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.

ACTIVITY: Listening to conversation and performing role play and Writing dialogues on various work context.

### 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.

ACTIVITY: Preparing Permission letters and short talks and presentation on various topics related to professions.

**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.

ACTIVITY: Listening to Group Discussion and sharing recommendation.

**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.

ACTIVITY: Reading about the modern gadgets and describing them.

**Total Periods: 30****COURSE OUTCOMES:**

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:** Short essays of a general kind and personal letters and emails in English.

**CO5:** Recognize the use of grammar in speech and writing.

**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.

## WEB REFERENCES

1. <https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabulary-exams/word-formation>
2. [https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20180316\\_21.pdf](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 – PSO 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	-	-	-

### SYSTEM OF EXAMINATION

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		100
50 %		50 %		50 %

23PH1103	ENGINEERING PHYSICS	L	T	P	C
		2	0	2	3
SDGs Mapped: 4, 8		Theory Cum Practical Course			

### COURSE OBJECTIVES:

- 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:** Density of Energy State - Intrinsic Semiconductors – energy band diagram – carrier concentration in intrinsic semiconductors – extrinsic semiconductors (theory) – application – Hall effect.

**Magnetic Materials:** Origin of magnetism – Basic definitions – Classifications of Magnetic Materials- Ferromagnetic Domain theory – M versus H Behavior- Hard and Soft Magnetic materials – applications.

### 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– industrial applications

**Fiber Optics:** components and principle of fiber optics – numerical aperture and acceptance angle derivation – types (material, refractive index, and mode) – losses associated with optical fiber – applications - 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 time independent and time dependent wave equations

**Nanoscience:** Introduction – Classification of nanomaterials (0D, 1D, 2D and 3D) – preparation (bottom up and top down approaches) - carbon nanotubes: types - mechanical, optical and electrical properties – applications.

### UNIT-V ELECTROMAGNETIC WAVES 6

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

**Total Periods: 30**

## 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**

### COURSE OUTCOMES:

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:** Have adequate knowledge on the concepts of semiconducting and magnetic materials and their applications in memory storage.
- CO3:** Acquire the knowledge on the concepts of lasers, fiber optics and their technological applications.
- CO4:** Get knowledge on fundamental concepts of quantum theory, nanoscience its applications.
- CO5:** Gain knowledge on the basics of electromagnetic waves and its properties.

### TEXT BOOKS

1. Ajoy Ghatak, Optics, 5<sup>th</sup> Ed., Tata McGraw Hill, 2012.
2. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, Concepts of Modern Physics, 6<sup>th</sup> Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2014.
3. B. K. Pandey and S. Chaturvedi, Engineering Physics, 1<sup>st</sup> 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).

### CO-PO-PSO MAPPING

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

### SYSTEM OF EXAMINATION

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 %

23ES1113	PROGRAMMING IN C LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 4,8,9		Practical Course			

### COURSE OBJECTIVES:

- Write, test, and debug simple C programs
- Implement C programs with conditional and looping statement
- Develop applications in C using strings, pointers, functions
- Implement C programs with structures and union
- Develop applications in C using file processing
- Develop an application in real time situation

### S.NO. LIST OF EXPERIMENTS

1. Programs using I/O statements and expressions
2. Programs using decision-making constructs.  
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)
3. Design a calculator to perform the operations, namely, addition, subtraction, multiplication, division and square of a number
4. Check whether a given number is Armstrong number or not?  
Given a set of numbers like <10,36, 54, 89, 2, 27>, find sum of weights based on the following conditions 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>
5. Populate an array with height of persons and find how many persons are above the average height.
6. Given a string —a\$bcd./fgll find its reverse without changing the position of special characters. (Example input:a@gh%;j and output:j@hg%;a)
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.  
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.
8. Replace a given word with another word
9. a) Sort the list of numbers using Selection sort and insertion sort  
b)Sort the list of numbers using pass by reference
10. Search an element from an unsorted array using linear search.  
Search an element in an array using Binary search recursion call.
11. Generate salary slip of employees using structures and pointers.  
Programs using Pointers
  - a. Pointer demonstration the use of & and\*
  - b. Access Elements of an Array Using Pointer
  - c. Perform the string operations like Length of the String.
  - d. 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.

### **MINI PROJECT**

Create a Railway reservation system with the following modules

19.
  - a. Booking
  - b. Availability checking
  - c. Cancellation
  - d. Prepare chart.

**Total Periods: 60**

### **COURSE OUTCOMES:**

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**

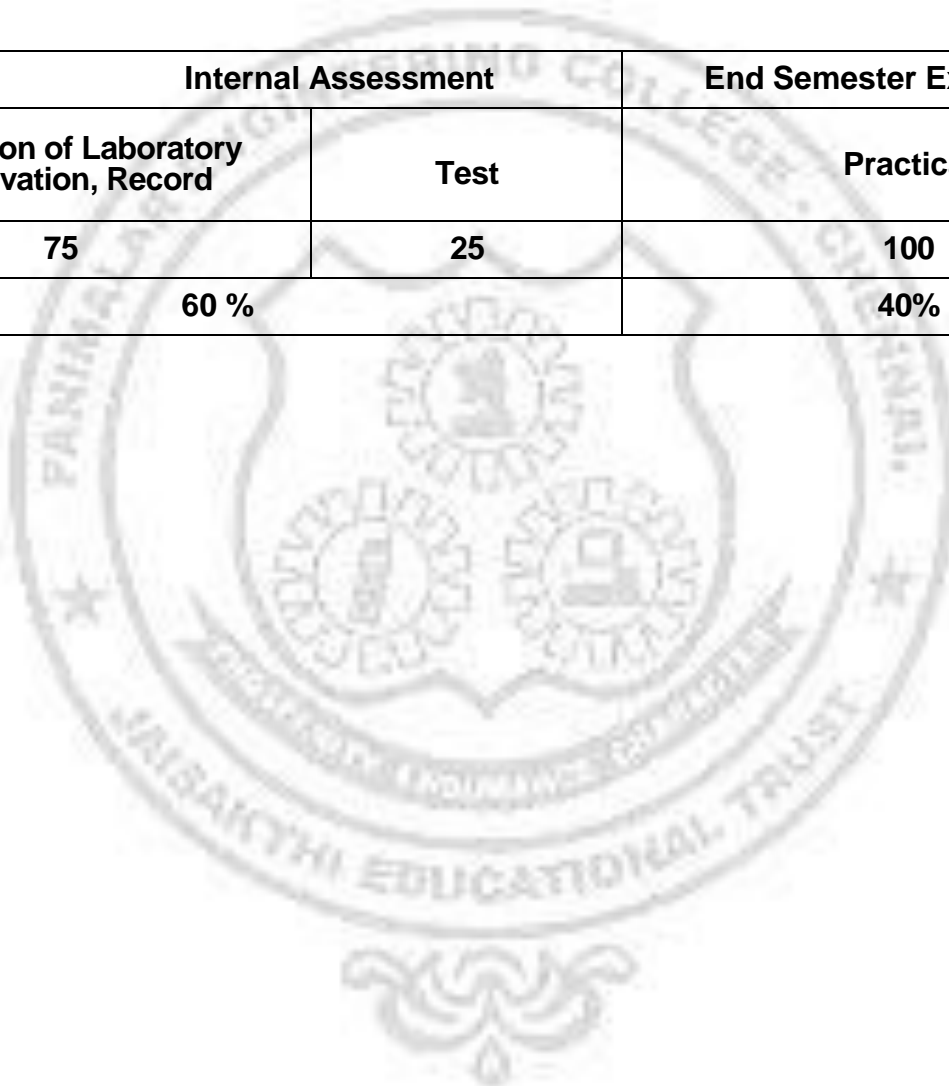
1. <https://www.programiz.com/c-programming/examples>
2. <https://beginnersbook.com/2015/02/simple-c-programs/>
3. <https://www.programmingsimplified.com/c-program-examples>
4. <https://www.tutorialgateway.org/c-programming-examples/>
5. <https://www.javatpoint.com/c-programs>
6. [https://www.tutorialspoint.com/learn\\_c\\_by\\_examples/simple\\_programs\\_in\\_c.htm](https://www.tutorialspoint.com/learn_c_by_examples/simple_programs_in_c.htm)

### CO-PO-PSO MAPPING

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

### SYSTEM OF EXAMINATION

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



23ES1115	COMPUTER AIDED ENGINEERING GRAPHICS	L	T	P	C
		0	0	4	2
SDGs Mapped: 4,8,9,12		Theory Course			

### COURSE OBJECTIVES:

- To familiarize students with technical drawing standards and drafting software for precise part modelling to enhance their skill set.
- To develop proficiency in orthographic and isometric projections for communicating engineering concepts, contributing to their technical expertise.
- To enhance drawing skills for clear and precise technical communication in engineering product design, enabling students to effectively convey their ideas.
- To utilize pictorial views proficiently for accurate isometric visualization of engineering objects, adding depth to their understanding of spatial relationships.
- To enable students to translate engineering concepts into tangible designs, fostering creativity and innovation in graphics and design to broaden their practical experience.

### UNIT-I INTRODUCTION TO CONVENTIONS IN ENGINEERING DRAWING AND CONIC SECTIONS 12

Introduction to Engineering Drawing - Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout – Lettering and dimensioning. Introduction to Drafting Packages – Coordinate Systems – Tools Introduction to Conic curves - Ellipse, Parabola and Hyperbola by Eccentricity method.

#### List of Experiments:

1. Drawing of a title block with necessary text, projection symbol and lettering using drafting software.
2. Drafting of Conic curves - Ellipse, Parabola and Hyperbola.

### UNIT-II ORTHOGRAPHIC PROJECTION 12

Visualization concepts and Orthographic Projection - Layout of views – Orthographic Projection- Conversion of pictorial diagram into orthographic views.

#### List of Experiments:

1. Drawing orthographic view of simple solids like Prism, Pyramids, Cylinder, Cone, etc, and dimensioning.
2. Drawing of orthographic views from the given pictorial diagram like machine parts, electrical vehicle layout, PCB Diagrams.

### UNIT-III PROJECTIONS OF PLANES 12

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

#### List of Experiments:

1. Drawing of plane Surface inclined to HP.
2. Drawing of plane Surface inclined to VP.

**UNIT-IV****PROJECTION OF SOLIDS****12**

Projection of simple solids like Prisms, Pyramids, Cylinder and Cone when the axis is inclined to HP by rotating object method.

**List of Experiments:**

1. Drawing of simple solids like prism and pyramids when the axis is inclined to HP.
2. Drawing of simple solids like cylinder and cone when the axis is inclined to HP.

**UNIT-V****ISOMETRIC DRAWING****12**

Principles of Isometric View – Isometric Views of simple solids – Prism, Pyramid, Cylinder and Cone.

**List of Experiments:**

1. Drawing Isometric View of simple solids.
2. Modeling of 2D to 3D objects using drafting software.

**Total Periods: 60****COURSE OUTCOMES:**

Upon successful completion of the course student will be able to:

**CO1:** Draw the engineering curves, draw orthographic projections of lines and planes.

**CO2:** Draw orthographic views of 3D primitive objects.

**CO3:** Apply and draw the sections and development of the surfaces of objects.

**CO4:** Apply projection concepts and drafting tools for solid projections.

**CO5:** Analyse and sketch free hand sketching of basic geometrical shapes, multiple views of objects.

**SOFTWARE TOOLS**

- AutoCAD
- Solid Works

**TEXT BOOKS**

1. Natarajan, K.V., "A text book of Engineering Graphics", 34<sup>th</sup> Ed., Dhanalakshmi Publishers, Chennai, 2021.
2. Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", 14th Ed, New Age Publications, 2016

**REFERENCE BOOKS**

1. Bhatt, N.D., Panchal V M and Pramod R. Ingle, "Engineering Drawing", Charotar Publishing House, 54th Edition, 2023.
2. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015
3. Agrawal, B. and Agrawal C.M., "Engineering Drawing", Tata McGraw, N.Delhi, 3rd Edition 2019

