SCHEME & SYLLABUS

OF

V TO VIII SEMESTERS B.E.

ELECTRONICS AND COMMUNICATION ENGINEERING

AY: 2024-25

(Applicable to 2022-23 Batch)

Vision

To be a center of excellence in education and research creating professionally competent and socially sensitive Electronics and Communication engineers capable of working in multicultural global environment.

Mission

- To provide quality education relevant to the current and future needs of the society ensuring experiential learning in Electronics and Communication engineers.
- To create state of the art infrastructure and research facility for learning-teaching-learning process and quality research.
- To imbibe professional ethics, human values and competency in students enabling them to work individually, and as a member or leader in multicultural global environment.

Programme Educational Objectives:

The graduates of Electronics and Communication engineering programme will

a) Be able to design and build systems for providing solutions to real life problems in the area of Electronics and Communication.

b) Be a successful entrepreneur, build careers in Industry, government, public sector undertakings, pursue higher education and research.

c) Work individually, within multidisciplinary teams and lead the team following sound professional and ethical practices.

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Graduate attributes: Program Outcomes (POs)

PO1: **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSOs)

A graduate of the Electronics and Communication Engineering Program will demonstrate

1. The ability to analyse and design systems in the areas related to microelectronics, Communication, Signal Processing and embedded systems for solving real world problems (Professional Skills).

2. The ability to identify problems in the areas of communication and embedded systems and provide efficient solutions using modern tools/algorithm individually or working in a team (Problem solving Skills).

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

ELECTRICAL AND ELECTRONICS ENGINEERING STREAM (EE, EC, EI, ET)

SCHEME OF TEACHING AND EXAMINATION FOR 160 CREDITS SCHEME

(EFFECTIVE FROM THE ACADEMIC YEAR 2022-23)

I Semester (Chemistry Cycle)

Sl. No.	Course Category and Course Code		Course Title	Teaching Dept.	Teaching hrs/week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	ASC(IC)	MATE1	Mathematics – I for EEE Stream	Maths	2	2	2	0	3	50	50	100	**4**
2	ASC(IC)	CHEE	Chemistry for EEE Stream	Che	3	0	2	0	3	50	50	100	**4**
3	ESC	ESCF1	Computer Aided Engineering Drawing	ME	2	2	0	0	3	50	50	100	**3**
4	ESC1	ESCOx	Engineering Science Course-I	ABE	3	0	0	0	3	50	50	100	**3**
5	PLC	PLCx	Programming Language Course	ABE	2	0	2	0	3	50	50	100	**3**
6	AEC	CC01	Communicative English	T&P	1	0	0	0	1:30	50	50	100	**1**
7	HSMC	CC05	Indian Constitution	HS	1	0	0	0	1:30	50	50	100	**1**
8	AEC/SDC	CC07	Scientific Foundations of Health	Any Dept.	1	0	0	0	1:30	50	50	100	**1**
		AAP	AICTE Activity Points		40 hours of work to be documented and produced for the examination at 8th Semester								
	Total									400	400	800	**20**

Note: Students have to choose any one course out of five options available in **Engineering Science Courses (Optional)**.
Students have to choose any one course out of four options available in **Programming Language Courses**

Code	Engineering Sciences Courses (Optional)	L	T	P	Cr
ESCO1	Introduction to Civil Engineering	3	0	0	3
ESCO2	Introduction to Electrical Engineering (Excluding EE)	3	0	0	3
ESCO3	Introduction to Electronics Engineering (Excluding EC, EI, ET)	3	0	0	3
ESCO4	Introduction to Mechanical Engineering	3	0	0	3
ESCO5	Introduction to C Programming	2	0	2	3

Code	Programming Language Courses	L	T	P	Cr
PLC1	Introduction to Web Programming	2	0	2	3
PLC2	Introduction to Python Programming	2	0	2	3
PLC3	Basics to JAVA programming	2	0	2	3
PLC4	Introduction to C++ Programming	2	0	2	3

ASC(IC)	Applied Science Course (Integrated Course)
ESC	Engineering Science Course
ETC	Emerging Technology Course
PLC	Programming Language Course
HSMC	Humanities, Social Science and Management Course
AEC	Ability Enhancement Course
SDC	Skill Development Course
ABE	Appropriate Branch of Engineering

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

ELECTRICAL AND ELECTRONICS ENGINEERING STREAM (EE, EC, EI, ET)

SCHEME OF TEACHING AND EXAMINATION FOR 160 CREDITS SCHEME

(EFFECTIVE FROM THE ACADEMIC YEAR 2022-23)

II Semester (Physics Cycle)

Sl. No.	Course Category and Course Code		Course Title	Teaching Dept.	Teaching hrs/week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	ASC(IC)	MATE2	Mathematics – II for EEE Stream	Maths	2	2	2	0	3	50	50	100	**4**
2	ASC(IC)	PHYE	Physics for EEE Stream	Phy	3	0	2	0	3	50	50	100	**4**
3	ESC	ESCF3	Elements of Electrical Engineering (for EE)	EE	2	2	0	0	3	50	50	100	**3**
		ESCF4	Basic Electronics (for EC, EI, ET)	EC	3	0	0	0					
4	ESC2	ESCOx	Engineering Science Course-II	ABE	3	0	0	0	3	50	50	100	**3**
5	ETC	ETCxx	Emerging Technology Course	ABE	3	0	0	0	3	50	50	100	**3**
6	AEC	CC02	Professional Writing Skills in English	T&P	1	0	0	0	1:30	50	50	100	**1**
7	HSMC	CC03 CC04	Balake Kannada Samkruthika Kannada	HS	1	0	0	0	1:30	50	50	100	**1**
8	AEC/SDC	CC06	Innovation and Design Thinking	Any Dept.	1	0	0	0	1:30	50	50	100	**1**
		AAP	AICTE Activity Points		40 hours of work to be documented and produced for the examination at 8th Semester								
	Total									400	400	800	**20**

Note: Students have to choose any one course out of five options available in **Engineering Science Courses (Optional)** excluding Engineering Science Course studied in I Semester.

Students have to choose any one course out of twelve options available in **Emerging Technology Courses**

Code	Engineering Sciences Courses (Optional)	L	T	P	Cr
ESCO1	Introduction to Civil Engineering	3	0	0	3
ESCO2	Introduction to Electrical Engineering (Excluding EE)	3	0	0	3
ESCO3	Introduction to Electronics Engineering (Excluding EC, EI, ET)	3	0	0	3
ESCO4	Introduction to Mechanical Engineering	3	0	0	3
ESCO5	Introduction to C Programming	2	0	2	3

Code	Emerging Technology Courses		L	T	P	Cr
ETC01	Smart Materials and Systems	(ME)	3	0	0	3
ETC02	Green Buildings	(CV)	3	0	0	3
ETC03	Operation and Maintenance of Solar Electric Systems	(EE)	3	0	0	3
ETC04	Introduction to Embedded System	(EE)	3	0	0	3
ETC05	Introduction to Nano Technology	(ME)	3	0	0	3
ETC06	Introduction to Drone Technology	(ET)	3	0	0	3
ETC07	Introduction to Sustainable Engineering	(ME)	3	0	0	3
ETC08	Renewable Energy Sources	(ME)	3	0	0	3
ETC09	Waste Management	(CH)	3	0	0	3
ETC10	Emerging Applications of Biotechnology	(EI)	3	0	0	3
ETC11	Introduction to Internet of Things (IoT)	(EC)	3	0	0	3
ETC12	Introduction to Cyber Security	(IS)	3	0	0	3

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics and Communication Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2023-24)

III Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S3ECI01	Mathematics for Signal Processing	ECE	3	0	2	0	3	50	50	100	4
2.	PCC	S3EC01	Fields, Lines & Waves	ECE	3	0	0	0	3	50	50	100	3
3.	IPCC	S3CESI1	Digital Electronic Circuits with Verilog $	ECE	3	0	2	0	3	50	50	100	4
4.	PCC	S3CES2	Analog Electronic Circuits $	ECE	3	0	0	0	3	50	50	100	3
5.	PCCL	S3ECL01	Analog Electronic Circuits Lab	ECE	0	0	2	0	3	50	50	100	1
6.	ESC	S3ECXX	ESC/ETC/PLC	ECE	3	0	0	0	3	50	50	100	3
7.	UHV	SHS01	Social Connect and Responsibility (Board: ME)	ME	0	0	2	0	-	50	-	50	1
8.	AEC/ SEC	S3ECAXX	Ability Enhancement Course/ Skill Enhancement Course - III	ECE	If offered as Theory Course				1½	50	50	100	1
					1	0	0						
					If offered as Integrated Course				1½				
					0	0	2						
9.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO	0	0	2	0		100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED									
		SMC03	Yoga	PED									
		SMC04	NCC										
			Total					0		550	350	900	20
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: PCC: Professional Core Course, IPCC: Integrated Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non Credit Mandatory Course, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course L: Lecture, T: Tutorial, P: Practical S= SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Engineering Science Course (ESC/ETC/PLC) (Offered by the Department)		
02.Computer Organization & Architecture		04.Electronic Measurements
03.Data Structures in C		05.Applied Numerical Methods for EC Engineering
Ability Enhancement Course – III (Offered by the Department)		
01.Electronic System Design		03. Electronic Circuit Analysis using open source
02.Matlab for EC Engineering		04. Signal Processing with R

$ Common to ECE/TCE/EI/EEE

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics and Communication Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2023-24)

IV Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PCC	S4EC01	Communication System – 1	ECE	3	0	0	0	3	50	50	100	3
2.	IPCC	S4CESI1	Control Systems $	ECE	3	0	2	0	3	50	50	100	4
3.	IPCC	S4CESI2	ARM Microcontroller $	ECE	3	0	2	0	3	50	50	100	4
4.	PCCL	S4ECL01	Communication System – 1 Lab	ECE	0	0	2	0	3	50	50	100	1
5.	ESC	S4ECXX	ESC/ETC/PLC	ECE	3	0	0	0	3	50	50	100	3
6.	BSC	S4BE01	Biology for Engineers (Board: BT)	BT, CH, Phy, Che	3	0	0	0	3	50	50	100	3
7.	UHV	SHS02	Universal Human Values Course (Board: IEM)	IEM	1	0	0	0	1½	50	50	100	1
8.	AEC/ SEC	S4ECAXX	Ability Enhancement Course/ Skill Enhancement Course - IV	ECE	If offered as Theory Course				1½	50	50	100	1
					1	0	0						
					If offered as Integrated Course				1½				
					0	0	2						
9.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO	0	0	2	0		100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED									
		SMC03	Yoga	PED									
		SMC04	NCC										
			Total					0		500	400	900	20
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: PCC: Professional Core Course, IPCC: Integrated Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non Credit Mandatory Course, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course L: Lecture, T: Tutorial, P: Practical S= SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Engineering Science Course (ESC/ETC/PLC) (Offered by the Department)	
02. Java Programming	04. Industrial Electronics
03. Object Oriented Programming with C++	05. Solid State Devices & Technology
Ability Enhancement Course – IV (Offered by the Department)	
01. Communication Applications using Python	03. Advanced Digital Design using System Verilog
02. Industrial IoT	04. Communication Systems using GNU Radio
05. Advanced Technical Training - C++ Lab (S4CCA02)	

$ Common to ECE/TCE/EI/EEE

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics and Communication Engineering
SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2024-25)

V Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs.				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PCC	S5EC01	IOT and Network Technology	ECE	42	-	-	48	3	50	50	100	3
2.	IPCC	S5ECI01	Digital Signal Processing	ECE	42	-	28	50	3	50	50	100	4
3.	IPCC	S5ECI02	Communication Systems – II	ECE	42	-	28	50	3	50	50	100	4
4.	PCCL	S5ECL01	IOT and Network Technology Lab	ECE	-	-	28	02	3	50	50	100	1
5.	PEC	SECEXX	**Professional Elective Course - 1**	ECE	42	-	-	48	3	50	50	100	3
6.	PROJ	S5ECMP	Mini Project	ECE	-	-	42	18	3	50	50	100	2
7.	AEC	SHS04	Research Methodology and IPR	ME, IM, CH	42	-	-	48	3	50	50	100	3
8.	HSMS	SHS05	Environmental Studies	CV	28	-	-	32	3	50	50	100	2
9.	AEC	ARAS	Aptitude Related Analytical Skills	T&P	-	-	28	02	1½	50	50	100	1
10.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO						100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED									
		SMC03	Yoga	PED									
11.		SMC04	NCC										
			Total							**550**	**450**	**1000**	**23**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **HSMS:** Humanity and Social Science and management Course **IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **EC**: Professional Elective Course; **PROJ**: Project/Mini Project;

AEC: Ability Enhancement Course; **NCMC**: Non-Credit Mandatory Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S**

SDA: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics and Communication Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2024-25)

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs.				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PCC	S6EC01	Communication Systems – III	ECE	42	-	28	50	3	50	50	100	4
2.	IPCC	S6ECI01	Digital VLSI Design	ECE	42	-	28	50	3	50	50	100	4
3.	PEC	SECEXX	Professional Elective Course - II	ECE	42	-	-	48	3	50	50	100	3
4.	OEC	SOEXX	Open Elective Course - 1	ECE	42	-	-	48	3	50	50	100	3
5.	PROJ	S6ECP	Major Project Phase I	ECE	-	-	42	18	3	100	-	100	2
6.	PCCL	S6ECL01	Communication System – III Lab	ECE	-	-	28	02	3	50	50	100	1
7.	NCMC	SMC05	Soft Skills	T&P					-	100	-	100	0
8.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO						100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED									
		SMC03	Yoga	PED									
9.		SMC04	NCC										
			Total							550	250	800	17
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: IPCC: Integrated Professional Core Course, PCC: Professional Core Course; PEC: Professional Elective Course; OEC: Open Elective Course; PROJ: Project Phase –I; PCCL: Professional Core Course laboratory; AEC: Ability Enhancement Course, SEC: Skill Enhancement Course; NCMC: Non Credit Mandatory Course; L: Lecture, T: Tutorial, P: Practical S= SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics and Communication Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2025-26)

VII Semester (Swappable VII and VIII Semester)

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S7ECI01	Cryptography & Network Security	ECE	3	0	2		3	50	50	100	4
2.	IPCC	S7ECI02	Static Timing Analysis	ECE	3	0	2		3	50	50	100	4
3.	HSMS	SHS05	Management & Entrepreneurship	ME	3	0	0		3	50	50	100	3
4.	PEC	SECEXX	**Professional Elective Course - III**	ECE	3	0	0		3	50	50	100	3
5.	OEC	SOEXX	Open Elective Course-II	ECE	3	0	0		3	50	50	100	3
6.	PROJ	S7ECP	Major Project Phase II	ECE	0	0	14		3	100	100	200	7
			Total							**350**	**350**	**700**	**24**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **IPCC**: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course;
OEC: Open Elective Course; **PROJ:** Project Phase –II;
L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation,
SEE: Semester End Evaluation.

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics and Communication Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2025-26)

VIII Semester (Swappable VII and VIII Semester)

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PEC	SECEXX	Professional Elective (Online Courses)	--	3	0	0		3	50	50	100	3
2.	OEC	SOEXX	Open Elective (Online Courses)	--	0	2	0		3	50	50	100	3
3.	INT	INT	Internship (Industry/Research) (14-20 weeks)	--	0	0	12		3	100	100	200	10
			Total							200	200	400	16
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: PEC: Professional Elective Course; OEC: Open Elective Course (Online); INT: Industry Internship / Research Internship / Rural Internship
L: Lecture, T: Tutorial, P: Practical S= SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Professional Elective (Online Courses – suggested by BoS, NPTEL)

Open Elective (Online Courses – suggested by BoS, NPTEL)

Note: VII and VIII semesters of IV years of the program

1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester.
2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC)			
Communication and Networking			
1	Optical Fiber Communication	10	Edge and Cloud Computing
2	Advanced Multimedia	11	Modeling & Data Networks
3	Satellite Communication	12	Software Defined Networks
4	RF & Microwave Circuit Design	13	Adhoc Wireless Networks
5	Error Control Coding	14	Wireless Sensor Networks
6	Advanced Wireless Communication	15	Radar Systems for Autonomous Driving
7	MIMO wireless Communication	16	Introduction to Quantum Information and Computing
8	Computational Electromagnetics		
9	Optical Networks		

Signal Processing			
17	Advanced Signal Processing	23	Medical Image Processing
18	Digital Image Processing	24	Data Science
19	Speech Processing	25	Deep Learning
20	DSP Algorithms & Architecture	26	Machine Learning
21	Wavelet Transforms	27	Computer Vision
22	Artificial Neural Networks		

Microelectronics			
28	Low Power VLSI Design	32	Smart materials and Smart systems
29	Analog and Mixed Mode VLSI design	33	Compound semiconductor devices and applications
30	ASIC Design	34	System Verilog
31	VLSI Testing and Verification		

Embedded Systems			
35	System Programming & Operating System	40	Real Time Systems
36	Advanced Computer Architecture	41	Embedded System Design
37	Parallel Processing & Distributed Systems	42	System on Chip
38	Sensors for Biomedical applications	43	Automotive Electronics
39	Applied Embedded Systems	44	Automotive Embedded Systems

Suggested flow (Stream wise) of Professional Electives

Embedded Systems

Professional Elective - I V sem	**Professional Elective - II VI sem**	**Professional Elective - III VII sem**
System On Chip	Automotive Embedded system	Parallel processing & Distributed system
Advanced Computer Architecture	Applied Embedded System	Real Time System
Automotive Electronics	System programming and Operating System	
Embedded System design	Sensors for Biomedical Applications	

Communication

Professional Elective - I V sem	**Professional Elective – II VI sem**	**Professional Elective - III VII sem**
Optical Fiber Communication	Advanced Multimedia	Error Control Coding
Satellite Communication	RF & Microwave Circuit Design	Advanced Wireless Communication
Linear Algebra and its Application	Radar for Autonomous Applications	Modern Wireless Standards
Computational Electromagnetics	--------------------------------	MIMO Wireless Communication

Networking

Professional Elective - I V sem	Professional Elective – II VI sem	Professional Elective - III VII sem
Optical Networks	Edge and Cloud Computing	Software Defined Networks
	Modeling & Data Network	Adhoc Wireless Sensor Networks
		Wireless Sensor Networks

Signal Processing

Professional Elective - I V	Professional Elective - II VI	Professional Elective - III VII
Digital Image Processing	DSP Algorithms and Architecture	Wavelet Transforms
Speech Processing	Medical Image Processing	Data Science
Machine Learning	Artificial Neural Networks	Computer Vision
	Deep Learning	
	Advanced Signal Processing	

Microelectronics

Professional Elective - I V	Professional Elective - II VI	Professional Elective - III VII
System Verilog	VLSI Testing and verification	Analog and mixed mode VLSI Design
Compound semiconductors and devices	Smart materials and smart systems	Low power VLSI Design
	ASIC design	

V SEM SYLLABUS

IOT AND NETWORK TECHNOLOGY

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	:S5EC01	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Build an understanding of the fundamental concepts of computer networking.
2.	Describe the data communication aspects in computer networks.
3.	Discuss protocols related to data link layer and network layer
4.	Understand and build IoT framework using Raspberry Pi.

UNIT I

Introduction: OSI model, TCP/IP model, comparison.

Physical layer: Topology, Line configuration or Type of Connection, Data flow, Manchester encoding, Synchronous and asynchronous TDM.

Data link layer: Flow control protocols: stop and wait, sliding window (go back n and selective repeat).

9 Hours

UNIT II

Data Link Control: HDLC – Types of frames, Information frame.

Multiple access protocols: Random access protocols - Slotted ALOHA, CSMA/CD, CSMA/CA. Controlled access protocols - Reservation, Polling, Token passing.

8 Hours

UNIT III

Network Layer: Logical addressing: Ipv4 addresses, Ipv6 addresses, Internet Protocol: Ipv4 and IPv6 header format, Transition from Ipv4 to Ipv6.

Routing Algorithms: Dynamic routing algorithms - Distance Vector Routing, Link State Routing.

8 Hours

UNIT IV
Wired LAN: Ethernet, IEEE standards, Standard Ethernet, IEEE 802.3 **Wireless LAN**: IEEE 802.11, Bluetooth, Connecting LANs, Backbone networks and virtual LANs. **Internet of Things**: Introduction, Definition & Characteristics of IoT, Physical design of IoT, Logical design of IoT.
8 Hours
UNIT V
IoT enabling Technology: WSN, cloud computing, communication protocols, AI for Network Management, IoT levels and deployment templates. **IoT Physical device and Endpoints**: Introduction to Raspberry Pi, board architecture, OS on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with python.
9 Hours

TEXT BOOKS		
1	Behrouz A Forouzan	Data Communications and Networking, McGraw Hill, 5th Edition, 2012.
2	Arshdeep Bahga, Vijay Madisetti	Internet of Things- a Hands on Approach, VPT, 1st edition, 2014.

REFERENCE BOOKS		
1	William Stallings	Data and Computer Communication, Pearson Education PHI, 8th Edition, 2011.
2	Andrew S Tanenbaum	Computer Networks, Pearson Education PHI, 5th Edition, 2011.

E-RESOURCES	
1	https://onlinecourses.nptel.ac.in/noc22_cs19
2	https://nptel.ac.in/courses/106105081
3	https://onlinecourses.nptel.ac.in/noc22_cs53
4	https://www.juniper.net/us/en/research-topics/what-is-ai-for-networking.html
5	https://www.cisco.com/c/en/us/solutions/artificial-intelligence/artificial-intelligence-machine-learning-in-networking.html

Course Outcomes:

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

CO1	Describe OSI reference model, TCP/IP suite and analyze framing and flow control techniques
CO2	Evaluate multiple access protocols and internet protocols
CO3	Analyze routing algorithms and evaluate the network performance
CO4	Compare frame formats of IEEE standards for wired and wireless LANs
CO5	Apply the knowledge of computer network onto IoT paradigm and analyze IoT physical devices.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	3			2							1	
	CO2	3	2			1			1					1
	CO3	3	2	1		1			2					1
	CO4	3	2											
	CO5	3	2	1		1			2					1

DIGITAL SIGNAL PROCESSING

Contact Hours/ Week:	: 3+0+2	Credits:	4
Total Lecture Hours:	: 42	CIE Marks:	50
Total Practical Hours:	: 28	SEE Marks:	50
Sub. Code:	: S5ECI01		

Course objectives:

This course will enable students to:

1. Represent and analyze information from analog world to digital domain.
2. Discuss algorithms to reduce computations involved in converting the signal from time to frequency domain and vice-versa.
3. Prepare the students to design and realize digital filters for applications in real world.

UNIT I

Introduction to Digital Signal Processing: Basic elements of a Digital Signal Processing system, Concept of frequency in continuous time and discrete-time domain Importance of Sampling (Section 1.4), Frequency ranges of natural signals.

Discrete Fourier Transform: Introduction, Fourier representations of finite- duration sequences, Properties of DFT, Linear convolution using DFT, Computation of Circular convolution, Spectral analysis using DFT.

Efficient Computation of DFT – Fast Fourier Transform Algorithms.

9 Hours

UNIT II

Frequency Domain Analysis of LTI Systems: Frequency Response of a system with a rational system function, Computation of frequency response function, Ideal Filter Characteristics, Lowpass, Highpass, and Band pass filters, Digital Resonators, Notch Filters, Comb Filters, All pass filters, Digital sinusoidal oscillators, Invertibility of linear tine invariant systems, Minimum-phase, maximum phase and mixed phase system, System identification and de-convolution.

8 Hours

UNIT III
Design and Realization of FIR Filters: Issues in filter design, importance of linear phase, Frequency response of linear phase FIR filters, Locations of zeros of FIR filters, Design techniques of FIR filters- Windowing method and Frequency sampling method. **Applications of FIR filters:** Design of Hilbert transformer and Ideal differentiators.
8 Hours
UNIT IV
Design of IIR filters: Elementary properties of IIR filters, Techniques for determining IIR filter coefficients, Frequency transformations in analog domain. Digital filter design from continuous time filters- Impulse invariant technique and Bilinear transformation methods. Comparison of FIR and IIR filters. (Butterworth and Chebyshev Filter tables can be used)
8 Hours

UNIT V		
Basic structures for FIR systems: Direct, Cascade, Linear Phase and Frequency sampling structures. Basic structures for IIR systems: Direct, Cascade, and Parallel structures. **Applications:** Filtering of long sequences: Overlap-save method and overlap-add method, DCT for Image Compression, DTMF Generation and Detection, Musical sound processing: Single echo and multiple echo filters.		
9 Hours		
TEXT BOOKS		
1	J. G. Proakis and D. G.Manolakis	Digital Signal Processing: Principles, Algorithms and Applications, PHI, 2022.
2	Alan V Oppenheim and Ronald W. Schafer	Discrete-Time Signal Processing, PHI, 3/E, 2014.

REFERENCE BOOKS		
1	S. Sanjit K. Mitra	Digital Signal Processing: A computer-Based Approach. TMH. 4/E, 2013.
2	Lonnie C. Ludeman	Fundamentals of digital signal processing, John Wiley &Sons, 2009.

E-RESOURCES	
1	https://ocw.mit.edu/courses/res-6-008-digital-signal-processing-spring- 2011/video_galleries/video-lectures/, Prof. Alan Oppeinheim, MIT
2	https://nptel.ac.in/courses/117102060, Prof. S C DuttaRoy, IIT Delhi

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Represent and process information in digital domain as a function of time or frequency.
CO2	Characterize discrete time LTI systems in the frequency domain.
CO3	Design a digital FIR filter for a given specification.
CO4	Design a digital IIR filter for a given specification.
CO5	Implement discrete time systems and basic signal processing algorithms for applications in Communication and Signal Processing.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1			2			2	2		2	2	2
	CO2	3	1			2			2	2		2	2	2
	CO3	3	2	2		2			2	2		2	2	2
	CO4	3	2	2		2			2	2		2	2	2
	CO5	3		3		2			2	2		2	3	2

Integrated Lab:

Experiments using Python/Matlab

1. Spectral Analysis using Discrete Fourier Transform
2. Linear Filtering using Discrete Fourier Transform
3. Design of LTI systems by placing poles and zeros
4. Design of FIR Filters and verifications
5. Design of IIR Filters and verification
6. Design of graphic equalizer
7. DTMF Generation and Detection
8. Echo Generation

COMMUNICATION SYSTEMS–II

Contact Hours/ Week:	: 3+0+2	Credits:	4
Total Lecture Hours:	: 42	CIE Marks:	50
Total Practical Hours:	: 28	SEE Marks:	50
Sub. Code:	: S5ECI02		

Course objectives:

This course will enable students to:

1.	Analyze the Microwave Passive Devices such as Magic Tee, Circulator, and Directional Coupler using S- parameters.
2.	Design of various filters using Butterworth, Stepped impedance and Kuroda’s identity using microstrip technology.
3.	Interpret the working of microwave passive devices and demonstrate their applications.
4.	Estimate various antenna parameters for an isotropic radiator and an isotropic antenna array.

UNIT I

Microwave Passive Devices: Introduction to Microwave Spectrum and Bands, Applications of microwaves; S matrix representation of Two-port & multi-port network, S-parameter properties (No proof); Magic TEE, Circulator, Directional Coupler - Derivation of S-matrix, Problems.

8 Hours

UNIT II

Planar Transmission Lines: Microstrip line (geometry, design equations), Strip line, coplanar waveguide, Slot lines - geometry only.

Microwave Filters: Design of Low Pass Filter using Butterworth filter, Stepped impedance and Kuroda’s identity method.

9 Hours

UNIT III
Power Dividers: Wilkinson Power Divider, 90^0 Branch Line Coupler and 180^0 Hybrid Coupler. Solve Basic Transmission line problems and Single stub matching using Smith Chart. **Antenna Basics:** Physical concept of radiation**,** Antenna Radiation Equation and Radiation; Basic antenna parameters: Radiation patterns, Beam area, Radiation intensity, Beam efficiency, Directivity, Gain, Aperture, Effective height, Radio communication link - FRIIS Transmission Formula, Antenna field zones, Polarization.
9 Hours

UNIT IV
Antenna arrays: Introduction, Types of Arrays, Array of n–isotropic point sources of equal amplitude and spacing, Null directions (broadside case, End-fire case), and Directivity, Examples on sketching radiation pattern, Principle of Pattern Multiplication (Qualitative).
8 Hours
UNIT V
Application Specific Antennas: Microstrip Patch Antenna, Horn Antenna, Helical Antenna, Embedded Antenna, Antennas for ground penetrating radar (GPR), Embedded antennas; **Introduction to Smart Antennas:** Need for smart antennas, overview, smart antenna configurations, architecture of smart antenna system, benefits, drawbacks, basic principles.
8 Hours

TEXT BOOKS		
1	David M Pozar	Microwave Engineering, 3rd Edition, John Wiley & Sons, 2005.
2	John D Kraus, Ronald J Marhefka, Ahmad S. Khan	Antennas and Propagation, 5th edition, Mc Graw Hill, 2017.

REFERENCE BOOKS		
1	Matthew N. O. Sadiku and S.V. Kulkarni	Principles of Electromagnetics, Oxford University Press, 6^{th} Edition, 2015.
2	Constantine A. Balanis	Antenna Theory- Analysis & Design, 4^{th} edition, John Wiley & Sons, 2016.