**WEB REFERENCES**

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

**ONLINE COURSES / RESOURCES**

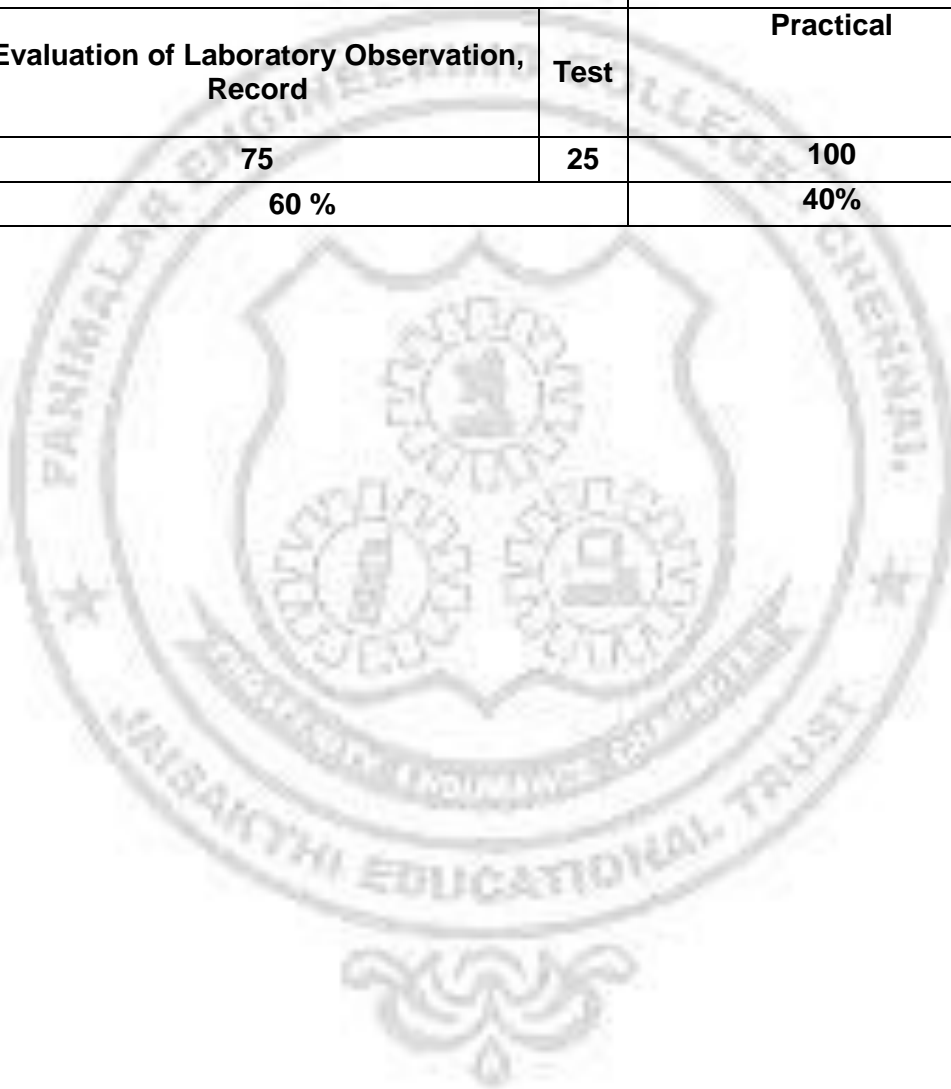
3. <https://nptel.ac.in/courses/112/103/112103019/>

### CO-PO-PSO MAPPING

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

### SYSTEM OF EXAMINATION

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





23TA1101	தமிழர் மரபு	L	T	P	C
		1	0	0	1
SDGs Mapped: 3, 4, 8, 10, 11, 12, 16		Mandatory Course			

<b>UNIT – I</b>	<b>மொழி மற்றும் இலக்கியம்</b>	<b>3</b>
<p>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.</p>		
<b>UNIT – II</b>	<b>மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை</b>	<b>3</b>
<p>நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளூர் சிலை - இசைக்கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.</p>		
<b>UNIT – III</b>	<b>நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்</b>	<b>3</b>
<p>தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.</p>		
<b>UNIT –IV</b>	<b>தமிழர்களின் திணைக் கோட்பாடுகள்</b>	<b>3</b>
<p>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.</p>		
<b>UNIT –V</b>	<b>இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு</b>	<b>3</b>
<p>இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிக்கள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.</p>		

**Total Periods:15**

**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. பொருறை - 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: International Institute 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 Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

### SYSTEM OF EXAMINATION

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	
40%				60 %

23HS1104	INTERPERSONAL COMMUNICATION SKILLS I	L	T	P	C
		0	0	2	0
SDGs Mapped: 4		Mandatory Course			

### COURSE OBJECTIVES:

- To understand and control emotions, promoting personal growth, self-confidence, and a positive mind-set.
- To strengthen skills in navigating relationships, staying motivated, adapting to new situations, and communicating effectively
- To teach methods for organizing tasks, meeting deadlines, and resolving disputes to improve productivity and relationships.
- To develop abilities in creative problem-solving and thoughtful decision-making using structured techniques for innovative solutions
- To collaborate effectively, lead with confidence, and inspire others in group and professional settings.

**UNIT- I** **6**

Self-Analysis - Growth Mind-set- Empathy for Self

**UNIT- II** **6**

Attitude Re engineering- Motivation- Interpersonal Skills

**UNIT- III** **6**

Time Management (Deadlines management, Prioritization)- Conflict Resolution - Change Management

**UNIT- IV** **6**

Decision Making - Creative Thinking Skills - Six Thinking Hats Technique

**UNIT- V** **6**

Leadership- Collaborative Skills- Teamwork- Presentation Skills

**Total Periods: 30**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1:** Manage emotions effectively, embrace a growth-oriented mind-set, and build stronger self confidence.
- CO2:** Demonstrate strong interpersonal skills, motivation, and adaptability, fostering effective communication across diverse settings.
- CO3:** Prioritize tasks and handle conflicts constructively, enhancing their productivity and interpersonal interactions.
- CO4:** Make informed decisions and address challenges creatively using structured problem-solving approaches.
- CO5:** Excel in teamwork, exhibit leadership, and positively influence others in group and community initiatives.

### TEXT BOOKS

1. Covey, Stephen R. The 7 Habits of Highly Effective People: 30th Anniversary Edition. Simon & Schuster, 2020
2. Goleman, Daniel. Emotional Intelligence: Why It Can Matter More Than IQ. 10<sup>th</sup>

anniversary ed., Bantam Books, 2005.

### REFERENCE BOOKS

1. Dweck, C. S. (2006). Mindset: The New Psychology of Success. Random House
2. De Bono, E. (2017). Six Thinking Hats (Revised Edition). Penguin Books.

### WEB REFERENCES

1. <https://casel.org/what-is-the-casel-framework/>
2. <https://ggie.berkeley.edu/sel-for-students-self-awareness-and-self-management/>

### ONLINE COURSES / RESOURCES

1. <https://www.coursera.org/learn/emotional-intelligence-leadership>
2. <https://www.coursera.org/learn/critical-thinking-skills>

### CO – PO – PSO 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			





## COURSE OUTCOMES:

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, 44<sup>th</sup> 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, 10<sup>th</sup> Edition, New Delhi
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3<sup>rd</sup> Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt. Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4<sup>th</sup> Edition, New Delhi, 2014.
5. Wyle, R.C. and Barrett, L.C., "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, 6<sup>th</sup> Edition, New Delhi, 2012.

## CO – PO – PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 7, 9, 12, 13		Theory Course			

### COURSE OBJECTIVES:

- 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 Capacitances, 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1:** Understand the VI characteristics of Semiconductor diode.  
**CO2:** Classify the configurations of BJT and understands its equivalent circuit.  
**CO3:** Explain the drain-transfer characteristics of FET.  
**CO4:** Illustrate the concepts of special semiconductor device.  
**CO5:** Explain the concepts of power devices.  
**CO6:** Outline the operation of Optical devices.

### TEXT BOOKS

1. Donald A Neaman, —Semiconductor Physics and DevicesII, Fourth Edition, Tata Mc Graw Hill Inc. 2012.

- Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, —Electronic Devices and circuits, Third Edition, Tata McGraw- Hill, 2008.

### REFERENCE BOOKS

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

### WEB REFERENCES

- <https://www.digimat.in/nptel/courses/video/108101091/L01.html>

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23ES1206	PROGRAMMING IN PYTHON	L	T	P	C
		3	0	0	3
SDGs Mapped: 4,8,9		Theory Course			

### COURSE OBJECTIVES:

- 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 Value Error exception if the input is not a valid integer, open a file and handles a File Not Found Error exception if the inputs are not numerical, executes an operation on a list and handles an Index Error exception if the index is out of range.

**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 data frame with 2D list.

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

**Total Periods: 45**

### **COURSE OUTCOMES:**

Upon successful completion of the course student will be able to:

**CO1:** Illustrate conditionals and loops for solving problems using Python programs.

**CO2:** Express proficiency in the handling of strings and functions

**CO3:** Apply Python lists, tuples, dictionaries, sets etc to Represent compound data

**CO4:** Compare and contrast reading and writing data from/to files and handle exceptions in Python programs.

**CO5:** Experiment with python packages in data analysis and design GUI

**CO6:** Build real time applications using problem solving concepts in python.

### **TEXT BOOKS**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. ReemaThareja," Problem Solving and Programming with Python", 2<sup>nd</sup> 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", 4<sup>th</sup> Edition, Mc-Graw Hill, 2018
2. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2<sup>nd</sup> Edition, No Starch Press, 2019.
3. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2<sup>nd</sup> 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
40%				

23HS1203	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS II	L	T	P	C
		2	0	2	3
SDGs Mapped: 4, 8, 9, 16		Theory Cum Practical Course			

### COURSE OBJECTIVES:

- 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 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:** Punctuation, Numerical Expressions and Sentence pattern. **Vocabulary Development:** Idioms and Phrases.

**ACTIVITY:** Writing and speaking about achievements of eminent personalities

### 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.

**ACTIVITY:** Reading transcripts of TED Talks and presenting them

### 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, Order of Adjectives, Impersonal Passive Voice and Phrasal verbs **Vocabulary Development:** Misspelt words. Homophones and Homonyms.

**ACTIVITY:** Reading Newspaper articles and presenting them

### 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

**ACTIVITY:** Presentation on Technical and non-technical topics of interests with reference to IELTS

### 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, Verbal Analogy. **Vocabulary Development:** Technical Vocabulary, Purpose Statement

**ACTIVITY:** Preparing an effective Resume' and participating in Mock interview.

**Total Periods: 30**

### **COURSE OUTCOMES:**

Upon successful completion of the course student will be able to:

**CO1:** Recognize 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.

### **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. (2017). Quantitative Aptitude for Competitive Examinations 3rd (Ed.) New Delhi: S.Chand Publishing.

### **REFERENCE BOOKS**

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication
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.

### **WEB REFERENCES**

1. <https://learnenglishteens.britishcouncil.org/exm//grammar-and- vocabulary exams / word formation.>
2. <https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f341478e/uploads/2018>
3. <https://xn--englishclub-ql3f.com/grammar/parts-of-speech.htm>
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>

### **LANGUAGE SKILLS LAB**

**30 PERIODS**

### **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.

### REFERENCE BOOKS

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication
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 – PSO 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			

### SYSTEM OF EXAMINATION

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

23ES1204	BASIC ELECTRICAL CIRCUITS AND ENGINEERING	L	T	P	C
		3	0	2	4
SDGs Mapped: 4,7,9		Theory Cum Practical Course			

### COURSE OBJECTIVES:

- To learn the basic concepts and behavior 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 and 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 Periods:45 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 analyze 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

### TEXT BOOKS

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", McGraw Hill education, 9<sup>th</sup> Edition, 2018.

2. thari 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’, Dhanpat Rai 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 Mahmood Nahvi, —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”, 7<sup>th</sup> 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](https://onlinecourses.nptel.ac.in/noc22_ee90/preview)
2. [https://onlinecourses.nptel.ac.in/noc22\\_ee90/preview](https://onlinecourses.nptel.ac.in/noc22_ee90/preview)

#### CO – PO – PSO 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

#### SYSTEM OF EXAMINATION

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 %

23EC1212	CIRCUITS AND DEVICES LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 4,7,9,12,17		Practical Course			

### COURSE OBJECTIVES:

- To gain practical experience on electric circuits and verification of theorem.
- To learn the characteristics of basic electronic devices and transistors.
- To learn the characteristics of Power and Optical devices.
- To design RL and RC circuits.
- To demonstrate the characteristics of semiconductor device using a simulation software.

### S.No.

### LIST OF EXPERIMENTS

1. Experimental verification of Kirchoff's current and voltage law.
2. Experimental verification of Superposition theorem.
3. Characteristics of PN Junction Diode.
4. Characteristics of rectifiers and voltage regulators.
5. Characteristics of Zener diode & Zener diode Load Regulation.
6. Common Emitter and Common Base input-output Characteristics.
7. FET Characteristics.
8. SCR Characteristics.
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.
13. Transient analysis of RL and RC circuits.

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

**Total Periods: 60**

### COURSE OUTCOMES:

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

- CO1** Understand the electrical circuits and verification of theorem.
- CO2** Study the characteristics of electronic devices.
- CO3** Experimenting the behavior of the transistors, UJT and SCR.
- CO4** Analyze the characteristics of Power and Optical devices.
- CO5** Design RL and RC circuits.
- CO6** Demonstration of simulated semiconductor devices and compare the characteristics.

### REFERENCES

1. H. Hayt, Jr. Jack E. Kemmerly, Steven M. Durbin, "Engineering Circuit Analysis", McGraw Hill Science Engineering, 9th Edition, 2018.
2. Donald A Neaman, "Semiconductor Physics and Devices", Tata McGraw Hill Inc. 2017.
3. Robert Boylestad and Louis Nashelsky, -Electron Devices and Circuit Theory Pearson prentice Hall, 12th edition, 2014.

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23ES1215	PROGRAMMING IN PYTHON LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 4,8,9		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.No.

### 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
17. Mini Project: Suggested Topics(but not limited to)
  - Dice roll simulator
  - Guess the number
  - Random password generator

**Total Periods: 60**

### COURSE OUTCOMES:

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** Develop functions to decompose a Python program.
- CO4** Compare various string operations in Python.
- CO5** Experiment with 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](https://www.w3schools.com/python/python_examples.asp)

## CO – PO – PSO 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	-	-	-	-	-	2	2	2	2
CO6	2	3	3	1	2	-	-	-	-	-	2	2	2	2

## SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4,8		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.No.

### 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 Periods: 30**

### 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 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. Reema Thareja, "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.

- Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill, 2000.

### ONLINE COURSES / RESOURCES

- <https://www.javatpoint.com/c-programming-language-tutorial>
- <https://www.tutorialspoint.com/cprogramming/>
- <https://nptel.ac.in/Courses/>

### CO – PO – PSO 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

### SYSTEM OF EXAMINATION

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

23TA1201	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1
SDGs Mapped: 3, 4		Mandatory Course			

**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 beads - Archaeological evidences - Gem stone types described in Silappathikaram

**UNIT- IV AGRICULTURE AND 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 Periods: 15**



24TA1201	தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1
SDGs Mapped: SDG4,SDG8		Mandatory COurse			

**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 3**

**தொழில்நுட்பம்**

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.