E-RESOURCES	
1	https://nptel.ac.in/courses/108101112
2	http://acl.digimat.in/nptel/courses/video/108105114/L22.html
3	https://www.youtube.com/results?search_query=all+about+electronics

Course Outcomes:

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

CO1	Demonstrate the working of Microwave passive devices by analyzing S-Matrix
CO2	Design and Analyze Micro Strip Lines and Microwave Filters
CO3	Design Power Divider Circuits using EDA tools
CO4	Interpret the radiation pattern for array of antennas and deduce the Directivity of the array
CO5	Design and analyze different application specific antennas
CO6	Design and simulate antennas for various communication applications using MATLAB/SCILAB

Integrated Lab:

List of Experiments:

1. Design and Simulation of Low Pass Filter using Stepped Impedance Method
2. Design and Simulation of Low Pass Filter using Kuroda's identity
3. Design and Simulation of 90^0 Branch Line Coupler
4. Design and Simulation of 180^0 Hybrid Coupler

5. Design and Simulation of Wilkinson Power Divider for Equal and Unequal Power Division
6. Radiation pattern for Half wave Dipole antenna
7. Radiation pattern for isotropic antenna array
8. Design of microstrip patch antenna for Wi-Fi and cellular communication
9. Design of helical antenna for monofilar axial mode of operation
10. Design and analysis of rectangular horn antenna
11. Design and analysis of smart antennas

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2			1			1			1	2	1
	CO2	2	2			1			1			1	2	1
	CO3	2	2			1			1			1	2	1
	CO4	2	2			1			1			1	2	1
	CO5	2	2			1			1			1	2	1
	CO6	2	2			1			1			1	2	1
	AVG	2	2			1			1			1	2	1

IOT AND NETWORK TECHNOLOGY LAB

Contact Hours/ Week:	: 0+0+2	Credits:	1
Total Practical Hours:	: 28	CIE Marks:	50
Sub. Code:	: S5ECL01	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Implement the Error correction and detection techniques of Data link layer using C programming.
2.	Implement the routing protocols of network layer using C programming.
3.	Setup and simulate the wired and wireless LAN scenarios using network simulator.
4.	Integrate the Raspberry Pi controller to Internet of Things (IoT) for sensor data acquisition.

PART A (using C language)

1. Develop a program to perform byte stuffing and bit stuffing for a given data.
2. Develop a program to find the transmitted data with CRC code for the given bit stream and generator polynomial.
3. Develop a program for detecting an error in the received data using CRC for the given generator polynomial.
4. Develop a program to implement a link state routing algorithm for a given network graph and build a routing table for the given node.
5. Develop a program to encrypt and decrypt the given message by substitution method
6. Develop a program to encrypt and decrypt the given message by transposition method

PART B (using NS-2 simulator)

1. Simulate an Ethernet LAN using N nodes, change error rate and data rate and compare throughput.
2. Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and determine collisions across different nodes.

Part C: IoT for sensors data acquisition using IoT Evaluation board

1. Develop a program on Raspberry pi to upload temperature and humidity data to thingspeak cloud.
2. Develop a program on Raspberry pi to publish temperature data to MQTT broker.
3. Develop a program on Raspberry pi to subscribe to MQTT broker for temperature data and print it.
4. Develop a program to create TCP server on Raspberry pi and respond with humidity data to TCP client when requested.

Part D: Open- ended experiments:

1. Develop a program on Raspberry pi to retrieve temperature and humidity data from thingspeak cloud.
2. Develop a program to create UDP server on Raspberry pi and respond with humidity data to UDP client when requested.
3. Simulate a simple BSS with transmitting nodes in wireless LAN by simulation and determine the performance with respect to transmission of packets.
4. Develop a Node-RED application that collects data from an IoT device, processes it, and takes an action based on the processed data over the given scenario

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of engineering fundamentals to design an algorithm for a given problem on computer networking
CO2	Create, implement and test the algorithms for network protocols using C Programming.
CO3	Simulate and evaluate wired and wireless LAN using Network simulator.
CO4	Integrate sensors with the Raspberry Pi controller to IoT using various IoT Protocols.
CO5	Demonstrate the ability to provide efficient solutions for complex engineering problems in the area of embedded systems individually.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	3							1			1	
	CO2	3	3			2			1	1			1	1
	CO3	3	3			2			1	1			1	1
	CO4	3	2			2			1	1			1	1
	CO5	3	2	1		2			2	1			1	1

RESEARCH METHODOLOGY AND IPR

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SHS04	SEE Marks:	50

Unit-I
RESEARCH METHODOLOGY: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations- Criteria of good research. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.
8-Hours
Unit-II
LITERATURE SURVEY AND DATA COLLECTION: Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Effective literature studies approaches, analysis, plagiarism, and research ethics. Data - Preparing, Exploring, examining anddisplaying. Referencing methods
8-Hours
Unit-III
RESEARCH DESIGN AND ANALYSIS: Meaning of research design - Need of research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes. Overview of Univariate/Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.
9-Hours

Unit-IV
INTELLECTUAL PROPERTY RIGHTS (IPR): Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Role of WIPO and WTO ni IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.
8-Hours
Unit-V
PATENT RIGHTS (PR): Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. Licenses, Licensing of related patents, patent agents, Registration of patent agents.
9-Hours

Text Books:		
1.	Prof. Kothari C. R.	"Research methodology: Methods and techniques", New Age International, 5th Edition, 2023. ISBN-13: 978-9389802559
2.	R. Ganesan	"Research Methodology for Engineers", MJP Publishers, Chennai, 2011.

Reference Books:		
1.	Cooper Donald R, Schindler Pamela Sand Sharma JK	"Business Research Methods", Tata McGraw HillEducation, 11th Edition, 2012.
2.	Catherine J. Holland	"Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3.	David Hunt, LongNguyen, Matthew Rodgers	"Patent searching: tools &techniques", Wiley, 2007.
4.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament	"Professional Programme Intellectual Property Rights,Law and practice", September 2013.

5.	Peter S. Menel Mark A. Lemley, Robert P.Merges	"Intellectual Property in the New Technological-Vol. IPerspectives, 2021.
6.	Laura R. Ford	"The Intellectual Property of Nations: Sociological and Historical Perspectives on a Modern Legal Institution Paperback -2021.

Course Outcomes: Upon completion of this course the student will be able to:		
CO1	:	Describe the research process & formulate research problem
CO2	:	Perform literature review, manage data & practice research ethics
CO3	:	Practice basic principles of experimental design, use standard codesand carry out research analysis
CO4	:	Distinguish between types of innovation, describe patenting procedure,maintenance and role of IPR establishments
CO5	:	Identify the significance of patent rights, licensing, technology transfer& manage patenting system

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4
CO1		3	2								2				
CO2		3	2				3				2				
CO3		3	3								2				
CO4		3	2								2				
CO5		3	2								2				

ENVIRONMENTAL STUDIES

Contact Hours/ Week:	: 2-0-0	Credits:	2
Total Lecture Hours:	: 28	CIE Marks:	50
Sub. Code:	: SHS05	SEE Marks:	50

COURSE OBJECTIVES:

This course will enable students to:

1	Problems of depletion of natural resources due to deforestation, agricultural practices, and adverse environmental effects, pesticides, soil erosion, mining.
2	Different types of energy- renewable, non-renewable and energy conservation, impact of environmental pollution on water quality, air quality, soil pollution and noise pollution.
3	Solid waste management- disposal, treatment of different types of solid waste including MSW, e- waste, biomedical waste, societal impact of environmental issues- ozone layer depletion, GHG effects, water conservation and harvesting and environmental protection & acts

UNIT I

Introduction:

- Components of Environment and their interactions
- Ecology, Ecosystem
  and types Natural
  Resources:
- Forest Resources-Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions
- Water resources, World's water reserves, Hydrological cycle
- Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types
- Numerical problems on rainfall & runoff

6 Hours

UNIT II

Energy and resources:

- Types of Energy-Renewable, Non renewable & sustainable energy & their advantages and disadvantages
- Renewable energy sources- Solar energy, Wind energy, Tidal energy, Ocean thermal energy. Geothermal energy, Hydroelectric power, Biomass energy, Hydrogen energy, Thermal power- environmental impacts
- Conservation of energy
- Numerical problems on Solar energy, Wind power

6 Hours

UNIT III

Environmental pollution: • Sources of pollution- Natural and anthropogenic sources • Pollutants - Classification & their effects on environment • Air Pollution -Composition of clean air, Sources of air pollution, Effect of air pollution on human health and climate • Water quality – Potable water, Wholesome water, Sources of water pollution Polluted water & Contaminated water• Common impurities in water(physical, chemical and bacteriological), Effects of impurities on human health • Soil Pollution – Sources, effects, and its control.

Noise pollution- Sources of noise, Effects on human health & its control

Numerical problems on pH, hardness of water, noise pollution.

6 Hours

UNIT IV

Solid Waste Management

- Refuse, Garbage, Rubbish, Ash, types of solid waste
- Necessity of safe disposal, Impacts on human health and environment
- Classification of solid wastes- Quantity and composition of MSW, Collection of solid waste- methods

- Disposal of solid waste-Sanitary land-fill
- E-waste- Problems and solutions
- Biomedical waste-Impacts on human health, storage, treatment methods and disposal
- Numerical problems on moisture content, density & proportioning of land fill

5 Hours

UNIT V

Sustainable development:

- Issues on energy utilization, water conservation, concept of 3 R's, Rain water harvesting- methods.
- Global environmental issues: Population growth, Urbanization, Global warming, Acid rains, Ozone layer depletion & controlling measures.
- Environmental acts, Regulations, Role of state & central governments.
- Numerical problem on carbon foot print & rainwater harvesting.

5 Hours

TEXT BOOKS:

1	Joseph, B	Environmental Studies (2009), India: Tata McGraw-Hill. ISBN: 9781283922524.
2	Tripathi, A. K	Environmental Studies(2016), India: Energy and Resources Institute. ISBN:9788179935828.

REFERENCES:

1	Erach Bharucha	Environmental studies for Undergraduate Courses, 1st Edition, University Press, (2013).
2	Santhosh Kumar Garg	Environmental Science and Engineering Ecology and Environmental Studies, Khanna Publishers, (2015), ISBN-10 : 8174092188 ISBN-13 : 978-8174092182.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Describe the importance of forestation, effects of deforestation, land degradation, adverse effects of mining on environment, using the principles of natural sciences compute the runoff from rainfall & estimates the conservation of water for beneficial use of humans.
CO2	Describe the Renewable sources of energy and formulate, review literature, calculate power potential of solar & wind energy by using the principles of natural sciences.
CO3	Describe the effects of pollution of air, water, soil & noise on humans and environment, identify & analyze the pollution problems related to air, water, soil & noise and quantify pollution levels & draw valid inferences using the principles of engineering sciences
CO4	Describe Impact of solid waste on human health and environment, its safe disposal. Use population data & compute percapita solid waste generation, land area requirement for sanitary landfill
CO5	Describe the sustainable development, its importance, current global environmental issues, Present state & central governments protection acts, compute carbon foot print using data(vehicles/industries) & asses its impact on environment.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO2	PSO3	PSO 4
CO1						2									
CO2						2									
CO3						2									
CO4						2									
CO5						2									

VI SEM SYLLABUS
COMMUNICATION SYSTEMS-III

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: S6EC01	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Learn the cellular concept and traffic theory.
2.	Understand challenges in wireless communication and fading in wireless channel.
3.	Learn source encoding and decoding techniques.
4.	Learn channel encoding and decoding techniques.

UNIT I

Introduction to 3G/4G/5G Wireless Communication: Introduction, 2G, 3G, 4G, 5G wireless standards, Overview of cellular communication

The Cellular Concept - System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems.

8 Hours

UNIT II

Wireless Channel: The wireless communication environment, Modelling of wireless channel, System model for narrowband signals, Rayleigh fading wireless channel, BER performance of wireless systems for various modulations, Intuition for BER in a fading channel, Channel estimation in wireless systems. Diversity in Wireless Communications: Multiple Receive Antenna system model, Symbol detection in multiple antenna systems, Diversity Order, Coherence bandwidth in wireless communications,

Relation between ISI and coherence bandwidth, Doppler fading in wireless systems, Doppler impact on a wireless channel, Coherence time of the wireless channel.
9 Hours

UNIT III
Code Division Multiple Access (CDMA): Introduction to CDMA, Basic CDMA mechanism, Spreading codes based on pseudo-noise sequences. **Orthogonal Frequency Division Multiplexing (OFDM):** Introduction to OFDM, Subcarrier concept, OFDM signal generation, IFFT/FFT operations in OFDM, Addition of cyclic prefix, End-to-End system model for OFDM. **Multiple-Input Multiple-Output (MIMO):** Introduction to MIMO, MIMO system.
8 Hours
UNIT IV
Fundamental Limits on Performance: Uncertainty, Information and Entropy, Source Coding Theorem, Huffman Coding, Discrete memory less Channels, Mutual Information, Channel Capacity, Channel Coding Theorem, Channel Capacity Theorem.
8 Hours

UNIT V
Error Control Coding: Types of Codes, Linear Block Codes, Cyclic Codes – Generator polynomial, Parity Check Polynomial, Encoding, Syndrome Calculation, Algebraic Structure, Convolution Coding, Convolution encoder in time and transform domain, Viterbi decoding.
9 Hours

TEXT BOOKS		
1	Aditya K agannatham	Principles of Modern Wireless Communication Systems, Mc. Graw-Hill Education (India), 2019.
2	Simon Haykin	"Digital Communications", John Wiley, 2017.

REFERENCE BOOKS		
1	Andreas, F. Molisch	Wireless Communications, John Wiley & Sons, 2012,
2	Theodore S. Rappaport	Wireless Communications-Principles and Practice, 2e, Pearson Education, 2002.
3	Shu Lin and Daniel JCostello	"Error Control Coding", Pearson Education Ltd., 2011.

E-RESOURCES	
1	https://nptel.ac.in/courses/117104115

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply cellular concepts and traffic theory to evaluate the signal reception performance in a cellular network
CO2	Characterize a wireless channel using different models and compare the performances
CO3	Analyse 3G (CDMA). 4G (OFDM) and 5G (MIMO) technologies used in wireless communication systems
CO4	Analyze the information characteristics of a discrete source and channels.
CO5	Apply different error control coding and decoding techniques to design and develop a communication channel.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2						2	2			2	2
	CO2	3	2			1			2	2			2	2
	CO3	3	2						2	2			2	2
	CO4	3	2						2	2			2	2
	CO5	3	2			1			2	2			2	2

DIGITAL VLSI DESIGN

Contact Hours/ Week:	: 3+0+2	Credits:	4
Total Lecture Hours:	: 42	CIE Marks:	50
Total Practical Hours:	: 28	SEE Marks:	50
Sub. Code:	: S6ECI01		

Course objectives:

This course will enable students to:

1.	Analyze the impact of fabrication technologies: Methods for optimizing the area, speed, and power of circuit layouts.
2.	Design and implement MOS combinational circuit.
3.	Design and implement sequential MOS system by considering specifications.
4.	Analyze the impact of RC effect in post simulation.