**TEXT-CUM REFERENCE BOOKS:**

**Total : 15 PERIODS**

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. பொருறை - 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: International Institute 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 Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

23HS1204	INTERPERSONAL COMMUNICATION SKILLS II	L	T	P	C
		0	0	2	0
SDGs Mapped: 4		Mandatory Course			

### COURSE OBJECTIVES:

- To enhance their vocabulary through understanding synonyms, antonyms, and word formation techniques.
- To identify and correct grammatical errors and use precise word choices in sentences.
- To apply grammar rules, including subject-verb agreement, pronouns, tenses, and sentence structure.
- To effectively rearrange sentences and solve para jumbles to improve coherence and logical flow in writing.
- To foster reading comprehension and creative storytelling abilities through structured activities and practice.

**UNIT-I** **6**

Introduction to Verbal-Word Building- Synonyms & Antonyms

**UNIT-II** **6**

Common Confusables- One Word Substitution- Sentence Completion

**UNIT-III** **6**

Error Spotting- Sentence Correction

**UNIT-IV** **6**

Sentence Rearrangement- Para jumbles

**UNIT-V** **6**

Reading Comprehension- Story Building Activity

**Total Periods: 30**

### COURSE OUTCOME(S):

Upon successful completion of the course student will be able to:

- CO1:** Demonstrate an expanded vocabulary and accurately use synonyms, antonyms and word building techniques in communication.
- CO2:** Identify and correct common grammatical errors and apply one-word substitutions and sentence completion strategies effectively.
- CO3:** Construct grammatically correct sentences, ensuring proper use of subject-verb agreement, pronouns, tenses, and modifiers.
- CO4:** Rearrange sentences and para jumbles to create coherent and logically structured texts.
- CO5:** Excel in reading comprehension and create engaging stories, showcasing improved analytical and creative writing skills.

### TEXT BOOKS

1. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Learners of English. 5th ed., Cambridge University Press, 2019.
2. Wren, P. C., and H. Martin. High School English Grammar and Composition. Revised ed., S. Chand Publishing, 2017.

## REFERENCE BOOKS

1. Leech, G., & Svartvik, J. (2013). A Communicative Grammar of English (3rd ed.). Routledge.
2. Azar, B. S., & Hagen, S. A. (2016). Understanding and Using English Grammar (5th ed.) Pearson Education.

## WEB REFERENCES

1. <https://learnenglish.britishcouncil.org/grammar>
2. [https://owl.purdue.edu/owl/general\\_writing/grammar/index.html](https://owl.purdue.edu/owl/general_writing/grammar/index.html)

## ONLINE COURSES / RESOURCES

1. <https://www.edx.org/course/english-grammar-and-style>
2. <https://www.coursera.org/learn/careerdevelopment>

### CO – PO – PSO 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			



### SEMESTER III

23MA1302	LINEAR ALGEBRA AND NUMERICAL ANALYSIS	L	T	P	C
		3	1	0	4
SDGs Mapped: 4		Theory Course			

#### COURSE OBJECTIVES:

- 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 EIGEN VALUE 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 Periods: 60**

#### COURSE OUTCOME(S):

Upon successful completion of the course student will be able to:

- CO1:** Understand the concepts of vector spaces, subspaces, and their applications in solving linear systems.
- CO2:** Apply matrix techniques, including linear transformations, eigenvalues, and eigenvectors, in solving algebraic problems.
- CO3:** Construct orthonormal bases using the Gram-Schmidt process and apply inner product spaces in orthogonalization.

**CO4:** Evaluate algebraic and transcendental equations using numerical methods and iterative techniques.

**CO5:** Identify interpolation and approximation techniques to solve real-life numerical problems.

**TEXT BOOKS**

1. Friedberg, A.H., Insel, A.J. and Spence, L., —Linear Algebra, Prentice Hall of India, New Delhi, 2015.
2. Seymour Lipschutz, Marc Lars Lipson., “Schaum's Outline of Linear Algebra”, McGraw-Hill Education - 6th Edition (2018).
3. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10<sup>th</sup> Edition, New Delhi, 2015.
4. Kumaresan, S., —Linear Algebra – A Geometric Approach, Prentice – Hall of India, New Delhi, Reprint, 2010.
5. Kandasamy, P., Thilagavathy, K., and Gunavathy, S., ‘Numerical Methods’, Chandand Co., 2016.

**REFERENCE BOOKS**

1. Kolman, B. Hill, D.R., —Introductory Linear Algebra, Pearson Education, New Delhi, First Reprint, 2013.
2. Lay, D.C., —Linear Algebra and its Applications, 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 Algebra, Prentice Hall of India, New Delhi, 2008.

**CO – PO – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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	
<b>40%</b>				

23EC1301	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3,4,7,8,9,11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

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. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, "Signals & Systems", 2<sup>nd</sup> 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", 2<sup>nd</sup> 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.nptelvideos.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 – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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	
<b>40%</b>				

23EC1302	ELECTRONIC CIRCUITS I	L	T	P	C
		3	0	0	3
SDGs Mapped: 4,7,9,11		Theory Course			

### COURSE OBJECTIVES:

- To study biasing concepts of Bipolar Junction Transistor.
- To analyze 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  $\pi$  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 –  $\alpha$ ,  $\beta$  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 Periods: 45**

### COURSE OUTCOMES:

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:** Analyze 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.Leblicic, 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](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-li-By-S-Ramalatha.pdf>
6. [https://www.ee.iitm.ac.in/videolectures/doku.php?id=ec3102\\_2012a:start](https://www.ee.iitm.ac.in/videolectures/doku.php?id=ec3102_2012a:start)

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 4,8,9,11,12		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

**CO1:** Outline the Boolean theorems and logical minimization methods.

**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", 6<sup>th</sup> Edition, Pearson, 2018.
2. Charles H.Roth. "Fundamentals of Logic Design", 7<sup>th</sup> Edition, Thomson Learning, 2014.

**REFERENCE BOOKS**

1. Thomas L.Floyd, "Digital Fundamentals", 10<sup>th</sup> Edition, Pearson Education Inc, 2018.
2. Leach, Malvino and Saha "Digital Principles and Applications", McGraw Hill Education, 8<sup>th</sup> Edition, 2014.
3. Ronald J. Tocci, Neal S. Widmer and Gregory L. Moss, "Digital Systems: Principles and Applications", 12<sup>th</sup> 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, 2<sup>nd</sup> Edition, 2017.

**WEB REFERENCES**

1. <https://www.geeksforgeeks.org/digital-logic/digital-electronics-logic-design-tutorials/>

**ONLINE COURSES / RESOURCES**

1. [https://onlinecourses.nptel.ac.in/noc21\\_ee10/preview](https://onlinecourses.nptel.ac.in/noc21_ee10/preview)

**CO – PO – PSO MAPPING**

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

## SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>



23EC1304	CONTROL SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 7, 9, 11, 12		Theory Course			

### COURSE OBJECTIVES:

- 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 analyze 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 - 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 – 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 Periods: 45**

### COURSE OUTCOME(S):

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.

**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, 6<sup>th</sup> Edition, January 2017.
2. M. Gopal, "Control System – Principles and Design", Tata McGraw Hill, 4<sup>th</sup> 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, 13<sup>th</sup> Edition, 2016.
3. Benjamin.C.Kuo, "Automatic Control Systems", Prentice Hall of India, 9th Edition, 2010.
4. S.K.Bhattacharya, "Control System Engineering", Pearson, 3<sup>rd</sup> Edition, 2013.
5. K.Ogata, "Modern Control Engineering", PHI, 5<sup>th</sup> 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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	
40%				60 %



23EC1311	ELECTRONIC CIRCUITS AND SIMULATION LABORATORY I	L	T	P	C
		0	0	4	2
SDGs Mapped: 4,7,9,12,17		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.NO

### 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.  
Measurement of h-parameters of transistor in
  - a. Common base configuration
  - b. Common emitter configuration
  - c. Common collector configuration
- 4.
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.

### SIMULATION USING PSPICE

12.
  - d. Common emitter amplifier
  - e. Common source amplifier

**Total Periods: 60**

### 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4,7,8,9		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.NO

### 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 Periods: 60**

### 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](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 – PSO 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	3	1		3						3	3	3	2
CO3	3	3	2	3	3						3	3	3	2
CO4	3	3	2	3	3						3	3	3	2
CO5	3	3	2	3	3						3	3	3	2
CO6	3	3	2	3	3						3	3	3	2

## SYSTEM OF EXAMINATION

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

23ES1312	CODING PRACTICES I	L	T	P	C
		0	0	2	0
SDGs Mapped: 4,8 & 9		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.No.

### LIST OF EXPERIMENTS

1. Data Types, Variables, Operators.
2. Expressions, Precedence of Operators.
3. Conditional Statement
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 Periods: 30**

### 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, 1<sup>st</sup> 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.

### WEB REFERENCES

1. [https://www.mathworks.com/matlabcentral/fileexchange/73716-implementation-of-control-system-experiments-in-matlab?s\\_tid=FX\\_rc2\\_behav](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>.

### 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/>

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examination
MOOC Score	Coding Platform Score	----
50	50	--
100 %		--

23HS1301	SKILLS FOR CAREER BUILDING AND DEVELOPMENT I	L	T	P	C
		0	0	1	0
SDGs Mapped:4		Mandatory Course			

**COURSE OBJECTIVES:**

- To improve language accuracy through error spotting, sentence correction, and text completion.
- To build critical thinking by analyzing arguments and organizing ideas.
- To create a strong personal brand and effective self-introduction using social media.
- To develop persuasion, negotiation, and business planning skills.
- To enhance teamwork, empathy, and feedback skills for better interpersonal relations.

**UNIT-I** **6**

Error Spotting- Sentence Correction- Subject Verb Agreement- Pronouns- Tense- Comparisons – Modifiers- Parallelism

**UNIT-II** **6**

Sentence Equivalence and Text completion: Grammar- Single, Double and Triple blanks.

**UNIT-III** **6**

Para jumble – Para Completion.

**UNIT-IV** **6**

Critical Reasoning – Facts – Inference – Judgment – Strengthening and Weakening An argument.

**UNIT-V** **6**

Reading Comprehension.

**Total Periods: 30**

**COURSE OUTCOMES:**

Upon successful completion of the course student will be able to:

- CO1:** Proficiently spot and correct advanced errors, complete texts, and achieve sentence equivalence with accuracy
- CO2:** Demonstrate strong critical reasoning by analyzing arguments, making judgments, and organizing coherent paragraphs.
- CO3:** Create impactful self-introductions and personal brands, leveraging social media for effective profiling.
- CO4:** Apply persuasion and negotiation skills to develop and market business plans successfully convince others and create solid business plans.
- CO5:** Exhibit strong interpersonal skills, empathy, and synergy, delivering constructive feedback to enhance team dynamics.

**TEXT BOOKS**

1. Powers, L., and T. Knapp. The Official Guide to the GRE General Test. 3rd ed.,

McGraw-Hill Education, 2019.

2. Gallo, Carmine. Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds. St. Martin's Press, 2016.

### REFERENCE BOOKS

1. Manhattan Prep. (2021). GRE Reading Comprehension & Essays (7th ed.). Manhattan Prep Publishing.
2. Cialdini, R. B. (2021). Influence, New and Expanded: The Psychology of Persuasion. Harper Business.

### WEB REFERENCES

1. <https://www.ets.org/gre/test-takers/general-test/prepare/practice-questions/verbal-reasoning.html>
2. <https://www.linkedin.com/learning/building-your-personal-brand>

### ONLINE COURSES / RESOURCES

1. <https://www.coursera.org/learn/critical-thinking-skills>
2. <https://www.coursera.org/learn/negotiation>

### CO – PO – PSO 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			

23HS1302	QUANTITATIVE APTITUDE PRACTICES III	L	T	P	C
		0	0	1	0
SDGs Mapped: 4		Mandatory Course			

### COURSE OBJECTIVES:

- Students can refine their problem solving skills by using ratio and proportion, simple and compound interest.
- To improve students' ability to use strategies for addressing logical reasoning, surds and indices problems.

#### Module 1                                      **Simple and Compound interest**                                      **3**

Simple interest - compound interest - problems on ages - simplification and approximation.

#### Module 2                                      **Ratio and Proportion**                                      **3**

Chain rule – percentage - ratio and proportion - profit and loss

#### Module 3                                      **Surds and Indices**                                      **3**

Surds and indices – clock – cubes – dices – direction - sense.

#### Module 4                                      **Logical Reasoning - II**                                      **3**

Puzzles – series – coding - decoding – classifications.

**Total Periods:                      12**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

**CO1:** Solve problems using ratio and proportion, simple and compound interest, and ease.

**CO2:** Comprehend and demonstrate solid knowledge for the surds and indices, as well as logical reasoning exercises.

### TEXT BOOKS

1. Aggarwal R.S., Quantitative Aptitude for Competitive Examinations 3rd edition New Delhi: S. Chand Publishing, 2017.
2. Abhijit Guha, Quantitative Aptitude for All Competitive Examinations, 6th edition. Noida: McGraw Hill Education Pvt.Ltd., 2016.
3. FACE, Aptipedia Aptitude Encyclopedia1(Ed.). New Delhi: Wiley Publications,2016.

### REFERENCE BOOKS

1. Sharma Arun, Quantitative aptitude,7th(Ed.). Noida McGraw Hill Education Pvt.Ltd, 2016.
2. Praveen. R.V, Quantitative aptitude and reasoning, PHI learning publication, 3rd edition.