UNIT I

VLSI Design Flow:

Design Specification, Design Entry, Functional Simulation, Planning Placement and Routing. MOSFET I-V characteristics, Current equation, C-V characteristics, Simple capacitance model.

Combinational Circuit Design

CMOS Inverter, CMOS Logic circuits, NAND Gate, NOR Gate, Compound Gates(full adder, parallel adder), Pass Transistors and Transmission Gates, Tristate buffer, Multiplexers.

DC Transfer Characteristic:

CMOS Inverter DC Characteristics, Beta Ratio Effect, Noise Margin, Pass Transistor Characteristics, NAND and NOR DC characteristics.

9 Hours

UNIT II
CMOS Processing Technology: Introduction, CMOS Technologies: Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide, Isolation, Gate Oxide, Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Metrology. **Layout Design Rules:** Well rules, transistor rules, contact rules, metal rules, via rules, other rules. **Layout design**: CMOS Inverter, Complex logic gates by using Euler graph. CMOS process enhancement: FINFETs, Gate all around FETs.
8 Hours
UNIT III
Circuit characterization and performance estimation: Introduction, delay estimation: Switch level RC delay models, linear delay model, logical effort, parasitic delay. Logical effort and transistor sizing: delay in a logic gate, delay in multistage logic networks, choosing the best number of stages.
8 Hours
UNIT IV
Circuit Families: Static CMOS, Ratioed Circuits: Pseudo nMOS, Tristate circuits, Dynamic Circuits: Domino Logic, Dual rail logic networks: Cascode Voltage Switch Logic and Complementary Pass-Transistor Circuits. BiCMOS logic circuits: Basic BiCMOS circuit, static behavior, switching delay in BiCMOS logic circuits, BiCMOS applications.
8 Hours

UNIT V
Sequential MOS Logic Circuits: Behavior of Bistable element, SR Latch Circuit, Clocked latch and Flip Flop Circuits, CMOS D-Latch and Edge Triggered Flip-Flop. Sequencing static circuits: Sequencing methods, Max-delay constraints, Min-delay constraints, time borrowing, clock skew, characterizing sequencing element delays. **Semiconductor memories:** Introduction, dynamic random access memory, static random access memory.
9 Hours

TEXT BOOKS		
1	Neil H.E. Weste, David Money Harris	CMOS VLSI Design: A Circuits and Systems Perspective, Pearson, 4th Edition, 2017.
2	Sung MO Kang, Yusuf Leblebici, Chulwoo Kim	CMOS Digital Integrated Circuits: Analysis and Design, Tata McGraw Hill, 4th Edition, 2014.
REFERENCE BOOKS		
1	Douglas A. Pucknell & Kamran Eshraghian	Basic VLSI Design, PHI, 3rd Edition, 2005.
2	John P. Uyemura	Introduction to VLSI Circuits and Systems, John Wiley, 2002.
3	Neil H.E. Weste, Kamran Eshraghian	Principles of CMOS VLSI Design: A Systems Perspective, Addison Wesley, 2nd Edition, 1993.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze transient and DC characteristics of CMOS circuits.
CO2	Describe the various processing steps for an integrated circuits and apply λ -based design rules to construct optimized layout.
CO3	Estimate the delay in CMOS circuits.
CO4	Design and compare advanced MOS circuit families.
CO5	Design and analyze various sequential MOS circuits, sequencing circuits, and memory.
CO6	Demonstrate capability of self-learning, team work and communication skills.

Course Articulation Matrix

		POs											PSOs	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	2			2			1	1		1	2	1
	CO2	3	2			2			1	1		1	2	1
	CO3	3	2			2			1	1		1	2	1
	CO4	2	2										2	
	CO5	3	1			2			1	1		1	2	1
	CO6	3	2			2			1	1		1	2	1

Integrated Lab

List of Experiments (Using Cadence Tool) :

1) Transient analysis of CMOS Logic circuit for the given Boolean expressions
2) Transient analysis of Boolean expressions using pass transistor logic
3) Transient analysis of transmission gates, designing of multiplexer using transmission gates and Logical unit using Multiplexer
4) Design of Master slave D – flip flop and T – Flip Flop using CMOS logic and to verify its transient analysis and design of 4-bit asynchronous Counter using D-flip flop.

5) (i)CMOS full adder design using minimum number of transistors and to verify its transient analysis.

   (ii) Design of Parallel adder using CMOS full adder
6) (i)Transient and DC Analysis of CMOS Inverter for the given specifications and parametric analysis

   (ii) layout design of CMOS inverter and post simulation
7) Transient and DC Analysis of CMOS NAND2 for the given specifications and layout design and post simulation
8) Transient and DC Analysis of CMOS NOR2 for the given specifications and optimized layout design and post simulation

COMMUNICATION SYSTEMS-III LAB

Contact Hours/ Week:	: 0+0+2	Credits:	1
Total Practical Hours:	: 28	CIE Marks:	50
Sub. Code:	: S6ECL01	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Appreciate the theoretical concepts in wireless communication through hands-on experiments using GNU radio software combine with universal software defined peripheral.
2.	Analyze the information characteristics of a discrete source and channels using Matlab/Scilab/Octave.

Experiments using GNU radio:

1. Two tone loop back
2. Generation and detection of ASK and FSK
3. FM Transmitter and Receiver
4. BER analysis for M-ary PSK
5. Eye Diagram plot
6. M-ary PSK Generation with channel model and reception with frequency offset, timing offset and phase recovery
7. Digital Broadcasting of audio and video signals
8. Simulation of Frequency selective fading channel
9. CDMA Transmitter and Receiver

Simulation Experiments using Matlab/Scilab/Octave:

1. Source coding-Huffman Coding
2. Channel Coding- Cyclic Code
3. Channel Coding- Convolutional Code

Open Ended Experiments:

1. Comparison of bit error rates for M-ary FSK, M-ary PSK and M-ary QAM
2. Performance Comparison of AWGN, Flat Fading and Frequency Selective Fading Channel for Wireless Communication System using 4-QPSK.

Course Outcomes:

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

CO1	Analyse and demonstrate various advanced modulation techniques for given specifications and interpret the results.
CO2	Design and demonstrate FM transmitter and FM receiver.
CO3	Analyse, design and verify the performance of quadrature and M-ary PSK modulation techniques with channel model and signal recovery.
CO4	Analyse different error control coding and decoding techniques to design and develop a communication channel.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2	1		3			1	2			2	2
	CO2	3	2	1		3			1	2			2	2
	CO3	3	2	1		3			1	2			2	2
	CO4	3	2	1		3			1	2			2	2
	CO5	3	2	1		3			1	2			2	2

PROFESSIONAL ELECTIVE COURSES (PEC)

I. COMMUNICATION AND NETWORKING:

OPTICAL FIBER COMMUNICATION

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE01	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand basics of optical communication system
2.	Understand the propagation of light through optical fiber waveguide and the losses that occur in the optical fiber
3.	Acquire knowledge on the engineering problems of optical communication like receiver characteristics, optical links and multiplexing techniques using WDM concepts.

UNIT I

OVERVIEW OF OPTICAL FIBER COMMUNICATION: Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber, single mode fiber, cutoff wave length, Mode- field diameter.

8 Hours

UNIT II

TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra model dispersion, Inter model dispersion.

8 Hours

UNIT III
OPTICAL SOURCES AND DETECTORS: Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Response time, double hetero structure Photo diodes, comparison of photo detectors. **OPTICAL RECEIVER:** Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver, operation, Analog receivers.
8 Hours

UNIT IV
ANALOG AND DIGITAL LINKS: Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links, microwave photonics. **Digital links** – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band and transmission distance for single mode fibers, Power penalties, Modal noise and chirping.
9 Hours
UNIT V
WDM CONCEPTS AND COMPONENTS: WDM concepts, overview of WDM operation principles, WDM standards, multiplexer, Isolators and circulators, dielectric thin film filters, active optical components, MEMS technology, variable optical attenuators, tunable optical filters, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion compensators, tunable light sources.
9 Hours

TEXT BOOKS		
1	John M. Senior	**Optical Fiber Communication,** Pearson Education, 3rdEdition, 2009.
2	Gerd Keiser	**Optical Fiber Communications,** Tata Mc-Graw Hill, 5th Edition, 2017..

REFERENCE BOOKS		
1	Joseph C Palais	**Fiber Optic Communication,** Pearson Education, 5th Edition, 2004.
E-RESOURES		
1	https://nptel.ac.in/courses/108106167	
2	https://www.youtube.com/watch?v=-ap00IUJm7k&list=PLFW6lRTa1g83YaqmM9r2MAAiJVY93bOP7	

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the basic parameters of optical fiber
CO2	Explain the channel impairments like losses and dispersion
CO3	Describe the principles of optical sources and detectors
CO4	Compare the characteristics of optical fiber receivers
CO5	Analyze Analog links, Digital links and WDM concepts

Course Articulation Matrix

PO CO⇩	POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2										2	
	CO2	2	2										2	
	CO3	2	2									⇨	2	
	CO4	2	2										2	
	CO5	2	2						2	2			2	2
AVG		2	2						2	2			2	2

ADVANCED MULTIMEDIA

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE02	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Provide basic concepts and techniques of multimedia systems
2.	Understand and compare various compression algorithms

UNIT I

Introduction to Data compression: why compression? The data compression problem. **Lossless compression Algorithms:** Introduction, Measuring information, Information channel, Coding Redundancy, Run-Length Coding, Variable –Length Coding- Shannon-Fano Algorithm, Huffman coding, Adaptive Huffman coding, Dictionary –Based Coding, Arithmetic Coding, Lossless Image Compression – Differential Coding of Images, Lossless JPEG.

9 Hours

UNIT II

Lossy compression Algorithms: Distortion measures, The rate distortion theory, Quantization – Uniform Scalar and Nonuniform Quantization, Transform Coding – discrete Cosine Transform(DCT), Karhunen- Loeve Transform, Wavelet-Based Coding, Embedded Zerotree of Wavelet Coefficients, Set Partitioning in Hierarchical Trees.

9 Hours

UNIT III

Image Compression Standards: The JPEG Standard, The JPEG2000 Standard –Region of Interest Coding, The JPEG-LS Standard- Prediction, context determination, Residual Coding, Bilevel Image Compression Standards- JBIG Standard.

8 Hours

UNIT IV
Basic Video compression Techniques: Introduction, Video Compression based on Motion Compensation, Search for Motion Vectors – Sequential Search, 2D Logarithmic Search, Hierarchical Search, H.261 – Intra-Frame Coding, Inter-frame Coding, Quantization, Encoder and Decoder,H.261 Video Bitstream, H.263- Motion Compensation.
8 Hours

UNIT V
MPEG Video Coding: MPEG-1 – Motion Compensation, Differences from H.261, Video Bitstream, MPEG-2 – Interlaced Video, Scalabilities, Differences from MPEG-1, Overview of MPEG-4, object based Visual coding in MPEG-4 – VOP-based vs Frame-based Coding, Motion Compensation, Texture coding, Shape coding, Synthetic Object coding in MPEG-4, MPEG-4 Object types, profiles and levels, H.264 – Core features.
8 Hours

TEXT BOOKS		
1	Khalid Sayood	Introduction to Data Compression, Morgan Kaufmann Publishers, Fifth Edition, 2017.
2	Ze-Nian Li and Mark S. Drew	Fundamentals of Multimedia, Pearson Edu. 2004

REFERENCE BOOKS		
1	Jerry D. Gibson, Toby Berger, Tom LOOKABAUGH, Dave Lindbergh and Richard L. Baker	Digital Compression for Multimedia, Morgan Kaufmann Publishers, 2006.

E-RESOURCES:	
1	https://nptel.ac.in/courses/117105083

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply lossless entropy coding for given data.
CO2	Apply lossy compression using different transform techniques.
CO3	Describe image compression technique used in different image compression standards.
CO4	Analyze and compare different search mechanisms for motion vector.
CO5	Describe and compare video compression standards.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2										3	
	CO2	3	2										3	
	CO3	3	2			1				1		1	3	1
	CO4	3	2			1				1		1	3	1
	CO5	3	2			1				1		1	3	1
	AVG	3	2			1				1		1	3	1

SATELLITE COMMUNICATION

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE03	SEE Marks:	50

Course objectives:

This course will enable students to learn:

1.	Orbital parameters necessary for the satellite to be in orbit and to communicate with earth station.
2.	Space and Earth segment and to perform Link budget analysis.
3.	Various multiple access techniques used in satellite communication.

UNIT I

OVER VIEW OF SATELLITE SYSTEMS: Introduction, frequency allocation.

ORBITS: Introduction, Kepler laws, definitions, orbital element, apogee and perigee heights, orbit perturbations, inclined orbits, sidereal time, orbital plane.

8 Hours

UNIT II

Geostationary orbit: Introduction, antenna, look angles, polar mix antenna, limits of visibility, earth eclipse of satellite, sun transit outage, launching orbits.

8 Hours

UNIT III

RADIO WAVE PROPAGATION: Introduction, atmospheric loss, ionospheric effects, rain attenuation, other impairments.

SPACE LINK: Introduction, EIRP, transmission losses, link budget, system noise, CNR, uplink, down link, effects of rain, combined CNR.

8 Hours

UNIT IV
SPACE SEGMENT: Introduction, power supply units, altitude control, station keeping, thermal control, TT&C, transponders, antenna subsystem. **EARTH SEGEMENT:** Introduction, receive only home TV system, outdoor unit, indoor unit, MATV, CATV, Tx – Rx earth station.
9 Hours

UNIT V
INTERFERENCE AND SATELLITE ACCESS: Introduction, interference between satellite circuits, satellite access, single access, preassigned FDMA, SCPC (spade system), TDMA: pre-assigned TDMA, demand assigned TDMA, down link analysis, comparison of uplink power requirements for TDMA & FDMA, on board signal processing satellite switched TDMA.
9 Hours

TEXT BOOKS		
1	Dennis Roddy	Satellite Communications, McGraw Hill education, 4th Edition, 2017.

REFERENCE BOOKS		
1	Timothy Pratt, Charles Bostian, Jeremy Allnutt	Satellite Communications, John Wiley & Sons, 2nd Edition, 2019.
2	W.L. Pitchand, H.L. Suyderhoud, R.A.Nelson	Satellite Communication Systems Engineering, Pearson Education., 2nd Ed., 2007.

E-RESOURCES:	
1	https://www.youtube.com/watch?v=Alt2WNlACd4
2	https://www.youtube.com/watch?v=dt4Ce8gQPns&list=PLAnjLC20C-XQnoowCtt-67WmyxoQPu2Fi
3	https://www.youtube.com/watch?v=Alt2WNlACd4

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the orbital parameters to identify the position of the satellite in an orbit.
CO2	Formulate Azimuth angle, Elevation angle and limits on visibility of a satellite from an earth station
CO3	Design the link power budget and CNR for the space link of a satellite communication system.
CO4	Apply the knowledge of digital communication to understand space and earth segment architectures.
CO5	Identify the use of multiple access techniques in satellite communication.

Course Articulation Matrix

PO ⇨ CO ⇩		**POs**											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	2	2	2									2	
	CO2	2	2	2									2	
	CO3	2	2	2									2	
	CO4	2	2										2	
	CO5	2	2	2						2			2	2
AVG		2	2	2						2			2	2

RF AND MICROWAVE CIRCUIT DESIGN

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE04	SEE Marks:	50

Prerequisites: Courses on Electromagnetic Field Theory and Transmission lines.

UNIT I

Basics of RF and Microwaves: Introduction- Properties of RF and Microwaves**,** reasons for using RF/Microwaves, RF/Microwave applications, low RF and high RF circuit design considerations.

RF Electronics: Introduction to component basics at RF/Microwave: wire, resistors, capacitors, Inductor, definitions- Decibel, Decibel watts, space factor, ripple, bandwidth, Resonance, circuit Q and loaded Q, insertion loss, impedance transformation, coupling of resonant circuits.

9 Hours

UNIT II

Passive Circuit Design: The Smith Chart, Application of the Smith Chart in Distributed and Lumped element circuit applications, Design of Matching networks'- Parameters and Microwave Transistor Definitions and use of S Parameters with passive and active devices - Noise analysis in linear two port networks - Modeling of microwave bipolar transistor - Microwave FET-DC biasing-Impedance matching.

8 Hours

UNIT III

Couplers and Power dividers: Basic properties, Types, Power combining efficiency, Wilkinson Power divider- equal and unequal types, 90° Hybrids, Branch line couplers, N-way combiners, Corporate structures, Spatial combining.

Phase shifters: Types, Transmission line type, Reflection types Phase shifters**.**

8 Hours

UNIT IV
Amplifier Design: Unilateral and non-unilateral design - One stage and multistage design - Low-noise amplifiers - High-power amplifiers - Balanced amplifiers - Feedback - Design examples - Small-signal distributed amplifiers. RF/MW Amplifiers Small Signal Design, Large Signal Design.
8 Hours

UNIT V
Oscillator Design: Resonators – Dielectric resonators – YIG resonators – Varactor resonators – Resonator measurements – Two-port oscillator design – Noise Lesson's oscillator model – Low-noise design, Non-linear oscillator model.
9 Hours

TEXT BOOKS		
1	Matthew. M. Radmanesh	Radio Frequency and Microwave Electronics Illustrated, Pearson Education, Low price edition, 2001.
2	David M. Pozar	Microwave Engineering, John Wiley & Sons, 3rd Edition, 2005.

REFERENCE BOOKS		
1	Reinhold Ludwig and Gene Bogdanov	RF Circuit Design, Theory and Applications, Pearson Education (Asia) Pte. Ltd., 2nd Edition, 2009.
2	Devendra. K. Mishra	Radio Frequency and Microwave Communication Circuits Analysis and Design, John Wiley & Sons, 2001.
3	Chris Bowick	R F Circuit Design, 2nd Edition, 2008.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain reasons for using RF/MW frequencies, limitations of lumped elements.
CO2	Analyze the RF circuits using S-parameters, Signal flow graphs and Smith charts.
CO3	Design Couplers & Power divider circuits using EDA tools.
CO4	Discuss the importance of noise, stability and gain considerations in active circuit design.
CO5	Analyze and design resonators and oscillators.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2			1			1			1	2	1
	CO2	2	2			1			1			1	2	1
	CO3	2	2			1			1			1	2	1
	CO4	2	2			1			1			1	2	1
	CO5	2	2			1			1			1	2	1
	AVG	2	2			1			1			1	2	1

ERROR CONTROL CODING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE05	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Learn techniques of traditional coding theory concepts
2.	Implement algorithms for error detection and correction.

UNIT I
Introduction to Algebra: Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic.
8 Hours

UNIT II
Vector spaces : Properties, matrices, Construction of G and H matrix, Single parity check codes, repetition codes, self dual codes Reed – Muller codes. Systematic and Non systematic cyclic codes, Encoding using Multiplication circuits, Encoder circuit using parity polynomial, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, (23, 12) Golay code, Shortened cyclic codes.
8 Hours

UNIT III
BCH Codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive

BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm. Majority Logic Decodable Codes: One – Step Majority logic decoding, one – step Majority logic decodable Codes, Two – step Majority logic decoding, Multiple – step Majority logic decoding.
9 Hours
UNIT IV
Convolutional Codes: Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.
8 Hours

UNIT V
Turbo coding: Introduction to Turbo coding and their distance properties, Design of Turbo codes. Burst – Error – Correcting Codes: Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.
9 Hours

TEXT BOOKS		
1	Shu Lin & Daniel J. Costello, Jr	Error Control Coding, Pearson / Prentice Hall, Second Edition, 2011.

REFERENCE BOOKS		
1	Blahut, R.E.	Algebraic Codes for Data Transmission Cambridge University Press, 2012.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Construct Galois fields as per the requirement and perform computations using Galois Field arithmetic.
CO2	Design various linear block codes and cyclic codes as per the specifications and develop encoding/decoding circuits.
CO3	Design BCH codes as per the specifications and perform Decoding.
CO4	Perform encoding/decoding of convolution codes.
CO5	Design Turbo Codes, Burst and random error correcting codes.

Course Articulation Matrix

		POs											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	2			1			1	1	1		2	1
	CO2	3	2	1		1			1	1	1		3	1
	CO3	3	2	1		1			1	1	1		3	1
	CO4	3	2			1							2	1
	CO5	3	2	1		1							2	
AVG		3	2	1		1							3	1

ADVANCED WIRELESS COMMUNICATION

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE06	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Introduce recent trends in wireless communication.
2.	Understand challenges in wireless communication and fading in wireless channel.
3.	Learn different technologies related to recent trends in wireless communication.

UNIT I

Introduction Wireless Communications: Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space.

9 Hours

UNIT II

Spread Spectrum Modulation – Introduction, Application and Advantage, Pseudo noise sequence, Pulse –Noise Jamming, Classifications: Direct Sequence SS, Frequency Hopped SS, Hybrid SS. Fast Hopping Versus Slow Hopping, Time Hopping SS systems. Synchronization of SS systems – Acquisition, Tracking. Jamming Consideration – Broadband, Partial band, Multiple tone, Pulse-repeat band, jamming suppression systems.

9 Hours

UNIT III
OFDM – Introduction, Advantages and drawbacks, Applications and standards. Multi Carrier Spread Spectrum - Principles of various schemes, Advantages and Drawbacks. MC-CDMA and MC-DS-CDMA Signal structure, Uplink and downlink signal, Spreading and detecting techniques.
8 Hours
UNIT IV
Multi carrier modulation and demodulation, synchronization, channel estimation, Channel coding and decoding. Signal Constellation, Mapping, De-mapping and equalization, Adaptive technique in multi carrier transmissions, RF Issues.
8 Hours

UNIT V
3G and 4G Wireless Standards: GSM, GPRS, WCDMA, LTE, WiMAX
8 Hours

TEXT BOOKS		
1	David Tse and Pramod Viswanath	Fundamentals of Wireless Communications Publisher: Cambridge University Press, 2005.

REFERENCE BOOKS		
1	K. Fazel, S. Kaiser,	Multi Carrier & Spread Spectrum Systems, Publisher: John Wiley & Sons, Edition II, 2008.
2	Ramjee Prasad	OFDM for Wireless Communications Systems, Publisher: Artech House, 2004.

E-RESOURCES	
1	https://nptel.ac.in/courses/117104099

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Model the wireless fading channel and evaluate the performance using bit error rate.
CO2	Analyse and demonstrate the spread spectrum modulation application and advantages.
CO3	Demonstrate different wireless technologies along with advantages and drawbacks.
CO4	Design different channel estimation techniques.
CO5	Compare and contrast different wireless standards.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2			2			1				2	1
	CO2	3	2	1		2			1				2	1
	CO3	3	2	1		2			1				2	1
	CO4	3	2	1		2			1				2	1
	CO5	3	2			2			1				2	1
	AVG	3	2	1		2			1				2	1

MIMO WIRELESS COMMUNICATION

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE07	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the fundamentals of MIMO systems.
2.	Learn capacity of MIMO systems and space time codes.

UNIT I

Introduction to MIMO channel models: Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation.

9 Hours

UNIT II

MIMO Channel Capacity: Capacity for deterministic MIMO Channels: SISO – SIMO – MISO – MIMO, Capacity of random MIMO channels: SISO – SIMO – MISO - MIMO(Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel.

9 Hours

UNIT III

Space-Time Codes: Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel,

Space-time turbo codes, BLAST Architectures: VBLAST – HBLAST – SCBLAST - DBLAST.
8 Hours
UNIT IV
MIMO Detection Techniques: Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection.
8 Hours

UNIT V		
Advances in MIMO : Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and Massive MIMO Systems, MIMO Applications in RADAR, Satellite Communication, Wi-Fi.		
8 Hours		
TEXT BOOKS		
1	R. S. Kshetrimayum	Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017.

REFERENCE BOOKS		
1	A. Chokhalingam and B. S. Rajan	Large MIMO systems, Cambridge University Press, 2014.
2	B. Kumbhani and R.S. Kshetrimayum	MIMO Wireless Communications over Generalized Fading Channels, CRC Press, 2017.
3	T. L. Marzetta, E. G. Larsson, H. Yang and H. Q. Ngo	Fundamentals of Massive MIMO, Cambridge University Press, 2016.

E-RESOURCES	
1	https://nptel.ac.in/courses/117105132

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the advantages of MIMO systems.
CO2	Determine the capacity and bit error rate for a given digital modulation scheme of SIMO, MISO, MIMO wireless communication system in Rayleigh frequency flat and frequency selective fading environment.
CO3	Analyze the inherent spatial diversity in MIMO channels through properly designed space-time codes.
CO4	Describe various algorithms used to detect the received signal in MIMO systems.
CO5	Describe the applications of MIMO systems.

Course Articulation Matrix

		POs											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**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	1			2			2	2			2	2

COMPUTATIONAL ELECTROMAGNETICS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE08	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the concepts of computational electromagnetics.
2.	Understand numerical stability and boundary conditions.
3.	Understand the concepts of FDTD and Finite Element Method.

UNIT I

Analytical Methods: Introduction, Separation of variables, Separation of variables in rectangular coordinates – Laplace equation, Separation of variables in cylindrical coordinates – Laplace equation.

9 Hours

UNIT II

Finite Difference Methods: Finite Difference Schemes, Finite differencing of Parabolic PDE, Hyperbolic PDEs, Accuracy and Stability, Absorbing boundary conditions of FDTD, Programming Aspects.

9 Hours

UNIT III

Variational Methods: Calculus of variations, construction of functions from PDEs, weighted residual method, Eigen value problems.

8 Hours

UNIT IV

Moment Methods: Introduction, Integral equations, Green's function for free space, Applications- Quasi static problems and Pocklington's integral equation.

8 Hours

UNIT V
Finite Element Method: Introduction, Solution of Laplace's equation, Solution of Poisson's equation, Solution of wave equation.
8 Hours

TEXT BOOKS		
1	Matthew. N.O Sadiku	Numerical Techniques in Electromagnetics with MATLAB, CRC Press Taylors and Francies Group, 3rd Edition, 2009.
2	Constantine A Balanis	Advanced Engineering Electromagnetic, John Wiley & Sons, 2nd Edition, 2012.

REFERENCE BOOKS		
1	Nathan Ida	Engineering Electromagnetic, Springer, 2nd Edition, 2007.
2	Anastasis C. Polycarpou	Introduction to the Finite Element Method in Electromagnetics, Morgon & Claypool Publishers, 1st Edition, 2006.

TEXT BOOKS	
1	https://nptel.ac.in/courses/108106152
2	https://www.youtube.com/playlist?list=PLRWKj4sFG7-4l5a3TsBwpc3-STQ2XjKXv

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the Laplace's equation using analytical methods.
CO2	Apply residual calculus in deriving and analyzing various computational techniques.
CO3	Apply and analyze Green's function for free space.

CO4	Classify and Prioritize different CEM techniques based on the applications.
CO5	Apply and analyze Poisson's and Laplace's equations using finite element method.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2			1			1			1	2	1
	CO2	2	2			1			1			1	2	1
	CO3	2	2			1			1			1	2	1
	CO4	2	2			1			1			1	2	1
	CO5	2	2			1			1			1	2	1
	AVG	2	2			1			1			1	2	1

OPTICAL NETWORKS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE09	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Understand the concepts of optical network.
2.	Analyse the issues like transmission aspects of Second generation fiber optic Networks and networking aspects such as architecture, control and Management.

UNIT I
Introduction to Optical Networks: Telecommunication network Architecture, services, circuit switching and packet switching, optical Networks, optical layer, transparency and all optical networks, optical packet switching, transmission basics, network evolution.
9 Hours
UNIT II
Components: Optical amplifiers. Transmitters, Detectors, Switches, Wavelength converters.
8 Hours
UNIT III
Transmission System Engineering: System model, Power penalty, Transmitter, receiver, optical amplifiers, Crosstalk, Dispersion, Fiber nonlinearities, overall design considerations.
8 Hours
UNIT IV
Client layers of optical network: SONET/SDH, optical transport network, generic framing procedure, Ethernet, IP, Multiprotocol label switching.
8 Hours

UNIT V
WDM Network Elements: Optical line terminals, optical line amplifiers, optical add/drop multiplexers, optical cross connects. **Control and Management**: Network Management Functions, optical layer services and interfacing, Layers within the optical layer.
9 Hours

TEXT BOOKS		
1	Kumar Sivarajan and Rajiv Ramaswamy	Optical Networks: A practical perspective, Morgan Kauffman, 3rd edition, 2009.

REFERENCE BOOKS		
1	Biswajit Mukherjee	Optical Communication Networks, TMH, 1998.
2	Ulysees Black	Optical Networks, Pearson education, 2007.