### WEB REFERENCES

1. <https://www.indiabix.com>

**Mode of Evaluation: Online Test**

## SEMESTER IV

<b>23MA1402</b>	<b>PROBABILITY AND RANDOM PROCESSES</b>	L	T	P	C
		3	1	0	4
<b>SDGs Mapped: 4</b>		<b>Theory Course</b>			

### COURSE OBJECTIVES:

- 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 IT 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 Periods: 60**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1:** Understand the basics of one-dimensional random variables and standard distributions and apply them to solve engineering problems.
- CO2:** Recognize the fundamental ideas behind two-dimensional random variables and use them in engineering applications.
- CO3:** Apply the concept of random processes in engineering disciplines.
- CO4:** Develop skills in solving problems on power spectral density function relevant to the various branches of engineering.
- CO5:** Analyze the response of random inputs to linear time invariant systems.

### TEXT BOOKS

1. Ibe, O.C., " Fundamentals of Applied Probability and Random Processes ", 1<sup>st</sup>

Indian Reprint, Elsevier, 2007.

2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4<sup>th</sup> Edition, New Delhi, 2002.
3. Veerarajan.T., "Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks", McGraw Hill, 3<sup>rd</sup> Edition, 2016.

### REFERENCE BOOKS

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3<sup>rd</sup> 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, 3<sup>rd</sup> Edition, 2002.
5. Yates. R.D. and Goodman. D.J., —Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2<sup>nd</sup> Edition, 2012.

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
40%				
				100
				60 %



## 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", 2<sup>nd</sup> Edition, OXFORD University Press, New Delhi, 2018.

## REFERENCE BOOKS

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

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>



23EC1401	COMMUNICATION THEORY	L	T	P	C
		3	0	0	3
SDGs Mapped: 8,9		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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, 5<sup>th</sup> Edition, Pearson Education, 2019.
2. Dr. Sanjay Sharma, "Communication Systems (Analog and Digital)", 7<sup>th</sup> Edition, S.K. Kataria & Sons, 2017.
3. Dennis Roddy, John Coolen, "Electronic Communications", 4<sup>th</sup> Edition Pearson Education, 2014.
4. B.P.Lathi, "Modern Digital and Analog Communication Systems", 4<sup>th</sup> 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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



23EC1402	ELECTRONICS CIRCUITS II	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 7, 9, 12		Theory Course			

**COURSE OBJECTIVES:**

- 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 Periods:                      45**

**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 CircuitsII; 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 Circuits, Fifth Edition, Oxford University, Press, 2008.
4. Millman J. and Taub H., Pulse Digital and Switching WaveformsII, TMH, 2000

### WEB REFERENCES

1. [http:// www.introni.it/pdf/Millman-Taub- Pulse and Digital Switching Waveforms 1965.pdf](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](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](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](https://www.electronics-tutorials.ws/sequential/seq_3.html)
4. <https://semiconductorclub.com/downloads/theory-and-design-of-electronic-circuits/>

### CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1403	ANALOG INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 7, 9, 11		Theory Course			

**COURSE OBJECTIVES:**

- 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 synchronization.

**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 Periods: 45**

## 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", 4th Edition, Tata McGraw-Hill, 2017.
2. Millman J. and Taub H., "Pulse, Digital and Switching waveforms", 3rd Edition, TMH, 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](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 – PSO 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	3	2								2	3	3	2
CO3	3	3	2								2	3	3	2
CO4	3	3	2								2	3	3	2
CO5	3	3	2								2	3	3	3
CO6	3	3	2								2	3	3	3

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>





- 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/](https://onlinecourses.nptel.ac.in/noc21_ee83/)

**CO – PO – PSO MAPPING**

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1411	ELECTRONICS CIRCUITS AND SIMULATION LABORATORY II	L	T	P	C
		0	0	4	2
SDGs Mapped: 4, 8, 9		Practical Course			

### COURSE OBJECTIVES:

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

### LIST OF EXPERIMENTS

#### S.NO 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):

8. Tuned Collector Oscillator
9. Twin -T Oscillator / Wein Bridge Oscillator
10. RC and RL Differentiator & Integrator Circuits
11. Double and Stagger tuned Amplifiers
12. Bistable Multivibrators
13. Schmitt Trigger circuit with Predictable hysteresis
14. Analysis of power amplifier
15. Study the characteristics of 555 Timer
16. AStable Multivibrator using 555 Timer

**Total Periods: 60**

### 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 Astable 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, 3<sup>rd</sup> Edition, Mc Graw Hill Education (India) Private Ltd., 2010.
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 11<sup>th</sup> Edition, Pearson Education, 2013.

## REFERENCE BOOKS

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

## WEB REFERENCES

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

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4,8,9		Practical Course			

### COURSE OBJECTIVES:

- To design amplifiers and data converters using op-amps.
- To design and analyze 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.

### S.No.

### 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 Periods: 60**

### 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](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](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 – PSO 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	2
CO2	2	2	2	1							2	3	2	2
CO3	3	2	2	2						1	3	3	2	1
CO4	3	3						1			2	3	1	1
CO5	3	3	3					1			2	3	2	1
CO6	3	3	3					1			2	3	2	2

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4,8,9		Practical Course			

### COURSE OBJECTIVES:

- To understand the fundamental concepts of data structures such as stack, queue, and linked lists and their operations.
- To develop programming skills for implementing linear and non-linear data structures using appropriate algorithms.
- To analyze and implement tree structures, including insertion, deletion, searching, and traversal techniques.
- To apply graph algorithms such as Breadth First Search (BFS) and Depth First Search (DFS) for problem-solving.
- To understand and implement optimization algorithms like Minimum Spanning Tree (Prim's and Kruskal's) and shortest path algorithms (Dijkstra's).
- To design and evaluate efficient searching and sorting techniques such as Linear Search, Binary Search, Quick Sort, and Merge Sort

### S.No.

### 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.  
Write a Program to perform the given operations on Trees
6.           a) Insertion  
              b) Deletion  
              c) Searching  
Write a Program to implement the following Tree Traversals Methods
7.           a) Pre-order  
              b) In-order  
              c) Post-order  
Write a program to implement the following Graph Traversal Methods
8.           a) Breadth First Search  
              b) Depth First Search  
Write a program to implement Minimum Spanning Tree using the following
9.           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 Periods: 60**

### 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 – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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

23ES1412	CODING PRACTICES II	L	T	P	C
		0	0	2	0
SDGs Mapped: 4,8 & 9		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.No. 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. List ADT
  - 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. Stack ADT
  - a. Implement stack using arrays
  - b. Implement stack using linked list
  - c. Implement stack using queues.
5. Problems on Postfix and Infix expressions.
6. Binary Tree Traversal.
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. Topology Sorting
11. Minimum Spanning tree
  - a. Kruskal Algorithm
  - b. Prim's Algorithm

**Total Periods: 30 Periods**

### **COURSE OUTCOMES:**

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",3<sup>rd</sup> 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, 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/>.

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examination
MOOC Score	Coding Platform Score	---
50	50	--
100 %		--



23HS1401	SKILLS FOR CAREER BUILDING AND DEVELOPMENT II	L	T	P	C
		0	0	2	1
SDGs Mapped: 4,8		Mandatory Course			

### COURSE OBJECTIVES:

- To equip students to develop profiles and understand the nuances of resume creation.
- To employ group discussion activities to exhibit expertise and abilities.
- To gain insight into effective interview techniques and acquire hands-on experience through mock interviews.
- To improve presentation skills while exploring potential career opportunities.
- To foster networking skills and build professional connections to enhance career prospects and industry engagement.

**UNIT-I** **6**

Professional Ethics- Etiquette- E-Mail Writing

**UNIT-II** **6**

Personal Branding- Resume Building and Cover Letter - SOP

**UNIT-III** **6**

Purpose and Role of GD in recruitment – GD preparation - Types of GD topics— Mock GDs

**UNIT-IV** **6**

Introduction to personal interview – Types of Interviews – PI preparation – Mock Interviews

**UNIT-V** **6**

Crafting STAR (Situation, Task, Action, Result) responses- Video Profile

**Total Periods: 30**

### COURSE OUTCOMES:

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

**CO1:** Develop a distinctive personal brand and craft a compelling, impactful resume.

**CO2:** Engage actively in group discussions to maximize their value and outcomes

**CO3:** Tackle personal and technical interviews with confidence and clear preparation.

**CO4:** Articulate ideas and perspectives in a structured coherent manner

**CO5:** Gain insight into industry expectations and explore potential career pathways

### TEXT BOOKS

1. Carnegie, Dale. How to Win Friends and Influence People. Revised ed., Simon & Schuster, 2010.
2. Bolles, Richard N. What Color Is Your Parachute? 2021: A Practical Manual for Job-Hunters and Career-Changers. Ten Speed Press, 2021

### REFERENCE BOOKS

1. Adler, L. (2013). The Essential Guide for Hiring & Getting Hired. Workbench Media

2. Yate, M. (2020). Knock 'em Dead Job Interview: How to Turn Job Interviews into Job Offers (10th ed.). Adams Media

#### WEB REFERENCES

1. <https://www.mindtools.com/pages/article/professionalism.html>
2. <https://www.themuse.com/advice/interviewing>

#### ONLINE COURSES / RESOURCES

1. <https://www.linkedin.com/learning/developing-your-professional-presence-and-influence>
2. <https://www.coursera.org/learn/career-networking-interviewing>

#### CO – PO – PSO 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	-	-	-

23HS1402	QUANTITATIVE APTITUDE PRACTICES IV	L	T	P	C
		0	0	2	1
SDGs Mapped: 4		Mandatory Course			

### COURSE OBJECTIVES:

- Students can improve their problem-solving abilities by applying permutation and combination, probability, alligation, and mixture.
- To improve student's ability to use strategies for addressing day sequence and data sufficiency problems.

#### Module 1      **Permutation and Combination, Probability**      **3**

Permutation – combination – probability – Partnership.

#### Module 2      **Alligation, Mixture and Analogy**      **3**

Alligation and mixture – stocks and shares – analogy – symbols and notations.

#### Module 3      **Time and work (advanced)**      **3**

Relative speed - work equivalence - division of wages – multiple pipe problems

#### Module 4      **Day sequence and Data sufficiency**      **3**

Day sequence - decision making - statement and assumptions - data sufficiency

**TOTAL PERIODS:** **12**

### COURSE OUTCOMES:

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

**CO1** : Understand the basic concepts of permutation and combination, probability, alligation and mixture.

**CO2** : Assist in understanding and exhibiting strong understanding for the advanced problems in relative speed and data sufficiency tasks.

### TEXT BOOKS

1. Aggarwal R.S. (2017). Quantitative Aptitude for Competitive Examinations 3<sup>rd</sup> edition New Delhi: S. Chand Publishing
2. Abhijit guha (2016). Quantitative Aptitude for All Competitive Examinations, 6<sup>th</sup> edition. Noida: McGraw Hill Education Pvt. Ltd.
3. FACE.(2016).Aptipedia Aptitude Encyclopedia1(Ed.).New Delhi: Wiley Publications

### REFERENCE BOOKS

1. Sharma arun.(2016).Quantitative aptitude,7<sup>th</sup> (Ed.).Noida : McGraw Hill Education Pvt. Ltd.
2. Praveen. R.V 3<sup>rd</sup> edition, Quantitative aptitude and reasoning, PHI learning publication

**Mode of Evaluation: Online Test**



Applications, Pearson Education, third Edition,2021.

- Wayner Tomasi, Electronic Communications Systems, Fundamentals through advanced, 5<sup>th</sup> Edition, Pearson Education, 2019

### REFERENCE BOOKS

- Proakis J.G, Digital Communication, Tata McGraw Hill Company, Fifth Edition, 2018.
- Sathishkumar, Digital Communication, PHI publication, 2018
- Lathi B. P, Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017.

### WEB REFERENCES

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

### ONLINE COURSES / RESOURCES

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

### CO – PO – PSO 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	1	-								2	2	2	1
CO3	3	1	-								2	3	2	1
CO4	3	2	1								3	2	2	2
CO5	3	3	1								3	3	2	2

### SYSTEM OF EXAMINATION

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	
40%				

23EC1502	DISCRETE TIME SIGNAL PROCESSING	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 11, 13		Theory Course			

### COURSE OBJECTIVES:

- To learn Discrete Fourier Transform (DFT) and its linear filtering application.
- To understand the characteristics and design of digital IIR filter.
- To analyze 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.
- To illustrate the real time applications of DSP.

### 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-in-frequency (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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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 of DSP Processors
- CO6:** Explain the real time signal processing applications.

### 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

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

### ONLINE COURSES / RESOURCES

1. [https://onlinecourses.nptel.ac.in/noc24\\_ee16/preview](https://onlinecourses.nptel.ac.in/noc24_ee16/preview)
2. <https://engineering.purdue.edu/online/programs/certificate-programs/digital-signal-processing>

### CO – PO – PSO 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	3	3								2	3	2	2
CO3	3	3	3								2	3	2	2
CO4	3	3	3								3	3	2	2
CO5	3	2	2								1	3	2	2
CO6	3	2	2								1	3	2	2

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>





## TEXT BOOKS

1. Krishna Kant, "Microprocessors and Microcontrollers", Prentice Hall of India, 2019.
2. Sunil Mathur, "Microprocessors and Microcontrollers", PHI learning private limited, 2018.
3. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088Family–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 Embedded System SPI, UART using Assembly & C for PIC18," Pearson International Edition, 2008.