E-RESOURCES:	
1	https://www.youtube.com/watch?v=4W7hieXDAmc
2	https://www.youtube.com/watch?v=bC11e6QgrqA&list= PLHj96QRJ0kOhH8xoXXrOgkMf9ZOvjhqYl&index=3
3	https://www.youtube.com/watch?v=KIPFP8wke9M&list= PLHj96QRJ0kOhH8xoXXrOgkMf9ZOvjhqYl&index=11
4	https://www.youtube.com/watch?v=KIPFP8wke9M&list= PLHj96QRJ0kOhH8xoXXrOgkMf9ZOvjhqYl&index=11

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain basic terms related to Optical Networks
CO2	Analyze the Optical Components
CO3	Charactering the optical transmission systems
CO4	Compare different layers of optical networks
CO5	Explain WDM networks

Course Articulation Matrix

PO CO⇩		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2										2	
	CO2	2	2										2	
	CO3	2	2										2	
	CO4	2	2										2	
	CO5	2	2						2	2			2	2
AVG		2	2						2	2			2	2

EDGE AND CLOUD COMPUTING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE10	SEE Marks:	50

Pre-requisite: Operating Systems/ RTOS, Computer Architecture, Embedded Systems, and IoT.

Course objectives:

This course will enable students to:

1.	Introduce the students to state-of-the-art technologies to enable computing at the cloud and edge as a professional subject to help in their careers and jobs.
2.	Demonstrate cloud-native and edge-native architectures for computing as well as the orchestration framework needed for the control of cloud and edge applications.

UNIT I

Need for Compute (Hardware and Architecture Overview): What is computing? What is the need for compute? Where does the compute happen? Cloud, edge, client. What are the relative advantages of cloud, edge, and client? Architecture of a datacenter (physical data center view of storage, accelerators, compute clusters, and over the network hardware access such as RDMA, InfiniBand, Architecture of edge and client.

Heterogeneous compute: Accelerators, Memory and Interconnect.

9 Hours

UNIT II

Software Components of Cloud and Edge: Software Abstraction: Bare-Metal, Virtual Machines (Hypervisors), and Containers (Container Engine): definitions and relative differences, Monolithic Architecture Vs

Microservices Architecture with examples Service-to-Service Communication: RESTfull connections, GraphQL, Khafka, gRPC, Service Mesh Architecture (SMA), Service Proxy, Side-Car-Proxy, and Controllers.
9 Hours

UNIT III
Networking the Cloud, Edge, and Clients: Intra-Data Center Networks, Inter-Data Center Networks, Undersea cables connecting continents, terrestrial networks, and Non-Terrestrial Networks (NTN), Distributed Virtual Networks (including container networking), Private wireless networks: Private-LTE, Private-5G, Softwarized RAN, Open RAN, Core Networks, WiFi Alliance, Industry 5.0.
8 Hours

UNIT IV
Orchestration at Cloud, Edge, and Client: Software Defined Approaches: Separation of Control and User plane, Understanding the role of Application Developers, DevOps, System Administrators, Quality Assurance and Reliability, Concept of Continuous Integration/Continuous Development (CI/CD), Continuous Orchestration and Kubernetes (K8s). Heterogenous Control Domains in an end-to-end solution.
8 Hours

UNIT V
End-to-End Use Cases: Private 5G standalone networks, Requirements of Fully Autonomous Driving and Telehealth, Industrial Control Systems with CIP protocol, content streaming and role-of-caching
8 Hours

TEXT BOOKS		
1	Barroso, Luiz André, Urs Hölzle, and Parthasarathy Ranganathan.	The datacenter as a computer: Designing warehouse-scale machines. Springer Nature, 2019.
2	Carneiro Jr, Cloves, and Tim Schmelmer	Microservices from day one: build robust and scalable software from the start. New York City: Apress, 2016
3	Agarwal, Gaurav	Modern DevOps Practices: Implement and secure DevOps in the public cloud with cutting-edge tools, tips, tricks, and techniques. Packt Publishing Ltd, 2021.
PAPER REFERENCES		
1	Shantharama, Prateek, Akhilesh S. Thyagaturu, and Martin Reisslein	Hardware-accelerated platforms and infrastructures for network functions: A survey of enabling technologies and research studies, IEEE Access 8 (2020): 132021-132085.
2	Thyagaturu, A. S., Shantharama, P., Nasrallah, A., & Reisslein, M.	Operating systems and hypervisors for network functions: A survey of enabling technologies and research studies. IEEE Access, 2022.
3	Levinson, Jesse, et al.	Towards fully autonomous driving: Systems and algorithms." 2011 IEEE intelligent vehicles symposium (IV). IEEE, 2011.
4	Yang, Mao, et al.	OpenRAN: a software-defined ran architecture via virtualization. ACM SIGCOMM computer communication review 43.4 (2013): 549-550.
WEB LINKS		
1	https://www.youtube.com/watch?v=CZ3wIuvmHeM	
2	https://www.youtube.com/@ByteByteGo/videos	
3	https://www.youtube.com/watch?v=hkXzsB8D_mo	
4	https://www.youtube.com/watch?v=6RvlKYgRFYQ&t=96s	
5	https://www.youtube.com/watch?v=bSvTVREwSNw	

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of embedded systems and computer networking to understand the basic building blocks of computing systems.
CO2	Analyze the implementation of the software stack and microservices in cloud and edge.
CO3	Apply the knowledge of computer networking to understand the non-conventional networking aspects of cloud and edge.
CO4	Integrate the cloud, edge, and client with the management with engineering concepts.
CO5	Develop skills to position themselves in the IT and software industry.

Course Articulation Matrix

		POs											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	CO1	3	2										2	
	CO2	3	2	2		1			1					2
	CO3	3	2	1									2	
	CO4	3	2	2		2			1					2
	CO5	3	2			1			1					1

MODELING AND DATA NETWORKS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE11	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Acquire core knowledge of data network design aspects.
2.	Understand queuing theory and probability, which is the basis for the design of network.
3.	Demonstrate descriptive and analytic treatment of various network design aspects.

UNIT I

DELAY MODELS IN DATA NETWORKS: Queuing Models, M/M/1, M/M/m, M/M/_, M/M/m/m and other Markov System, M/G/1 System, infinite server systems, open and closed queuing networks, Jackson's theorem, Little's law Networks of Transmission Lines, Time Reversibility, Networks of Queues.

9 Hours

UNIT II

Performance analysis of networks: Discrete and continuous time Markov chains, birth-death processes, time reversibility, traffic management - models, classes, scheduling.

Basics of Probability: Probability concepts, Network performance estimates.

9 Hours

UNIT III
Design & analysis of network nodes: Transmission links, node design, node architecture and analysis, node processor, node memory **Topological Design:** Selection, Multipoint connection between a Terminal, Link and link capacity assignment, Disjoint Route topology.
8 Hours

UNIT IV
Flow control: Network congestion, Flow control, Various Flow control techniques, Comparison, deadlocks, Protocol dead locks, Buffer dead locks.
8 Hours

UNIT V
ROUTING IN DATA NETWORKS: Introduction, Deterministic routing, Reliability in deterministic routing, disjoint deterministic routes, Adaptive routing strategies, centralized adaptive routing, Random routing, Hierarchical adaptive routing, and other adaptive routing schemes.
8 Hours

TEXT BOOKS		
1	Dimitri Bertsekas and Robert Gallager,	Data Networks, Prentice Hall of India, 2nd edition, 2003.
2	Vijay Ahuja	Design and analysis of computer communication networks, McGraw Hill computer science series, 2007.

REFERENCE BOOKS		
1	S. Keshav,	An Engineering Approach to Computer Networking, Pearson Education, 1997.
2	I. Mitrani,	Modeling of Computer and Communication Systems, Cambridge, 2020.

E-RESOURCES:	
1	https://nptel.ac.in/courses/106101238

Course Outcomes:

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

CO1	To apply the fundamentals of mathematics and probability to understand the delay models on data networks.
CO2	Analyse the performance of data networks using various network parameters.
CO3	Design and analyse the topological model of the network node with respect to node parameters.
CO4	Analyse and compare the flow control techniques in data network.
CO5	Analyse the routing models used in data networks.

Course Articulation Matrix

		POs											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	2			2			1				2	1
	CO2	3	2			2			1				2	1
	CO3	3	2	2		2			1				2	1
	CO4	3	2			2			1				2	1
	CO5	3	2			2			1				2	1
	AVG	3	2	2		2			1				2	1

SOFTWARE DEFINED NETWORKS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE12	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the fundamentals of SDN Network
2.	Learn the various Network virtualization frame works
3.	Articulate the programming skills of SDN and various use cases

UNIT I

History and Evolution of Software Defined Networking (SDN): Separation of Control Plane and Data Plane, IETF Forces, Active Networking. Control and Data Plane Separation: Concepts, Advantages and Disadvantages, Open Flow protocol.

8 Hours

UNIT II

Network Virtualization: Concepts, Applications, Existing Network, Virtualization Framework (VMWare and others), Mininet based examples. Control Plane: Overview, Existing SDN Controllers including, Floodlight and Open Daylight projects.

9 Hours

UNIT III

Customization of Control Plane: Switching and Firewall, Implementation using SDN Concepts. Data Plane: Software-based and Hadrware-based; Programmable Network Hardware.

8 Hours

UNIT IV
Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.
8 Hours

UNIT V
Data Center Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering. Assignments: Programming Assignments for implementing some of the theoretical concepts listed above.
9 Hours

TEXT BOOKS		
1	Thomas D. Nadeau, Ken Gray	Software Defined Networks, An Authoritative Review of Network Programmability Technologies, O'Reilly Media Publication, 2013.

REFERENCE BOOKS		
1	Paul Goransson and Chuck Black	Software Defined Networks: A Comprehensive Approach, Morgan Kaufmann Publication, 2014.
2	Vivek Tiwari	SDN and OpenFlow for Beginners,MMDD Multimedia LLC Publisher, 2013.

E-RESOURCES	
1	https://youtu.be/I3E-C1j-Sjg

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the basic concepts on Software Defined Networking and Separation of Control plane with data plane
CO2	Analyze the existing network virtualization framework (VM Ware and others)
CO3	Illustrate Control Plane and Data plane implementation using SDN concepts.
CO4	Analyze network functions virtualization and programming with SDNs.
CO5	Illustrate the use cases of SDNs, such as Data centers, Backbone networks, etc.

Course Articulation Matrix

		POs											PSOs	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	1			2			2	2			2	2
	CO2	3	2			2			2	2			2	2
	CO3	3	2	2		2			2	2			2	2
	CO4	3	2			2			2	2			2	2
	CO5	3	1			2			2	2			2	2

ADHOC WIRELESS NETWORKS

Contact Hours/ Week:	: 3+0+0	Credits :	3
Total Lecture Hours:	: 42	CIE Marks :	50
Sub. Code:	: SECE13	SEE Marks :	50

Course objectives:

This course will enable students to:

1.	Understand the fundamental principles of Adhoc Wireless Networks.
2.	Discuss a comprehensive understanding of adhoc network MAC protocols.
3.	Outline the current and emerging trends adhoc routing protocols.
4.	Analyze energy management and security techniques in adhoc wireless networks.

UNIT I

AD HOC NETWORKS: Introduction, Issues in Ad hoc wireless networks, Ad hoc wireless internet.

7 Hours

UNIT II

MAC PROTOCOLS FOR ADHOC WIRELESS NETWORKS: Introduction, Issues in designing a MAC protocol for Ad hoc wireless Networks, Design goals of a MAC protocol for Ad hoc wireless Networks, Classification of MAC protocols. Contention - based MAC protocols with scheduling mechanism, MAC protocols that use directional antennas, Other MAC protocols.

12 Hours

UNIT III
ROUTING PROTOCOLS FOR ADHOC WIRELESS NETWORKS-1: Introduction, Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Table drive routing protocol, On-demand routing protocol.
8 Hours
UNIT IV
ROUTING PROTOCOLS FOR ADHOC WIRELESS NETWORKS-2: Hybrid routing protocol, Routing protocols with effective flooding mechanisms, Hierarchical routing protocols, Power aware routing protocols.
7 Hours

UNIT V
TRANSPORT LAYER PROTOCOLS FOR ADHOC WIRELESS NETWORKS: Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless Networks. **SECURITY:** Security in wireless Ad hoc wireless Networks, Network security requirements, Issues & challenges in security provisioning.
8 Hours

TEXT BOOKS		
1	C. Siva Ram Murthy, B.S.Manoj	Ad hoc wireless Networks, Pearson Education, 2nd Edition, reprint 2005.

REFERENCE BOOKS		
1	Ozan K. Tonguz, Gianguigi Ferrari	Ad hoc wireless networks: a communication-theoretic perspective, Hoboken: Wiley, 2009.
2	Xiuzhen Cheng, Xiao Hung, Ding- Zhu Du	Ad hoc wireless Networking, Springer publishers, 2011.

E-Resources:	
1	https://www.digimat.in/nptel/courses/video/106105160/L01.html

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the fundamental concepts and issues in Adhoc Wireless Networks.
CO2	Analyse the MAC protocols of Adhoc Wireless Networks.
CO3	Classify Routing protocols of Adhoc Wireless Networks.
CO4	Analyze Routing protocols and transport layer protocols of Adhoc Wireless Networks.
CO5	Analyze transport layer protocols of Adhoc Wireless Networks.

Course Articulation Matrix

	POs												**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	CO1	3	2										3	
	CO2	3	2	1									2	
	CO3	3	2			1			1					1
	CO4	3	2	1					1	1				1
	CO5	3	2	1									2	

WIRELESS SENSOR NETWORKS

Contact Hours/ Week:	: 3+0+0	Credits :	3
Total Lecture Hours:	: 42	CIE Marks :	50
Sub. Code:	: SECE14	SEE Marks :	50

Course objectives:

This course will enable students to:

1.	To introduce the challenges in deployment of WSN and issues in IOT.
2.	Acquire the knowledge of various sensor network standards and protocols for WSN.
3.	Emphasis on the practical implementation of sensor network scenarios.

UNIT I

Introduction, Challenges for WSNs, Development of WSN, Hardware components, Energy consumption of sensor nodes, Operating systems and execution environments, Examples of sensor nodes-'MICA MOTE' family, EYES node, BTnodes.

8 Hours

UNIT II

Sensor network scenarios-Sources and Sinks, single hop vs. multihop, optimization goals and figures of merit, Design principles for WSNs, Physical layer and transceiver design considerations in WSNs.

8 Hours

UNIT III

Practical implementation issues-Partitioning decision, Transducer interfaces, Time based accuracy and average power consumption, Power management, Antennas and RF performance definitions.

8 Hours

UNIT IV
MAC protocols for WSN, Low duty cycle protocols and wakeup concepts (STEM, SMAC), Contention based protocols, schedule based Protocols. Energy efficient unicast, Routing for mobile nodes- mobile sinks, mobile data collectors.
9 Hours

UNIT V		
Wireless sensor network standards-IEEE 802.15.4 Low rate WPAN standard, The ZIGBEE alliance etc. Future trends in wireless sensor networks: Wireless Multimedia Sensor Networks, Sensor Network Applications in Challenging Environments.		
9 Hours		
TEXT BOOKS		
1	Edgar H. Callaway Jr.	Wireless Sensor Networks - Architectures and Protocols, AUERBACH Publications, CRC Press, 2004.
REFERENCE BOOKS		
1	J. Zheng and A. Jamalipour,	Wireless Sensor Networks: A Networking Perspective, John Wiley & Sons, 2009.
2	Holger Karl, Andreas Willig	Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2006.
E-Resources:		
1	https://www.digimat.in/nptel/courses/video/106105160/L01.html	

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of network technology to understand the challenges of WSN.
CO2	Analyse the network scenario of sensor network and its design principles.

CO3	Demonstrate the practical implementation issue of WSN.
CO4	Analyse the MAC protocols used in WSN implementation.
CO5	Analyse the WSN IEEE standards and design the application.

Course Articulation Matrix

	POs												**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	CO1	3	2										3	
	CO2	3	2	1		2								1
	CO3	3	2			2								1
	CO4	3	2	1					1	1				1
	CO5	3	2	1					1				2	

RADAR SYSTEMS FOR AUTONOMOUS DRIVING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE15	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Use radar techniques for target detection and tracking in autonomous driving scenario.
2.	Examine real-world case studies and applications of radar systems in autonomous cars, including adaptive cruise control (ACC), collision avoidance, pedestrian detection, and intersection management.

UNIT I

Fundamentals of Radar Systems: Introduction, Essential Functions of Radar, Radar System Fundamentals, Antennas for Radar Measurements, Challenges for Automotive Radar Developers, Mathematical model of Radar Range Equation, Radar Equation for Automotive Applications.

8 Hours

UNIT II

FMCW Radars: Fundamentals, Block diagram of FMCW radars, Range and Velocity measurement using FMCW radars, Range resolution, velocity resolution, Application of FMCW radars for Autonomous driving, Case Study: TI FMCW Radar.

9 Hours

UNIT III

LiDAR for Autonomous Driving: Introduction to LiDAR, Types of LiDAR, Components and architecture of a typical LiDAR system, Role of LiDAR in autonomous vehicles, Object detection and classification using LiDAR, Range measurement using LiDAR, Current limitations and challenges in LiDAR technology.

9 Hours

UNIT IV
Modern Radar Sensors in Advanced Automotive Architectures: Motivation for Advanced Systems, The Evolving Automotive Radar Landscape, Vehicle Network and Compute Considerations, Design Considerations for Automotive Radar.
8 Hours
UNIT V
Automotive Radar Applications: Introduction, Short-Range Radar (SRR, Long-Range Radar (LRR), Trends in Automotive Applications, Future Roadmaps Automotive Applications, Future Contributions of Automotive Applications.
8 Hours

TEXT BOOKS		
1	Jonah Gamba	Radar Signal Processing for Autonomous Driving, Springer, 2020.
2	Matt Markel	Radar for Fully Autonomous Driving, Artech House, 2022.
REFERENCE BOOKS		
1	Merrill I. Skolnik	Handbook of Radar Systems, McGraw Hill; 3rd edition, 2008.
2	Pinliang Dong	LiDAR Remote Sensing and Applications, CRC Press, 2017.
E-RESOURCES		
1	Merrill I. Skolnik	Handbook of Radar Systems, McGraw Hill; 3rd edition, 2008.
2	Pinliang Dong	LiDAR Remote Sensing and Applications, CRC Press, 2017.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify the key components of a radar system and their functions for autonomous cars.
CO2	Analyze the advantages and challenges of using radar in various driving scenarios.
CO3	Interpret radar signal processing algorithms and their impact on object detection, tracking, and localization.
CO4	Assess the performance metrics of radar systems, such as range, resolution, accuracy, and sensitivity.
CO5	Analyze the limitations and potential improvements of radar technology for future autonomous driving applications.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	1										2	
	CO2	2	3	2									2	
	CO3	2	2	2									2	
	CO4	2	2										2	
	CO5	2	1										1	
	AVG	2	2	2									2	

INTRODUCTION TO QUANTUM INFORMATION AND COMPUTING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE16	SEE Marks:	50

Prerequisites: Linear Algebra

Course objectives: This course will enable students to:	
1.	Become familiar with 1-qubit and 2-qubit gate operations and gain the ability to build simple quantum circuits.
2.	Become familiar with the concepts of superposition and entanglement and be able to analyze quantum state transformations
3.	Understand quantum algorithms (Deutsch-Jozsa, Bernstein Vazirani, Grover, and Shor) and compare effectiveness versus classical algorithms
4.	Understand the problem of noise and analyze the effectiveness of simple error correction codes.
5.	Become familiar with NISQ model of computation, and perform intelligent qubit mapping and error mitigation.

UNIT I
Basics of quantum computing Superposition, Polarization of light, Single qubit notation, Measurement of Qubit, BB84 Quantum Key Dist, Bloch Sphere Notation. Model of computation (movement on Bloch Sphere), X, Y, Z, H gates, CNOT, Toffoli, Fredkin, SWAP gate, Simple circuits.
8 Hours
UNIT II
Quantum entanglement: Entangled States, Testing for Entangled States, Bell Pair and Bell States, EPR Paradox & Bell Theorem, Conditional Instructions, Quantum Teleportation, Super dense Coding.
8 Hours

UNIT III
Simple quantum algorithms: Deutsch algorithm-Types of functions, classical computation, Deutsch-Jozsa algorithm, Bernstein Vazirani algorithm-Input/output entanglement, Grover algorithm-Geometrical interpretation, Grover operator, Grover rotation-interpretation, maximum iterations, diffusion operator.
9 Hours
UNIT IV
Quantum error correction: Types of errors, Device Level Metrics, System Level Metrics, Bench-marking, Current machines (5-50 qubit), What is NISQ Model? NISQ Metrics, Qubit Mapping Problem, Qubit Allocation Problem.
8 Hours
UNIT V
Programming a quantum computer: The IBMQ, coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis, programming using IBM quantum experience and circuit composer.
9 Hours

TEXT BOOKS		
1	Phillip Kaye, Raymond Laflamme et. al.,	An Introduction to Quantum Computing, Oxford University Press, 1st Edition, 2007.
2	Eleanor Rieffel and Wolfgang Polak	"Quantum Computing: A Gentle Introduction" The MIT Press, Edition, 2014.

REFERENCE BOOKS		
1	M. A. Nielsen & I. Chuang	Quantum Computation and Quantum Information, Cambridge University Press, 2013.

2	Chris Bernhardt	Quantum Computing for Everyone, The MIT Press, Cambridge, 2020.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze simple states of superposition and the effect of doing the measurement in different basis states and build simple quantum circuits with single and two-qubit gates.
CO2	Analyze quantum circuits with entanglement.
CO3	Analyze simple quantum algorithms and complexity
CO4	Implement quantum programs in NISQ model of computing
CO5	Build circuits using circuit composer or Qiskit

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	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	2
	CO5	3	1			2			2	2			2	2

II. SIGNAL PROCESSING:

ADVANCED SIGNAL PROCESSING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE17	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	To understand the fundamentals of multirate signal processing.
2.	Learn its applications in communication systems and signal processing

UNIT I
Review of Signals and Systems – Discrete time processing of continuous signals - Frequency domain analysis of a digital filter; Quantization error; Fourier Analysis – DFT, DTFT, DFT as an estimate of the DTFT for Spectral estimation. DFT for convolution, DFT/DCT for compression, FFT. Ideal Vs non ideal filters,Digital Filters – State Space realization, Robust implementation of Digital Filters, Robust implementation of equi – ripple FIR digital filters.
9 Hours

UNIT II
Multirate Systems and Signal Processing. Fundamentals – Problems and definitions; Up sampling and down sampling; Sampling rate conversion by a rational factor; Multistage implementation of digital filters; Efficient implementation of multirate systems.
8 Hours

UNIT III
DFT filter banks and Transmultiplexers – DFT filter banks, Maximally Decimated DFT filter banks and Transmultiplexers. Application of transmultiplexers in communications Modulation.
8 Hours

UNIT IV
Maximally Decimated Filter banks – Vector spaces, Two Channel Perfect Reconstruction conditions; Design of PR filters Lattice Implementations of Orthonormal Filter Banks, Applications of Maximally Decimated filter banks to an audio signal.
9 Hours

UNIT V		
Introduction to Time Frequency Expansion; The STFT; The Gabor Transform, The Wavelet Transform; The Wavelet transform; Recursive Multi resolution Decomposition.		
8 Hours		
TEXT BOOKS		
1	Roberto Cristi	Modern Digital Signal Processing, Cengage Publishers, India, (erstwhile Thompson Publications), 2003.

REFERENCE BOOKS		
1	S.K. Mitra	Digital Signal Processing: A Computer Based Approach, Tata McGraw Hill, III Ed, India, 2007.
2	E.C. Ifeachor and B W Jarvis	Digital Signal Processing, a practitioners approach, Pearson Education, II Edition, India, 2002 Reprint.
3	Proakis and Manolakis	Digital Signal Processing, Prentice Hall 1996 (third edition).

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Design and Analyze discrete time systems and implement
CO2	Derive an efficient implementation of discrete time system using multirate operations and polyphase decomposition
CO3	Design and analyze filter banks and transmultiplexers using DFT concept
CO4	Analyze perfect reconstruction filter banks using orthogonal basis functions and time frequency representation of signals
CO5	Demonstrate the capacity of self-learning and communication skills through simulation of discrete time systems using Matlab/Scilab/Simulink

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2			1							2	
	CO2	3	2			1							2	
	CO3	3	2			1							2	
	CO4	3	2			1							2	
	CO5	3	2			1							2	

DIGITAL IMAGE PROCESSING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE19	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand fundamentals of digital image processing.
2.	Learn different image processing algorithms.

UNIT I

Digital Image Fundamentals: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sampling and Quantization, Some Basic Relationships between Pixels, connected component analysis.

Two-dimensional orthogonal & unitary transforms, Two dimensional Discrete Fourier transform, Discrete cosine transform, Hadamard transform, Haar transform, KL transform.

9 Hours

UNIT II

Enhancement in Spatial and Frequency Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.

Image Smoothing Using Frequency Domain Filters, Image Sharpening Using Frequency Domain Filters.

9 Hours

UNIT III

Image Restoration: A Model of the Image Degradation/Restoration Process, Restoration in the Presence of Noise Only-Spatial Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Geometric Mean Filter.

8 Hours

UNIT IV		
Image Segmentation: Fundamentals, Point, Line and Edge Detection, Hough transform, Thresholding, Region-Based Segmentation.		
8 Hours		
UNIT V		
Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms.		
8 Hours		
TEXT BOOKS		
1	Rafael C. Gonzalez and Richard E. Woods	Digital Image Processing, IV edition, Pearson Education, 2018.
2	Anil K. Jain	Fundamentals of Digital Image Processing, PHI, 2011.
REFERENCE BOOKS		
1	Jayaraman, Esakkirajan, Veerakumar	Digital Image Processing and Analysis, Mc Graw Hill India, 2009.
E-RESOURCES		
1	https://nptel.ac.in/courses/117105079	
2	https://nptel.ac.in/courses/108106168	

Course Outcomes:

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

CO1	Identify various steps and components in a digital image processing system, analyze digital images in spatial and transform domain.
CO2	Choose a suitable technique in spatial or frequency domain to enhance a given image.
CO3	Develop a suitable model for image degradation and perform image restoration.
CO4	Apply various image segmentation techniques to partition image into regions or objects.

CO5	Apply suitable morphological operations to extract image components that are useful in the representation and description of region shapes.
CO6	Use modern engineering tools to develop image processing systems working in a team.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2			1							3	
	CO2	3	2			1							3	
	CO3	3	2			1							3	
	CO4	3	2			1							3	
	CO5	3	2	2		2		1	1	1	1	1	2	1

SPEECH PROCESSING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE20	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the characteristics of speech signal
2.	Apply signal processing concepts to speech signal
3.	Get an insight into a few applications of speech processing.

UNIT I

Production and Classification of Speech Sounds: Anatomy and physiology of speech production, spectrographic analysis of speech, categorization of speech sounds Digital models for the speech signal: The acoustic theory of speech production.

8 Hours

UNIT II

Time domain models for speech processing: Short-time energy, average magnitude, average zero-crossing rate, speech vs. silence discrimination using energy and zero-crossings, pitch period estimation using a parallel processing approach, short-time autocorrelation function, average magnitude difference function, pitch period estimation using autocorrelation

Short-time Fourier analysis: Fourier transform interpretation, Linear filtering interpretation, Sampling rates of STFT in time and frequency, Filter bank summation method of short-time synthesis, Overlap addition method of short-time synthesis.

9 Hours

UNIT III
Homomorphic Speech Processing: Homomorphic systems for convolution, complex cepstrum of speech, pitch detection, formant estimation.
8 Hours
UNIT IV
Linear prediction analysis of speech: Principles of linear prediction, Computation of the gain for the model, Solution of the LPC equations, Comparison between autocorrelation and covariance methods, Frequency domain interpretation of mean squared prediction error, synthesis of speech from LP parameters, pitch detection and formant analysis using LPC parameters.
8 Hours
UNIT V
Applications: Speaker recognition systems, speech recognition systems, isolated word recognition, connected word recognition and large vocabulary word recognition, hidden Markov models, Three basic problems of HMM, Types of HMM.
9 Hours

TEXT BOOKS

1	Lawrence R. Rabiner and Ronald W. Schafer	Digital processing of speech signals, Pearson Education, Second Indian Reprint, 2005

REFERENCE BOOKS

1	Thomas F. Quatieri	Discrete-time speech signal processing Principles and Practice, Pearson Education, First Indian Reprint, 2004.
2	Lawrence R. Rabiner, Biing-Hwang Juang, B. Yegnanarayana	Fundamentals of speech recognition, Pearson Education, 2009

E-RESOURCES	
1	https://nptel.ac.in/courses/117105145

Course Outcomes:

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

CO1	Analyse the speech signal in time and frequency domain and relate to human speech production mechanism
CO2	Derive simple features used in speech applications.
CO3	Develop a model for analyzing and synthesizing speech using homomorphic signal processing.
CO4	Develop a model for analyzing and synthesizing speech using linear prediction.
CO5	Distinguish between template matching, vector quantization and probabilistic model, HMM for use in speech applications.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1			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

DSP ALGORITHMS AND ARCHITECTURE

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE21	SEE Marks:	50

Course objectives:
This course will enable students to:

1.	Learn the architecture of digital signal processors
2.	Implement DSP algorithms.

UNIT I

Introduction to Digital Signal Processing

Introduction, A Digital Signal-Processing System, The Sampling Process, Discrete Time Sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time-Invariant Systems, Digital Filters, Decimation and Interpolation. **Architectures for Programmable Digital Signal-Processing Devices:** Introduction, Basic Architectural Features, DSP Computational Building Blocks.