## REFERENCE BOOKS

1. Douglas V.Hall, —Microprocessors and Interfacing, Programming and Hardware, TMH,2012.
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rdedition,Tata McGrawHill, 2012.
3. A. K. Ray and K.M. Bhurchandani," Advanced Microprocessors and Peripherals", TMH,2nd Edition 2006.
4. K.Uma Rao, Andhe Pallavi,"The 8051Microcontrollers, Architecture and Programming and Applications, 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>
4. [www.nptel.ac.in](http://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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1504	TRANSMISSION LINES AND WAVEGUIDES	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 7, 9		Theory Course			

### COURSE OBJECTIVES:

- 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, Infinite line, Wavelength, Velocity of propagation, Waveform distortion, Distortion-less line, Loading and different methods of loading, Line not terminated in  $Z_0$ , 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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.

- E.C.Jordan and K.G.Balmain, "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, 2006.

### REFERENCE BOOKS

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

### WEB REFERENCES

- [https://www.electronics-notes.com/articles/radio/ef-filters/what-is-constant-k-filter.php#google\\_vignette](https://www.electronics-notes.com/articles/radio/ef-filters/what-is-constant-k-filter.php#google_vignette)
- <https://www.everythingrf.com/community/what-is-propagation-velocity-in-a-cable>
- [https://www.rp-photonics.com/phase\\_velocity.html](https://www.rp-photonics.com/phase_velocity.html).

### ONLINE COURSES / RESOURCES

- [https://onlinecourses.nptel.ac.in/noc22\\_ee43/](https://onlinecourses.nptel.ac.in/noc22_ee43/) preview
- <https://www.shiksha.com/online-courses/design-of-transmission-line-modelling-and-performance-course-courl6325>

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				

23EC1511	DISCRETE TIME SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 3, 4, 8, 9		Practical Course			

### COURSE OBJECTIVES:

- To implement generation of sequences.
- To realize Linear Convolution, Circular Convolution and Correlation.
- To analyse 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.

### S.No.

### LIST OF EXPERIMENTS

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. Perform 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 Periods: 60**

### COURSE OUTCOMES:

Upon successful completion of the course, student 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 ProcessingII, 4th Edition, Pearson, 2007.
2. P. Ramesh Babu, —Digital Signal ProcessingII, Scitech Publications in 2011.

3. Sanjit K. Mitra, —Digital Signal Processing – A Computer Based Approach, Tata Mc Graw Hill, 2007.

### CO – PO – PSO 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

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4,9,11		Practical Course			

### COURSE OBJECTIVES:

- To explain the architecture, instruction sets and addressing modes of 8086/8051.
- To apply assembly language instructions to perform arithmetic and logical operations on 8-bit and 16-bit data.
- To develop assembly programs for data transfer, code conversion and array manipulation tasks.
- To analyze algorithms for identifying largest/smallest elements and sorting data using assembly language..
- To interface microcontrollers with external peripherals and design real time applications.

S.No.

### LIST OF EXPERIMENTS

#### 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 Periods: 60**

### COURSE OUTCOMES:

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

**CO1** Write and execute assembly language programs on 8086, 8051, and PIC microcontrollers for arithmetic and logical operations..

- CO2** Demonstrate data transfer, exchange, and code conversion techniques using assembly language instructions using 8086 and 8051.
- CO3** Implement algorithms to determine largest/smallest elements and sorting of data sets using 8086 and 8051.
- CO4** Develop assembly programs for matrix addition/subtraction and number complement operations.
- 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 limited, 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 Embedded System SPI, UART using Assembly & C for PIC18," Pearson International Edition, 2008

#### REFERENCE BOOKS

1. Douglas V.Hall, —Microprocessors and Interfacing, Programming and Hardware, TMH,2012
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3 rd edition, Tata McGraw Hill, 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4, 9, 11		Practical Course			

### COURSE OBJECTIVES:

- To review amplitude and Frequency modulation and demodulation techniques.
- To understand and realize the effects of sampling and TDM.
- To explore the operation of PCM & Line coding techniques.
- To examine Delta modulation and demodulation techniques.
- To simulate various Digital modulation and demodulation schemes.
- To implement Error control coding schemes.

### S.No.

### 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 Periods: 60**

### COURSE OUTCOMES:

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

- CO1** Demonstrate Amplitude and Frequency modulation and demodulation techniques.
- CO2** Illustrate sampling and time division multiplexing techniques.
- CO3** Interpret line coding and Pulse code modulation techniques.
- CO4** Explore Delta modulation and Adaptive delta modulation techniques.
- CO5** Execute various digital modulation schemes.
- CO6** Analyze the performance of error control codes.

### TEXT BOOKS

1. Simon Hawkins, "Communication Systems", Wiley, 5<sup>th</sup> Edition, 2009
2. B.Preetham Kumar, "Communications System Laboratory, 1<sup>st</sup> edition, 2016

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23ES1512	CODING PRACTICES III	L	T	P	C
		0	0	2	0
SDGs Mapped: 4,8,9		Practical Course			

### COURSE OBJECTIVES:

- 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

### S.No

### 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 Periods: 30**

### COURSE OUTCOMES:

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)

Coding Practices shall be offered as a Self-Learning Course through Massive Open Online Courses (MOOC) / National Programme on Technology Enhanced Learning (NPTEL).

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examination
MOOC Score	Coding Platform Score	----
50	50	--
100 %		--



## SEMSTER VI

23EC1601	WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- To understand the concepts of Wireless Channels
- To study 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 - Handoff- Interference & System Capacity, Trunking and Grade of Service - Coverage and Capacity Improvement - Evolution of 5G and the Upcoming Utilization of 6G.

#### UNIT-III Digital Signaling for Fading Channels 9

Structure of a Wireless Communication Link, Principles of Offset-QPSK,  $\pi/4$ -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 and LMS 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 - Precoding - Introduction to Space Time Modulation and Coding - Alamouti Scheme - Beamforming - Transmitter Diversity, Receiver Diversity - Channel State Information - Capacity in Fading and Non Fading Channels - Introduction to Massive MIMO.

**Total Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student will be able to:

**CO1:** Understand the Concepts of Wireless Channels

**CO2:** Interpret various Multiple Access Techniques and Cellular Architecture.

**CO3:** Categorize various Signaling Techniques for Fading Channels.

**CO4:** Investigate various Multipath Mitigation Techniques.

**CO5:** Analyze various Concepts of Multiple Antenna Techniques

### TEXT BOOKS

1. Rappaport, T.S., "Wireless Communications Principles and Practice",

updated Second Edition, Cambridge University Press, 2024

2. Andrea Goldsmith, "Wireless Communication", Draft of Second Edition, 2019

### REFERENCE BOOKS

1. Shillin Wang, Yunfei Cai, Youyun Xu, Yuanyuang Cai "Wireless Communication Network Technology and Evolution" World Scientific Pub Co Inc, 2022.
2. T L Singal, "Wireless Communications", McGraw Hill Education, 2017.
3. ITI Saha Misra, "Wireless Communications and Networks 3G and Beyond", Second Edition, McGraw Hill Education, 2017
4. Andreas.F. Molisch, "Wireless Communications", Second Edition, John Wiley, 2013.
5. Upena Dalal, "Wireless Communication and Networks", Oxford University Press, 2014
6. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.

### WEB REFERENCES

1. <https://www.sourcengine.com/blog/the-evolution-of-5g-and-the-upcoming-utilization-of-6g>
2. [https://web.stanford.edu/class/ee359/doc/WirelessComm\\_Chp1-6\\_Dec182019.pdf](https://web.stanford.edu/class/ee359/doc/WirelessComm_Chp1-6_Dec182019.pdf)
3. [https://web.stanford.edu/class/ee359/doc/WirelessComm\\_Chp1-7\\_Feb82020.pdf](https://web.stanford.edu/class/ee359/doc/WirelessComm_Chp1-7_Feb82020.pdf)

### ONLINE COURSES / RESOURCES

1. <https://www.coursera.org/learn/wireless-communications>
2. <https://www.udemy.com/course/introduction-to-wireless-communications>
3. <https://nptel.ac.in/courses/106106167>

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				

23EC1602	ANTENNA AND WAVE PROPAGATION	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 9, 13		Theory Course			

### COURSE OBJECTIVES:

- To impart knowledge on antenna parameters and wire antennas.
- To interpret the features of various antenna arrays.
- To analyze 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, Phased arrays, Yagi array antenna.

#### UNIT-III APERTURE AND PRINTED ANTENNAS 9

Huygenes' 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. Antenna Measurement - Anechoic chamber- Measurement of Gain, Directivity, Polarization and Radiation pattern.

#### 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 Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student 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:** Analyze 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 – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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



- CO3:** Analyze 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:** Assess various application layer protocols to enable users to access files efficiently.

#### TEXT BOOKS

- Behrouz A. Forouzan, "Data Communications & Networking with TCP/IP Protocol Suite", 6<sup>th</sup> Edition, McGraw Hill, [New York], 2021

#### REFERENCE BOOKS

- James F. Kurose, Keith W. Ross, "Computer Networking—A Top-Down Approach Featuring the Internet", Seventh Edition, Pearson Education, 2016.
- Nader F. Mir, "Computer and Communication Networks", Pearson Prentice Hall Publishers, 2nd Edition, 2014.
- Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", Mc Graw Hill Publisher, 2011.
- Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers, 2011.

#### WEB REFERENCES

- <https://www.imperva.com/learn/application-security/osi-model/>
- [https://www.tutorialspoint.com/data\\_communication\\_computer\\_network/physical\\_layer\\_switching.htm](https://www.tutorialspoint.com/data_communication_computer_network/physical_layer_switching.htm)

#### ONLINE COURSES / RESOURCES

- [https://onlinecourses.nptel.ac.in/noc22\\_ee61/preview](https://onlinecourses.nptel.ac.in/noc22_ee61/preview)
- <https://ocw.mit.edu/courses/6-263j-data-communication-networks-fall-2002/>

#### CO – PO – PSO MAPPING

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

#### SYSTEM OF EXAMINATION

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	
40%				

23EC1604	VLSI DESIGN	L	T	P	C
		3	0	0	3
SDGs Mapped: 4,7,9		Theory Course			

### COURSE OBJECTIVES:

- 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 circuits and 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,  $\beta_n/\beta_p$  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 and 1T,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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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

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

### WEB REFERENCES

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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1611	WIRELESS COMMUNICATION AND NETWORKS LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 4, 8, 9, 11, 16		Practical Course			

### COURSE OBJECTIVES:

- 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 examine congestion control and Security algorithms.

### S.No. LIST OF EXPERIMENTS

1. Wireless Channel Simulation including Rayleigh Fading and distribution.
2. OFDM Signal Transmission and Reception.
3. MIMO beamforming algorithms.
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 algorithm.
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 Periods: 60**

### 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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

23EC1612	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 4, 8, 9, 11		Practical Course			

### COURSE OBJECTIVES:

- To learn Hardware Descriptive Language (Verilog/VHDL).
- To gain knowledge on fundamental principles Digital System Design using HDL.
- To familiarize importing of logical modules on FPGAs.
- To provide hands on design experience with professional design (EDA) platforms.
- To extract the layouts of Digital and Analog circuits using EDA tools.
- To analyze the performance parameters of Digital and Analog circuits.

### S.No.

### 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 (Min 4 Bit ) 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 of Universal Shift Register using HDL.
9. Design of Finite State Machine (Moore/Mealy) using HDL.
10. Design of Memories using HDL.

#### Part-II Digital and Analog Circuit Design

11. Design and simulate a CMOS inverter using digital flow.  
Design and simulate a CMOS Basic Gates & Flip-Flops .
12. Generation and Post Layout Extraction for experiments 11 & 12 and also analyse the power, area and timing for experiments 11 & 12 by performing Pre-Layout and Post Layout Simulations.  
Design and Simulate basic Common Source, Common Gate and Common Drain Amplifiers.
13. Analyze the input impedance, output impedance, gain and bandwidth for experiments 13 and 14 by performing Schematic Simulations.
14. Design and simulate simple 5 transistors differential amplifier. Analyze Gain, Bandwidth and CMRR by performing Schematic Simulations.
15. Mini Project in Digital System Design or Digital and Analog Circuit Design.

**Total Periods: 60**

### COURSE OUTCOMES:

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

#### WEB REFERENCES

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

#### CO – PO – PSO MAPPING

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

#### SYSTEM OF EXAMINATION

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

23ES1612	CODING PRACTICES IV	L	T	P	C
		0	0	2	0
SDGs Mapped: 4,8,9,16		Practical Course			

### COURSE OBJECTIVES:

- To enable students to create and manage databases and tables using SQL commands.
- To develop the ability to insert, retrieve, update, and delete data from databases effectively.
- To provide knowledge of relational integrity through primary keys and foreign key constraints.
- To equip students with skills to write sub-queries.
- To familiarize students with creating and using view to simplify the database and build practical problem-solving skills using SQL for real-world database applications.

### S.NO

### LIST OF EXPERIMENTS

1. Create new databases
2. Create new tables in a database
3. Insert records in a database
4. Retrieve data from a database
5. Update records in a database
6. Special keyword LIKE
7. Distinct and Order by
8. Functions in SQL
9. Constraints and Foreign key
10. Join Operation

**Total Periods: 30**

### COURSE OUTCOMES:

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

**CO1:** Create and manage databases using SQL commands.

**CO2:** Design and implement relational tables with appropriate datatypes and constraints.

**CO3:** Insert, update, and delete, and retrieve data using SQL.

**CO4:** Apply relational integrity by creating and enforcing foreign key relationships.

**CO5:** Construct sub-queries to solve complex data retrieval problems and use views to simplify database

**CO6:** Demonstrate practical problem-solving skills using SQL for real-world database applications.

### 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>

**Coding Practices shall be offered as a Self-Learning Course through Massive Open Online Courses (MOOC) / National Programme on Technology Enhanced Learning (NPTEL).**

### SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examination
<b>MOOC Score</b>	<b>Coding Platform Score</b>	----
<b>50</b>	<b>50</b>	--
<b>100 %</b>		--



## SEMESTER VII

23EC1701	EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3,4,7,9,11		Theory Course			

### COURSE OBJECTIVES:

- To understand the concepts of embedded system.
- To explain the architecture of ARM processor.
- To illustrate the interfacing of ARM Processor.
- To interpret the concepts of real time systems.
- To analyze the features of 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 real time operating systems- Interprocess communication mechanisms, Example Real time operating systems-POSIX-Windows CE.

**Total Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1:** Summarize the concepts of embedded systems.
- CO2:** Interpret the architecture ARM processor.
- CO3:** Illustrate the interfacing of ARM processor in various applications.
- CO4:** Analyze the concepts of real time systems.
- CO5:** Assess the features of 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 – PSO 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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>

23EC1702	OPTICAL COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 8, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- To understand about basic elements of optical fiber, various modes and configurations.
- To explore the transmission characteristics and measurements of optical fibers.
- To explain the optical sources and detectors and its performance.
- To outline the concepts of optical fiber networks.
- To explain 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

**CO1:** Outline basic elements in optical fibers, different modes and configurations.

**CO2:** Infer the transmission characteristics associated with dispersion and polarization techniques.

**CO3:** Summarize the optical sources and detectors associated in optical communication systems.

**CO4:** Interpret the concepts of fiber optic networks.

**CO5:** Identify various routing and switching techniques in optical networks.

**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**

1. [https://www.tutorialspoint.com/principles\\_of\\_communication/principles\\_of\\_optical\\_fiber\\_communications.htm](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](https://onlinecourses.nptel.ac.in/noc23_ee76/preview)
2. [https://onlinecourses.nptel.ac.in/noc23\\_ee61/preview](https://onlinecourses.nptel.ac.in/noc23_ee61/preview)

**CO – PO – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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	
<b>40%</b>				

23EC1703	MICROWAVE ENGINEERING	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 7, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 MICROWAVE PASSIVE 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 MICROWAVE MEASUREMENTS 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1:** Understand the concepts of microwave network parameters.  
**CO2:** Illustrate the characteristics of various microwave passive devices  
**CO3:** Analyze the working operation and characteristics of microwave active devices  
**CO4:** Examine various techniques to measure microwave parameters.  
**CO5:** Assess microwave concepts in various real time applications.

### TEXT BOOKS

1. Annapurna Das and Sisir K Das, "Microwave Engineering", Fourth Edition, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2020.

- David M. Pozar, "Microwave Engineering", Fourth Edition, Wiley India, 2012.

## REFERENCE BOOKS

- Robert E. Collin, "Foundations for Microwave Engineering", John Wiley & Sons Inc., 2005.
- Samuel Y. Liao, "Microwave Devices & Circuits", Prentice Hall of India, 2006.
- Thomas H. Lee, "Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits", Cambridge University Press, 2004.

## WEB REFERENCES

- [http://www.ittc.ku.edu/~jstiles/622/handouts/section\\_2E\\_Microwave\\_Network\\_Theory\\_package.pdf](http://www.ittc.ku.edu/~jstiles/622/handouts/section_2E_Microwave_Network_Theory_package.pdf)
- [https://d13mk4zmvuctmz.cloudfront.net/assets/main/study-material/notes/electronics-communication\\_engineering\\_microwave-engineering\\_microwave-passive-devices\\_notes.pdf](https://d13mk4zmvuctmz.cloudfront.net/assets/main/study-material/notes/electronics-communication_engineering_microwave-engineering_microwave-passive-devices_notes.pdf)
- [https://www.ssgmce.ac.in/student\\_resource/Electronics%20&%20Telecommunication%20Engg./UHF%20and%20Microwaves\\_4U/Unit\\_II.pdf](https://www.ssgmce.ac.in/student_resource/Electronics%20&%20Telecommunication%20Engg./UHF%20and%20Microwaves_4U/Unit_II.pdf)
- <https://uspas.fnal.gov/materials/10MIT/Lecture13.pdf>
- <https://www.slideshare.net/slideshow/presentation-on-applications-of-microwave/158755722>

## ONLINE COURSES / RESOURCES

- <https://archive.nptel.ac.in/courses/108/103/108103141/>
- <https://archive.nptel.ac.in/courses/108/101/108101112/>

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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

23HS1701	CLIMATE CHANGE AND SUSTAINABILITY	L	T	P	C
		1	0	0	1
SDGs Mapped: 4, 11, 12, 13, 17		Theory Course			

## COURSE OBJECTIVES:

- To understand the basic concepts of climate and the factors influencing climate system
- To understand climate change and its relationship with sustainability.
- To understand the concept of sustainable development and the Sustainable Development Goals (SDGs), highlighting their structure, key themes, and relevance to India in promoting inclusive and sustainable development.
- To understand the governance structures, institutional mechanisms, and stakeholder roles involved in the implementation of Sustainable Development Goals (SDGs) in India.

### UNIT- I CLIMATE 9

Climate and weather, Meteorology and climatology, Composition and structure of atmosphere. Factors influencing Climate-Insolation, Temperature, Humidity, Pressure, Wind, Precipitation, Topography. Atmospheric stability, Lapse rate, Inversions, Types of inversions. Cyclones and Anticyclones

### UNIT- II CLIMATE CHANGE 9

Climate change, anthropogenic drivers of climate change, Global warming, Greenhouse effect, Air pollution, carbon foot print, Impact of climate change on water cycle, agriculture, forest, water resources, urban areas, biodiversity, human health. Carbon sequestration, vulnerability index.

### UNIT- III URBANIZATION AND SUSTAINABLE DEVELOPMENT 9

Urbanization and Industrialization, Problems of urbanization, Urban flooding, water conservation and ecological aspects. Urban Planning, Zoning of Land Use Pillars of Sustainable development, Sustainability indicators, Life cycle analysis, Material flow analysis, Green energy, Waste management, 3R concepts, Sustainable cities, Sustainable Urbanization.

### UNIT- IV INTRODUCTION TO SUSTAINABLE DEVELOPMENT GOALS 9

Concept of sustainable development, Origin and Framework of SDGs, Overview of the 17 Sustainable Development Goals, SDGs and India, Role of stakeholders and higher education in achieving SDGs, Contemporary issues and challenges in achieving SDGs. Case studies relevant to the program to be discussed and evaluated during the internal Assessment.

### UNIT- V SDG GOVERNANCE AND IMPLEMENTATION 9

SDG Governance – Concept and framework, Global institutions and SDG implementation, SDG Governance in India, Decentralized governance and Localization of SDGs, Financing SDGs and Mobilization, Stakeholder participation and policy integration, Monitoring, Evaluation and Challenges

**Total Periods: 15**

## **COURSE OUTCOMES:**

Upon successful completion of the course student will be able to:

- CO1:** Understand the fundamental concepts of climate and its influencing factors.
- CO2:** Understand the factors affecting climate change and the harmful impacts due to climate change.
- CO3:** Analyze the effects of urbanization and industrialization on climate and sustainability, and evaluate sustainable urban planning practices.
- CO4:** Understand the Sustainable Development Goals (SDGs) and their importance in India and sustainable development.
- CO5:** Understand the governance structure and implementation mechanisms of the Sustainable Development Goals, with reference to India and key stakeholders.

## **TEXT BOOKS**

1. Swarnalatha, B., & Binu, S. M. Introduction to Sustainable Engineering, 1st Edition. Orbit Publisher & Distributors, 2015.
2. Houghton, J. T., & Pasternak, J. Climate Change: Causes, Effects, and Solutions, 1st Edition. Wiley Publications, 2003.
3. Iverson, K. D., & Zommers, Z. Resilience: The Science of Adaptation to Climate Change, 1st Edition. Elsevier, 2018.
4. Joachim Monkelbaan: Governance for the Sustainable Development Goals: Exploring an Integrative Framework of Theories, Tools, and Competencies, Springer Nature Singapore, 2019.
5. Baleswar Thakur, Rajiv R. Thakur, Srikumar Chattopadhyay, Rajesh K. Abhay: Resource Management, Sustainable Development and Governance: Indian and International Perspectives, Springer Nature, 2021.

## **REFERENCE BOOKS**

1. Jonathan Tomkin, Tom Theis, "Sustainability - A Comprehensive Foundation", 12th Media Services, 2018.
2. A. S. Bradley, A. O. Adebayo, and P. Maria, Engineering Applications in Sustainable Design and Development, 1st Edition, Cengage Learning, 2015.
3. John T. Hardy, Jean Ponce, "Climate Change - Causes, Effects, and Solutions", Wiley Publications, 2003.
4. Neeru Sidana: Sustainable Development Goals: A Multidisciplinary Ingress, Bloomsbury Publishing, 2004.

## **WEB REFERENCES**

1. <http://www.digimat.in/nptel/courses/video/120108558/L06.html>
2. <https://se-ed.org.uk/a-collated-list-of-online-climate-change-learning-resources/>
3. <https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts>
4. <https://edu.rsc.org/resources/collections/climate-change-and-sustainability>

## **ONLINE COURSES / RESOURCES**

1. <https://www.coursera.org/learn/climate-change-mitigation>
2. [https://onlinecourses.nptel.ac.in/noc25\\_ce09/preview](https://onlinecourses.nptel.ac.in/noc25_ce09/preview)
3. <https://unitar.org/courses/introductory-e-course-climate-change-6190>
4. <https://www.futurelearn.com/microcredentials/recycling-and-waste-in-a-circular-economy>
5. <https://alison.com/course/sustainability-and-climate-change>
6. <https://www.lse.ac.uk/study-at-lse/executive-education/programmes/politics-and-policy-of-climate-change-and-sustainability>

### CO-PO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

23EC1711	EMBEDDED SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2
SDGs Mapped: 3, 4, 7, 9, 11, 12, 13		Practical Course			

**COURSE OBJECTIVES:**

- To study the working of ARM processor.
- To relate the concept of memory map and memory interface.
- To implement programs to interface memory, I/O's with processor.
- To demonstrate the interrupt performance of ARM and FPGA.
- To design ARM Processor based system.

**S.NO**

**LIST OF EXPERIMENTS**

1. Study of ARM evaluation system.
2. Interfacing LED blinking and Buzzer.
3. Interfacing ADC and DAC.
4. Interfacing PWM with LED.
5. Interfacing real time clock and serial port.
6. Interfacing keyboard and LCD.
7. Interfacing EEPROM and interrupt.
8. Interrupt performance characteristics of ARM and FPGA.
9. Interfacing stepper motor and temperature sensor.
10. Implementing Zigbee protocol with ARM.
11. Mini Project using Embedded systems.

**Total Periods: 60**

**COURSE OUTCOMES:**

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

**CO1:** Implement programs in ARM for a specific Application.

**CO2:** Interface A/D and D/A convertors with ARM system

**CO3:** Analyze the performance of memory, interrupts.

**CO4:** Implement program for interfacing keyboard, display, motor and sensor.

**CO5** : Design a real time application using embedded system.

**CO – PO – PSO MAPPING**

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

## SYSTEM OF EXAMINATION

Internal Assessment		End Semester Examinations
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
SDGs Mapped: 4, 8, 9, 12		Practical Course			

### COURSE OBJECTIVES:

- 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.

### S.NO

### LIST OF EXPERIMENTS

#### OPTICAL EXPERIMENTS

1. Measurement of connector, bending and fiber attenuation losses.
2. Numerical Aperture and Mode Characteristics of Fibers.
3. DC Characteristics of LED and PIN Photodiode.
4. Fiber optic Analog and Digital Link Characterization-frequency response (analog), eye diagram, and BER (digital)

#### MICROWAVE EXPERIMENTS

5. Study of Various Microwave Components.
6. VSWR and Impedance Measurement and Impedance Matching.
7. Characterization of Directional Couplers, Isolators, Circulators.
8. Characteristics of Gunn Diode
9. Characteristics of Reflex Klystron Oscillator
10. Microwave IC–Filter Characteristics

**Total Periods: 60**

### COURSE OUTCOMES:

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

- CO1:** Demonstrate the performance of a 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:** Analyze the response of the system using arbitrary inputs.
- 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 – PSO 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

### SYSTEM OF EXAMINATION

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

23EC1713	COMMUNITY SERVICE PROJECT	L	T	P	C
		0	0	2	1
SDGs Mapped: 2,3,6, 7,8,, 9,11,12,14,15		Employment Enhancement Course			

### COURSE OBJECTIVES:

- To introduce students to independent project work by applying basic theoretical concepts to a defined problem.
- To develop problem identification and formulation skills in a focused and time-bound manner.
- To enhance practical and technical skills through implementation using appropriate tools, techniques, or software.
- To improve teamwork and coordination abilities by working collaboratively in small groups.
- To strengthen documentation and presentation skills through preparation of a mini project report and demonstration of results.

### GUIDELINES FOR REVIEW AND EVALUATION

Students may form groups of two to four members and carry out the mini project under the guidance of a project supervisor. This course is intended to provide students with preliminary exposure to the project work to be undertaken in the eighth semester. Students are required to select a suitable domain and conduct a literature survey to identify research gaps. Based on this, each group shall submit a project report outlining the proposed methodology for their work. The progress and report will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end of the semester, the mini project will be evaluated based on the project report and an oral presentation by examiners appointed by the Head of the Department.

**TOTAL : 60 PERIODS**

### SYSTEM OF EXAMINATION

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

23EC1714	INDUSTRIAL TRAINING/INTERNSHIP	L	T	P	C
		-	-	-	2
SDGs Mapped: 3, 4, 7, 9,11,12		Employment Enhancement Course			

### COURSE OBJECTIVES:

- To provide practical exposure to industrial environments and understand real-world engineering practices and workflows.
- To bridge the gap between academic learning and industry requirements through hands-on experience in relevant technologies.
- To develop professional skills such as communication, teamwork, work ethics, and adaptability in a corporate setting.
- To enhance technical competency by working on live projects, tools, and industry-standard practices.
- To cultivate problem-solving and critical thinking abilities by addressing practical challenges encountered during the internship.

### GUIDELINES FOR REVIEW AND EVALUATION

The students shall undergo industrial training/internship for a minimum duration of four weeks (continuous) or two spells of two weeks each during the summer or winter vacation, anytime between Semester III and Semester VI. The training may be carried out in industries, research organizations, government institutions, relevant technical establishments or in industries or organizations having a Memorandum of Understanding (MoU) with the institution to gain practical exposure to real-world engineering practices. Upon completion of the training, students shall submit a comprehensive internship report detailing the organization profile, work undertaken, technical learning outcomes, and skills acquired.

The internship/industrial training will be evaluated in Semester VII based on the submitted report and a viva voce examination conducted by a committee constituted by the Head of the Department. The evaluation will assess the student's understanding of industrial processes, technical competence, and ability to relate academic knowledge practical experience with Credit Allocation:

Two weeks of internship/industrial training shall carry one credit, subject to successful completion and evaluation.



## SEMESTER VIII

23EC1811	PROJECT WORK	L	T	P	C
		0	0	16	8
SDGs Mapped: 2,3,6, 7,8,, 9,11,12,14,15		Practical Course			

### COURSE OBJECTIVES:

- 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 analyze the concept of Maxwell's equations and time varying fields.
- To assess the behavior of Electromagnetic Wave Propagation for various medium.

### GUIDELINES FOR REVIEW AND EVALUATION

The students, in groups of three to four, shall work on a project topic approved by the Head of the Department under the guidance of a faculty member. They are required to prepare a comprehensive project report upon completion of the work to the satisfaction of the supervisor. The progress of the project shall be evaluated through a minimum of three review assessments. The review committee may be constituted by the Head of the Department. A final project report must be submitted at the end of the semester. The project work shall be evaluated based on the project report and an oral presentation, jointly assessed by internal and external examiners appointed by the Head of the Department.

**Total Periods: 240**

### SYSTEM OF EXAMINATION

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

## VERTICAL I BIOMEDICAL TECHNOLOGIES

<b>23EC1901</b>	<b>BIOMEDICAL INSTRUMENTATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SDGs Mapped: 3, 4, 6, 9</b>		<b>Theory Course</b>			

### COURSE OBJECTIVES

- To explain the principles and challenges of bio electrode 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 BIOPOTENTIAL ELECTRODES 9**

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode — skin interface and motion artifacts, polarizable and non-polarizable 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 BIOPOTENTIAL 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, pO<sub>2</sub> and pCO<sub>2</sub>, Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors, Electrophoresis, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.

**Total Periods: 45**

## COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

**CO1:** Identify and explain the origin and propagation of bio-potentials.

**CO2:** Measure and analyze different physiological signals accurately.

**CO3:** Design and implement effective bio-potential amplifiers.

**CO4:** Analyze different non-electrical physiological signals accurately.

**CO5:** Utilize biochemical sensors and measurement techniques effectively.

**CO6:** Interpret data from Electrophoresis, photometer, blood cell counter to analyze 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

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://ocw.mit.edu/courses/health-sciences-and-technology/hst-582j-medical-device-development-spring-2006/>
4. <https://nptel.ac.in/courses/103/104/103104122/>

## CO – PO – PSO 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	3	1	2
CO3	3	2	3								2	3	2	2
CO4	2	3									2	3	3	2
CO5	2	2	2								3	3	2	3
CO6	3	2	3								3	3	3	3

## SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>



23EC1902	DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 10, 12		Theory Course			

### COURSE OBJECTIVES:

- 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, Electrodiagnostic 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, Bekesy audiometer system, Evoked response audiometry system, Hearing aids, cochlear implants, Tonometry, Measurement of basal skin response and galvanic skin response.

### UNIT- V ELECTROMAGNETIC WAVES 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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

### **WEB REFERENCES**

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](https://onlinecourses.swayam2.ac.in/nou23_bt05/preview)

### CO – PO – PSO 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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

23EC1903	WEARABLE DEVICES	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 8, 9		Theory Course			

## COURSE OBJECTIVE

- To analyze 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 Periods: 45**

## COURSE OUTCOMES:

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, Elsevier, 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

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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1904	BODY AREA NETWORKS AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 9		Theory Course			

### COURSE OBJECTIVES:

- To understand the technical challenges of body area networks (BAN) in healthcare.
- To analyze 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 arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill, Telemedicine.

**Total Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

**CO1:** Discuss technical challenges and architecture of BAN.

**CO2:** Identify and explain hardware components and design considerations for BAN.

**CO3:** Analyze 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

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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1905	TELEMEDICINE AND TELEHEALTH	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 10, 11		Theory Course			

### COURSE OBJECTIVES:

- To understand the principles and applications of wireless technology in patient monitoring.
- To explore various technologies employed in medical information processing.
- To analyze 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 from Patients - Body Temperature, Heart Rate, Blood Pressure, Respiration Rate, Blood Oxygen Saturation, Bio signal Transmission and Processing - Medical Imaging, Medical Image Transmission and Analysis - Image Compression - Bio potential 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-IV 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 Periods: 45**

## COURSE OUTCOMES:

Upon successful completion of the course student 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

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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1906	MEDICAL IMAGE ANALYSIS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 10		Theory Course			

### COURSE OBJECTIVES:

- To understand the fundamental components and classification of medical image processing.
- To analyze 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

**COURSE OUTCOME(S):**

Upon successful completion of the course student 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:** Integrate 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**

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. <https://in.mathworks.com/help/medical-imaging/>
2. [https://onlinecourses.nptel.ac.in/noc22\\_bt34/preview](https://onlinecourses.nptel.ac.in/noc22_bt34/preview)
3. <https://hslguides.med.nyu.edu/medicalimages>
4. <https://www.ucl.ac.uk/child-health/about-us/support-services/library/resources-z/medical-image-repositories>

**CO – PO – PSO MAPPING**

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

## SYSTEM OF EXAMINATION

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



23EC1907	BRAIN COMPUTER INTERFACE	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 10		Theory Course			

### COURSE OBJECTIVES:

- 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 analyze 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, Identification, and Authentication - Ethics of Brain-Computer Interfacing : Medical, Health, and Safety Issues,

**COURSE OUTCOMES:**

Upon successful completion of the course student 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:** Analyze 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 practice, 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**

1. <https://www.coursera.org/learn/neural-networks-deep-learning>
2. <https://spectrum.ieee.org/>
3. <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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

## VERTICAL II IoT ARCHITECTURE AND APPLICATIONS

<b>23EC1908</b>	<b>WIRELESS NETWORKS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
SDGs Mapped: 3, 4, 9, 11, 13		Theory Course			

### COURSE OBJECTIVES:

- 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 9 **WIRELESS LAN**

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 9 **MOBILE NETWORK LAYER**

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 9 **3G AND INTERNETWORKING BETWEEN WLANS AND WWANS**

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 9 **4G & BEYOND**

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 9 **WIRELESS NETWORKS FOR IoT**

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 Periods: 45**

## COURSE OUTCOMES:

Upon successful completion of the course student 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, Wiley -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

1. [https://onlinecourses.nptel.ac.in/noc21\\_ee66/preview](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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1909	IoT ARCHITECTURES AND PROTOCOLS	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 8, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 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 Periods: 45**

## **COURSE OUTCOMES:**

Upon successful completion of the course student 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 Vestry, "Internet of Things: Architectures, Protocols and Standards", 2019, 1st Edition, Wiley Publications, USA.
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, 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, 1<sup>st</sup> Edition, Universities press, India.
2. Vlasios Tsiatsis, Jan Holler, Catherine Mulligan, Stamatis Karnouskos and David Boyle. Internet of Things: Technologies and Applications for a New Age of Intelligence, 2018, 2<sup>nd</sup> Edition, Academic Press, USA.
3. Vermesan, Ovidiu, and Peter Friess, eds. Internet of things-from research and innovation to market deployment, 1<sup>st</sup> edition, Aalborg: River publishers, 2014.

## **WEB REFERENCES**

1. <https://learn.microsoft.com/en-us/azure/loT/>
2. <https://loT-analytics.com/>
3. <https://www.ibm.com/topics/internet-of-things>

## **ONLINE COURSES / RESOURCES**

1. [https://onlinecourses.nptel.ac.in/noc21\\_cs17/preview](https://onlinecourses.nptel.ac.in/noc21_cs17/preview)

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

<b>23EC1910</b>	<b>IoT SECURITY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SDGs Mapped: 4,11,16</b>		<b>Theory Course</b>			

**COURSE OBJECTIVES:**

- 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 Periods: 45**

**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, 2<sup>nd</sup> Edition,2018.
2. Fei Hu, “Security and Privacy in Internet of Things (IoT): 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, Muthucumar Maheswaran, Salman Hashmi, “Security Challenges and Approaches in Internet of Things,” Springer, 2016.
3. Arshdeep Bahga, Vijay Madiseti, “Internet of Things — A Hands-on approach,” VPT Publishers, 2014, ISBN: 978-0996025515.

**WEB REFERENCES**

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 – PSO MAPPING**

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

## SYSTEM OF EXAMINATION

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	
40%				60 %



23EC1911	DATA ANALYTICS FOR IoT	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 8, 9, 11, 13		Theory Course			

### COURSE OBJECTIVES:

- 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 the 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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:** Analyze 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 Minter, "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

1. <https://www.udemy.com/course/loT-data-analytics/>
2. <https://www.cognixia.com/course/loT-analytics/>
3. <https://www.jigsawacademy.com/loT-analyst-certification/>

## ONLINE COURSES / RESOURCES

1. <https://www.classcentral.com/course/edx-loT-data-analytics-and-storage-12664>
2. <https://www.educba.com/loT-analytics/>

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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



## 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, Raghuv eer, 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 AhmedShah, IoT-Enabled Smart Healthcare Systems, Services and Applications, Wiley, 2022.
4. IoT in Automotive Industry: <https://www.biz4intellia.com/blog/loT-applications-in-automotive-industry>

## WEB REFERENCES

1. <https://www.coursera.org/lecture/internet-of-things-history/loT-automotive-0vJj52>.
2. <https://www.coursera.org/lecture/network-transformation-101/loT-verticals-connected-car-odaAf>
3. <https://www.udemy.com/course/fundamentals-of-connected-car-technology/>
4. <https://www.udemy.com/course/loT-based-emergency-health-care-system/>
5. <https://cmpd.doctorasyou.com/courses/continuum-digital-education/internet-of-medicalthings-in-healthcare-11/>

## ONLINE COURSES / RESOURCES

1. [https://onlinecourses.nptel.ac.in/noc21\\_cs17/preview](https://onlinecourses.nptel.ac.in/noc21_cs17/preview)
2. <https://nptel.ac.in/courses/106105195>

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 7,9,11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

## **COURSE OUTCOME(S):**

Upon successful completion of the course student 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/](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**

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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1914	IoT AND EDGE COMPUTING	L	T	P	C
		3	0	0	3
SDGs Mapped: 7,9,11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student 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, 2<sup>nd</sup> 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 Edge Computing: 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

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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>





**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. Rulph Chassaing 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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



## 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. Sophocles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000.

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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 %	



- 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 R.M. 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1918	BIOSIGNAL PROCESSING	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

23EC1919	SPEECH PROCESSING	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 8, 9, 10		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES

Upon successful completion of the course student 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", 2<sup>nd</sup> 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 – PSO 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

## SYSTEM OF EXAMINATION

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



23EC1920	COMPUTER VISION	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 8, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1921	UNDERWATER IMAGING SYSTEMS AND IMAGE PROCESSING	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 9, 14		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student 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 Processin", 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, Wiley Interscience,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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



- CO2:** Interpret the Architecture of Cognitive Radio.  
**CO3:** Analyze spectrum sensing techniques and dynamic spectrum access.  
**CO4:** Analyze 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, Maziar Nekovee, 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

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\(SDR\)](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-etworks>
3. <https://www.sanfoundry.com/cognitive-radio-certification/>

### CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 3, 4, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 Analyze 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 Periods: 45**

### COURSE OUTCOMES:

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 Fiber 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

- Niel Ransom and Albert A. Azzam, "Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS, McGraw Hill 2002

### REFERENCE BOOKS

- Gilbert Held, "Next Generation Modems: A Professional Guide to DSL
- William Webb, "Introduction to Wireless Local Loop broadband and narrow band system", Artech House, 2000.
- Martin P. Clarke, "Wireless Access Network: Fixed Wireless Access and WLL network Design and operation", John Wiley & Sons 2000

### WEB REFERENCES

- <https://ipcisco.com/lesson/internet-access-technologies/>
- <https://www.tutorialspoint.com/article/what-are-the-different-access-technologies-in-computer-networks>

### ONLINE COURSES / RESOURCES

- <https://nptel.ac.in/courses/117101050>
- <https://www.commscopetraining.com/courses/fiber-optic/sp1000/infrastructure-solutions-for-broadband-applications/>
- [https://onlinecourses.nptel.ac.in/noc23\\_ee63/preview](https://onlinecourses.nptel.ac.in/noc23_ee63/preview)

### CO – PO – PSO 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	3	3								2	3	2	1
CO3	3	2	2								2	3	2	2
CO4	3	3	3								2	3	2	2
CO5	3	2	2								1	3	2	2
CO6	3	3	3								1	3	2	3

### SYSTEM OF EXAMINATION

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

23EC1924	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3
SDGs Mapped: 9		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student 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, Sundeeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

#### CO – PO – PSO MAPPING

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

#### SYSTEM OF EXAMINATION

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



## COURSE OUTCOMES:

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

1. <https://massivemimobook.com/>
2. <https://www.cambridge.org/Marzetta>

## ONLINE COURSES / RESOURCES

1. [https://onlinecourses.nptel.ac.in/noc22\\_ee65/preview](https://onlinecourses.nptel.ac.in/noc22_ee65/preview)
2. <https://www.coursera.org/learn/5g-for-everyone>
3. <https://www.youtube.com/c/WirelessFuture>

## CO – PO – PSO 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	1	1	1

## SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>



23EC1926	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR COMMUNICATION ENGINEERS	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 8, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 search Techniques: 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, hyper parameter tuning, batch normalization, regularization, dropout.

**Total Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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. Elaine Rich. 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

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](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](https://onlinecourses.nptel.ac.in/noc22_cs24/preview)

### CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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 %



23EC1927	MACHINE LEARNING FOR FUTURE WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 7, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOME(S):

Upon successful completion of the course student 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. 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. T 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23E C1928	TERAHERTZ COMMUNICATION	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 8, 9, 12		Theory Course			

### COURSE OBJECTIVES:

- To know the principles of Terahertz principles
- To study THz sources for a given for different applications.
- To determine THz detectors for given applications.
- To analyze suitability of THz imaging and spectroscopy systems.
- To Apply THz systems knowledge for different Industrial applications.
- To design terahertz communication systems considering propagation effects.

#### 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

Pyroelectric detectors, gallium doped Germanium photoconductive detector, Bolometer detectors, composite Germanium Bolometer, unturned Indium Antimode, Golay 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 Periods: 45**

## COURSE OUTCOMES:

Upon successful completion of the course student 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.

**CO6:** Analyze terahertz communication systems by propagation effects for efficient wireless communication.

## 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. Bjornson, 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

## WEB REFERENCES

1. [https://www.rohde-schwarz.com/us/solutions/wireless-communications-testing/wireless-standards/6g/thz-communication/thz-communication\\_257042.html](https://www.rohde-schwarz.com/us/solutions/wireless-communications-testing/wireless-standards/6g/thz-communication/thz-communication_257042.html)
2. <https://www.comsoc.org/publications/magazines/ieee-wireless-communications/cfp/terahertz-communications-and-sensing-6g-and>

## ONLINE COURSES / RESOURCES

1. [https://onlinecourses.nptel.ac.in/noc22\\_ee102/preview](https://onlinecourses.nptel.ac.in/noc22_ee102/preview)
2. [https://unlab.tech/nano\\_courses/eece-5698-terahertz-communications-for-6g/](https://unlab.tech/nano_courses/eece-5698-terahertz-communications-for-6g/)

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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 %





## 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.

## WEB REFERENCES

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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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 %	

23EC1930	CAD FOR VLSI DESIGN	L	T	P	C
		3	0	0	3
SDGs Mapped: 4,8,9		Theory Course			

**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 Periods: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course student 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, 2<sup>nd</sup> Edition, 2019.
3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2014.

### ONLINE COURSES / RESOURCES

1. <https://archive.nptel.ac.in/courses/106/106/106106089>

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1931	SYSTEM VERILOG	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 9, 12		Theory Course			

### COURSE OBJECTIVES:

- 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.

#### 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 Periods: 45**

## COURSE OUTCOMES:

Upon successful completion of the course student 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

1. <https://www.chipverify.com/tutorials/systemverilog>

## ONLINE COURSES / RESOURCES

1. [https://www.cadence.com/en\\_US/home/training/all-courses/82143.html](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>

## CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>



23EC1932	LOW POWER IC DESIGN	L	T	P	C
		3	0	0	3
SDGs Mapped: 7, 9, 12		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods:45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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](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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
40%				60 %

23EC1933	VLSI TESTING AND DESIGN FOR TESTABILITY	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 8, 9, 12, 17		Theory Course			

### 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 Periods: 45**

### 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.

- M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital systems and Testable Design", Jaico Publishing House, 2001.

### REFERENCE BOOKS

- Lala, Parag K., "An Introduction to Logic Circuit Testing", United States: Morgan & Claypool Publishers, 2022.
- M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits", Kluwer Academic Publishers, 2013.
- P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.

### WEB REFERENCES

- <https://www.cerc.utexas.edu/~jaa/vlsi/lectures/20-2.pdf>
- [http://smdpc2sd.gov.in/downloads/IEP/IEP%205/IEP\\_C2SD\\_2017\\_HR.pdf](http://smdpc2sd.gov.in/downloads/IEP/IEP%205/IEP_C2SD_2017_HR.pdf)

### ONLINE COURSES / RESOURCES

- <https://www.maven-silicon.com/advanced-vlsi-design-and-dft-course>
- <https://chip-edge.com/design-for-test-course>

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>

23EC1934	SYSTEM ON CHIP	L	T	P	C
		3	0	0	3
SDGs Mapped: 7, 9, 12, 13		Theory Course			

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1** Understand the fundamental 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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	
<b>40%</b>				<b>60 %</b>

23EC1935	NETWORK ON CHIP	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 7, 9, 11, 12, 13		Theory Course			

### 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 integrations of NoC.

### UNIT- I INTRODUCTION 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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. Fayezegebal, Haythamelmiligi, Hqahedwatheq 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 – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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
<b>40%</b>				<b>60 %</b>



## 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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

23EC1937	RFID SYSTEM AND APPLICATIONS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9		Theory Course			

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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

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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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 %

23EC1938	RF MEMS	L	T	P	C
		3	0	0	3
SDGs Mapped: 7, 9, 11, 12, 13		Theory Course			

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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.DeLosSantos,"Introduction toMicro-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.
5. SK Koul & S Dey, "Micromachined Circuits and Devices", Springer Singapore, 2022.
6. Naser Pour Aryan, "Design and Modeling of Inductors, Capacitors and Coplanar Waveguides at Tens of GHz Frequencies", Springer International Publishing AG, 2014.

## WEB REFERENCES

1. <https://link.springer.com/article/>
2. <https://www.researchgate.net/>

## ONLINE COURSES / RESOURCES

1. <https://nptel.ac.in/courses/117105082>

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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 %	

23EC1939	SMART ANTENNAS	L	T	P	C
		3	0	0	3
SDGs Mapped: 4, 8, 9, 11		Theory Course			

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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**

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 – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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

23EC1940	RF SYSTEM DESIGN	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 7, 8, 9, 11, 12		Theory Course			

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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

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](https://onlinecourses.nptel.ac.in/noc24_ee75/preview)

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 3, 4, 7, 8, 9, 11, 12		Theory Course			

### 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,  $Z_0$  and  $T_d$  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 –  $R_s$ ,  $\tan\delta$  , 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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

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](https://onlinecourses.nptel.ac.in/noc24_ee67/preview)

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1942	COMPUTATIONAL ELECTROMAGNETICS	L	T	P	C
		3	0	0	3
SDGs Mapped: 7, 9, 11, 13		Theory Course			

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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 Electromagnetic 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, "Electromagnetics & 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, Boca Raton, 2009.

**WEB REFERENCES**

1. <https://link.springer.com/article/>
2. <https://www.researchgate.net/>

**ONLINE COURSES / RESOURCES**

1. [https://onlinecourses.nptel.ac.in/noc22\\_ee105/preview](https://onlinecourses.nptel.ac.in/noc22_ee105/preview)

**CO – PO – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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



- 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**

- Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
- Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.

**REFERENCE BOOKS**

- Gerd Keiser," Optical Fiber Communications", 2012, 4th edition, McGraw-Hill Science, Delhi.
- John G Webster, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Florida.
- Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", 2013, 2nd edition, Wiley, New Jersey.
- Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York

**CO – PO – PSO MAPPING**

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

**SYSTEM OF EXAMINATION**

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



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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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

23EC1945	FLEXIBLE AND WEARABLE SENSORS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 8, 9, 11, 12		Theory Course			

## COURSE OBJECTIVES:

- 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 Periods: 45**

## COURSE OUTCOMES:

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, Clíodhna 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, 1<sup>st</sup> 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, Maker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1<sup>st</sup> 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](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 – PSO 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	3								2	3	2	1
CO3	3	2	3								2	3	2	1
CO4	2	3	2								3	2	3	1
CO5	2	3	2								3	2	3	1
CO6	2	1	2								3	2	1	1

## SYSTEM OF EXAMINATION

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
<b>40%</b>				<b>60 %</b>



23EC1946	MICROSYSTEMS AND HYBRID TECHNOLOGY	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 7, 9		Theory Course			

**COURSE OBJECTIVES:**

- 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 components, 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. thin film technology Structure dimensions, Assembly and packaging Surface mount technology (SMT) Active and passive devices (SMD), Connection technologies, Packaging

**Total Periods: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course student 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", 2<sup>nd</sup> Edition, John Wiley & Sons, 2020.
2. Alberto Corigliano, Raffaele Arditto, 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 – PSO MAPPING

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

#### SYSTEM OF EXAMINATION

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

23EC1947	NANO MATERIALS AND SENSORS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 4, 9, 12		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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
SDGs Mapped: 4,7,9,11,13		Theory Course			

### COURSE OBJECTIVES:

- To understand the fundamentals of data acquisition and signaling 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 Periods: 45**

### COURSE OUTCOMES:

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, 1<sup>st</sup> 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, 3<sup>rd</sup> Edition, Springer, 2003.
5. Pallas Areny. R and Webster. J. G, Sensors and Signal conditioning, 2<sup>nd</sup> 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 2, 3, 6, 7, 9, 11, 13, 15		Theory Course			

### COURSE OBJECTIVES:

- 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

MAC Protocols : Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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. Ibrahim M.M, El Mary, Ramakrishnan S, "Wireless Sensor Networks from Theory to Applications", CRC Press, 2013
2. Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", John Wiley & Sons, 2010.

## REFERENCE BOOKS

1. Walteneagus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", 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 – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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 VIII EMERGING TECHNOLOGIES

<b>23EC1950</b>	<b>CRYPTOGRAPHY AND SECURITY PRACTICES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SDGs Mapped: 9, 11, 16</b>		<b>Theory Course</b>			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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=PLBlnK6fEyqRgJU3EsOYDTW7m6SUmW6kl>

### ONLINE COURSES / RESOURCES

1. [https://onlinecourses.nptel.ac.in/noc22\\_cs90/preview](https://onlinecourses.nptel.ac.in/noc22_cs90/preview)

### CO – PO – PSO 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

### SYSTEM OF EXAMINATION

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

23EC1951	BLOCK CHAIN TECHNOLOGIES AND APPLICATIONS	L	T	P	C
		3	0	0	3
SDGs Mapped: 3, 8, 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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
3. Alex Leverington "Ethereum Programming", Packt Publishing Limited, 2017
4. Arshdeep Bahga and Vijay Madiseti, "Blockchain Applications : A Hands-On Approach", 2017.

## WEB REFERENCES

1. [https://onlinecourses.nptel.ac.in/noc22\\_cs44/preview](https://onlinecourses.nptel.ac.in/noc22_cs44/preview)
2. [https://onlinecourses.swayam2.ac.in/aic21\\_ge01/preview](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 – PSO 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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 4, 8, 9		Theory Course			

### COURSE OBJECTIVES:

- 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 r<sup>2</sup> – 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

-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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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

1. [https://www.w3schools.com/datascience/ds\\_python.asp](https://www.w3schools.com/datascience/ds_python.asp)

### ONLINE COURSES / RESOURCES

1. <https://nptel.ac.in/courses/106106179>

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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
SDGs Mapped: 9, 11		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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. Saro Velrajan, "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, bentham books publisher, 2021.

### CO – PO – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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



- CO4:** Interpret different multiple access technique end coding methods for satellite communication.
- CO5:** Explain the applications of Satellite Communications
- CO6:** To evaluate and analyze satellite and mobile communication systems for global communication, navigation, and broadcasting applications.

#### 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. Wilbur L.Pritchard, HendriG. 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

1. <https://www.inmarsat.com/en/insights/corporate/2023/a, straightforward, introduction, to, satellite, communications.html>
2. <https://www.itu.int/hub/2020/05/satellite, communications, an, essential, link, for, a, connected, 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](https://onlinecourses.nptel.ac.in/noc24_ce56/preview)

#### CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
SDGs Mapped: 4, 8, 9, 11, 12, 17		Theory Course			

### COURSE OBJECTIVES:

- 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student will be able to:

- CO1:** Understand the concepts and theories related to human-computer interaction.  
**CO2:** Infer user-centered 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 Weinholt, "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

1. [https://link.springer.com/referenceworkentry/10.1007/978-0-387-39940-9\\_192](https://link.springer.com/referenceworkentry/10.1007/978-0-387-39940-9_192)

## CO – PO – PSO MAPPING

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

## SYSTEM OF EXAMINATION

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
		3	0	0	3
SDGs Mapped: 3, 4, 9		Theory Course			

### COURSE OBJECTIVES:

- 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).

#### 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 Periods: 45**

### COURSE OUTCOMES:

Upon successful completion of the course student 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 – PSO MAPPING

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

### SYSTEM OF EXAMINATION

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