9 Hours

UNIT II

Architectures for Programmable Digital Signal-Processing Devices(Contd...): Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability an Program Execution, Speed Issues, Features for External Interfacing. **Programmable Digital Signal Processors:** Introduction, Commercial Digital Signal-processing Devices, Architecture of TMS320C54xx Digital Signal Processors, Data Addressing Modes of TMS320C54xx Processors.

9 Hours

UNIT III

Programmable Digital Signal Processors (Contd...): Memory Space of TMS320C54xx Processors, Program Control, TMS320C54xx Instructions and Programming, On-Chip peripherals, Interrupts of TMS320C54xx Processors, Pipeline Operation of TMS320C54xx Processors.

8 Hours

UNIT IV
Implementations of Basic DSP Algorithms Introduction, The Q-notation, FIR Filters, IIR Filters, Implementation of FFT Algorithms, Introduction, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and Scaling, Bit-Reversed Index Generation, FFT Implementation on the TMS320C54xx, Computation of the Signal Spectrum.
8 Hours

UNIT V
Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices Introduction, Memory Space Organization, External Bus Interfacing Signals, Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA).
8 Hours

TEXT BOOKS		
1	Avatar Singh and S. Srinivasan	Digital signal processing Implementations using DSP microprocessors with examples from TMS320C54xx, Tenth Indian Reprint, Cengage Learning, 2010.

REFERENCE BOOKS		
1	Texas Instruments	TMS320C54x DSP Reference Set Vol. 1: CPU and peripherals, 2001
2	Texas Instruments	TMS320C54x DSP Reference Set Vol. 2: Mnemonic Instruction Set, 2001
3	Ifeachor E. C., Jervis B. W	Digital signal processing: A practical approach, Pearson Education, 2e, 2002.
4	B. Venakataramani and M. Bhaskar	Digital signal processors, TMH, 2002.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyse basic signal processing concepts and apply them for DSP processor implementation.
CO2	Identify the need of basic DSP operations, formulate the logic and provide hardware solutions to implement these operations
CO3	Identify and apply the architectural features of TMS320C54xx to provide efficient design solutions
CO4	Develop ALP for TMS320C54xx DSP processors exploring different functional units and addressing modes
CO5	Provide solutions for signal processing problems by implementing FFT, FIR and IIR algorithms on TMS320C54xx processor.
CO6	Design an interfacing circuit to connect DSP processor to memory and peripherals.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3											2	
	CO2	2	2										1	
	CO3	2	2	1									2	
	CO4	2	2	1									2	1
	CO5	3	1	1									2	1
	CO6	2	2										2	

WAVELET TRANSFORMS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE22	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	To establish the theory necessary to understand and use wavelets in signal processing.
2.	To understand the different types of wavelets.
3.	To apply wavelets for speech, image and video compression

UNIT I

Introduction: Review of Fourier theory, why wavelets, filter banks, multi-resolution analysis?

Continuous time bases and wavelets: Introduction, C-T wavelets, definition of CWT, CWT as a correlation, Constant Q-Factor filtering interpolation and time-frequency resolution, CWT as an operator, inverse CWT.

10 Hours

UNIT II

Discrete-time bases and wavelets: Approximation of vectors in nested linear vector spaces, (i) example of approximating vectors in nested subspaces of a finite dimensional linear vector space: (ii) example of approximating vectors in nested subspaces of an infinite dimensional of vectors in linear vector spaces.

9 Hours

UNIT III
Multi-resolution analysis: Formal definition of MRA, construction of a general orthonormal MRA (i) scaling function and subspaces, (ii) implication of dilation equation and orthogonality, a wavelet basis for MRA (i) two scale relations for (t), (ii) basis for the detail subspace (iii) direct sum decomposition, digital filtering interpolation (i) decomposition filters, (ii) reconstruction of the signal, Example MRA (i) bases for the approximations subspaces and Harr scaling function, (ii) bases for detail subspaces and Harr wavelet.
10 Hours
UNIT IV
Examples of wavelets: Examples of orthogonal basis generating wavelets, (i) Daubechies D_4 scaling function and wavelet (ii) band limited wavelets, interpreting orthogonal MRAs for discrete time MRA (iii) basis functions for DWT.
7 Hours
UNIT V
Applications: Speech, audio, image and video compression, denoising, feature extraction, inverse problems.
6 Hours

TEXT BOOKS		
1	Raghuveer M. Rao and Ajit S. Bopardikar	Wavelet transforms-Introduction to theory and applications, Pearson Education, 2000

REFERENCE BOOKS		
1	Prasad and Iyengar	Wavelet transforms, Wiley Eastern, 2001
2	Gilbert Strang and Nguyen Yegnanarayana	Wavelet and filter banks, Wellesley Cambridge Press, 1996

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Discuss the basics of continuous wavelet transform and its properties
CO2	Implement discrete type wavelets for vectors approximation
CO3	Apply multi-resolution analysis for subspaces
CO4	Analyse different types of wavelets
CO5	Illustrate the use of wavelets for Speech, audio, image and video compression

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3											2	
	CO2	3	2										2	
	CO3	3	2			1							2	
	CO4	3	1			1							2	
	CO5	3	1			1							2	

ARTIFICIAL NEURAL NETWORKS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE23	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Learn basic differences between human and machine intelligence. Understand the attractive features of the biological neural networks to realize some of features through parallel and distributed processing models.
2.	Explain the biological and mathematical foundations of neural network models.
3.	Learn different learning models to train an artificial neural network.
4.	Identify various pattern recognition tasks & select suitable neural network architectures.
5.	Design, build and train neural networks to solve various pattern recognition tasks.

UNIT I

Review of Linear algebra: Linear combination of vectors, linearly dependent and independent set of vectors, Vector space, subspace, basis, rank, Eigen vectors, orthogonal vectors, inner product, outer product.(No questions will appear in the end exam from these topics)

Basics of Artificial Neural Networks: Trends in computing, Pattern and Data, Pattern recognition tasks. Basic methods of pattern recognition, Basics of Artificial Neural Networks, Biological Neural Network, Models of neuron: McCulloch-Pitts Model, Perceptron, Adaline, topology, Supervised and unsupervised learning, Basic learning laws, Realization of logic functions using MP neuron.

9 Hours

UNIT II
Functional units of ANN & Single layer perceptron: Basic ANN Models (architectures) for Pattern recognition task**,** Pattern recognition tasks by i) Feed-forward ii) Feed-back iii) competitive learning Neural networks. Feed-forward neural network: Linear associative network, Analysis of pattern classification networks, Linear separability, Perceptron convergence theorem.
8 Hours

UNIT III
Multi-Layer perceptron: Linear Inseparability**:** Hard problems, MLFFNN: Back propagation learning, Draw backs of back propagation algorithm, Heuristics to improve the performance of Back propagation learning discussion on error back propagation, Convolution neural network (**CNN**).
8 Hours
UNIT IV
Feedback Neural Networks: Analysis of pattern storage networks, The Hopfield Model, Energy analysis of Hopfield model, State transition diagram, Pattern storage: Hard problems, Stochastic Networks and simulated annealing. **Competitive learning network**: Basic competitive learning, Analysis of pattern clustering Networks. Analysis of Feature Mapping Network.
8 Hours
UNIT V
Architectures for complex pattern recognition tasks: Bidirectional associative memory, Architecture of Radial basis function (RBF) networks, Theorems for function approximation, RBF networks for function approximation, Covers theorem on separability of patterns, The XOR problem, RBF Networks for pattern Classification, comparison of RBF with MLP networks.
9 Hours

TEXT BOOKS		
1	B. Yegnanarayana	Artificial neural networks, PHI, 2010.
REFERENCE BOOKS		
1	Simon Haykin	Neural Networks for Pattern Recognition, Pearson Education Limited, 2004.
2	Robert J. Schalkoff	Artificial Neural Networks, Mcgraw-Hill Inc., 2004.
3	Jacek M. Zurada	Introduction to artificial neural systems, Jaico publishing house, 2003.
4	Christopher M. Bishop	Neural networks for pattern recognition, Oxford University Press (1995)
E-RESOURCES		
1	https://onlinecourses.nptel.ac.in/noc22_cs73/course	
2	https://onlinecourses.nptel.ac.in/noc22_cs124	

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Distinguish between human and machine intelligence
CO2	Analyze various learning methods of neural networks.
CO3	Illustrate the use of feed-forward neural network for simple patter recognition tasks.
CO4	Illustrate use of feed-back neural network for pattern storag problems.
CO5	Apply Radial basis function networks for complex pattern recognition tasks

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3												
	CO2	3	2	2		2							2	2
	CO3	3	2	2		2							2	2
	CO4	3	2	2									2	2
	CO5	3	2	2									2	2

MEDICAL IMAGE PROCESSING

Contact Hours/ Week:	3+0+0	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Sub. Code:	SECE24	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Understand various medical imaging modalities, acquisition techniques with advantages and limitations.
2.	Understand processing of medical images to improve visualization and extract region of interest.

UNIT I
Introduction to Bio-medical Images: Introduction, Block diagram of Computer Aided Diagnosis (CAD), Objectives of bio medical image analysis, Nature of biomedical images, body temperature as an image, Transillumination, Medical imaging types and modalities: X-ray Imaging, Computed Tomography (CT), Nuclear medicine imaging, Ultrasound Imaging, Magnetic Resonance Imaging (MRI).
9 Hours
UNIT II
Image Quality and Information content: Difficulties in biomedical Image acquisition and analysis, Characterization of Image quality, review of concept of sampling and quantization, spatial and gray level resolution, optical density, dynamic range, contrast, histogram, entropy, blur and spread functions with reference to medical images, Fourier spectra of biomedical images.
9 Hours

UNIT III
Biomedical Image denoising: Characterization of artifacts or noise in biomedical images, examples of noise PDFs, power line interference in biomedical images, physiological interference, signal dependent noise, multiframe averaging in confocal microscopy, mean filters, order statistics filters. Noise reduction in nuclear medicine imaging.
8 Hours

UNIT IV
Biomedical Image enhancement:: Digital subtraction angiography, Dual energy and energy subtraction X-ray imaging, temporal subtraction, Gray scale transforms, Histogram transformation, unsharp masking, high frequency emphasis, homomorphic filtering applied to medical images.
8 Hours

UNIT V
Biomedical Image Segmentation: Thresholding and binarization, detection of isolated points and lines, edge detection, Laplacian of Gaussian (LOG), Canny's method for edge detection, Fourier domain methods for edge detection, region growing, splitting and merging applied to Medical Images.
8 Hours

TEXT BOOKS		
1	Rangaraj M Rangayyan	Biomedical Image Analysis, CRC Press, 1st Edition, 2004.
2	Geoff Dougherty	Digital Image Processing for Medical Applications, Cambridge University Press, 1st Edition, 2010.

REFERENCE BOOKS		
1	Klaus D. Toennies	Guide to Medical Image Analysis-Methods and Algorithms, Springer, I Edition, 2012.
2	James S Dankan and Nicholas Ayache	Medical Image Analysis: Progress over two decades and the Challenges ahead, IEEE Transactions on PAMI, vol 22, No. 1, Jan 2000.
3	Rafael C. Gonzalez and Richard E. Woods	Digital Image Processing, Pearson Education, IV edition, 2018.

E-Resources:	
1	https://onlinecourses.nptel.ac.in/noc22_bt34/preview
2	https://onlinecourses.nptel.ac.in/noc20_ee40/preview

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify various blocks of computer aided diagnosis system and objectives of biomedical image analysis, compare and contrast various medical imaging modalities
CO2	Identify the difficulties in biomedical image acquisition and analysis, characterize medical images w r t resolution, contrast, and entropy.
CO3	Characterize noise/artifacts in biomedical images, apply suitable filters for denoising
CO4	Choose and apply a suitable technique to enhance biomedical images
CO5	Apply various image segmentation techniques for partitioning of medical images to identify the regions of interest.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2										3	
	CO2	3	2			1				1		1	3	1
	CO3	3	2			1				1		1	3	1
	CO4	3	2			1				1		1	3	1
	CO5	3	2			1				1		1	3	1

DATA SCIENCE

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE25	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Describe the concept of data science, its scope in business and explain the available techniques. (L1, L2)
2.	Understand Predictive modeling, explain supervised segmentation and given data set should be able to select (through solving) the attribute for segmentation using the available techniques. (L2, L3)
3.	Explain the concept of Classification and classify (solve) a given data set. (L3)
4.	Understand and describe the concept of similarity, neighbors and clustering and apply it for any real world data. (L3, L4)
5.	Explain the concepts of mining text and other data science tasks and techniques. (L2, L4)

UNIT I

Introduction: Data-Analytic Thinking: The Ubiquity of Data Opportunities, Example: Hurricane Frances, Example: Predicting Customer Churn. Data Science, Engineering, and Data-Driven Decision Making, Data Processing and “Big Data”, Data and Data Science Capability as a Strategic Asset, Data-Analytic Thinking.

Business Problems and Data Science Solutions: From Business Problems to Data MiningTasks, Supervised Versus Unsupervised Methods, Data Mining and Its Results, The Data Mining Process, Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Deployment, Other Analytics Techniques and Technologies: Statistics, Database Querying, Data Warehousing, Regression Analysis, Machine Learning and Data Mining.

9 Hours

UNIT II
Introduction to Predictive Modeling: From Correlation to Supervised Segmentation Models, Induction, and Prediction, Supervised Segmentation, Selecting Informative Attributes Example: Attribute Selection with Information Gain, Supervised Segmentation with Tree-Structured Models, Visualizing Segmentations, Trees as Sets of Rules, Probability Estimation, Example: Addressing the Churn Problem with Tree Induction.
8 Hours
UNIT III
Fitting a Model to Data: Classification via Mathematical Functions: Linear Discriminant Functions, Optimizing an Objective Function, An Example of Mining a Linear Discriminant from Data, Linear Discriminant Functions for Scoring and Ranking Instances, Support Vector Machines briefly, Regression via Mathematical Functions, Class Probability Estimation and Logistic “Regression”. Logistic Regression: Some Technical Details. Example: Logistic Regression versus Tree Induction, Non Linear Functions, Support vector machines and Neural Networks. Over fitting and Its Avoidance: Fundamental Concepts, Exemplary Techniques, Regularization, Genaralization, Over fitting, Over fitting Examined.
8 Hours

UNIT IV
Similarity, Neighbors, and Clusters: Similarity and Distance, Nearest-Neighbor Reasoning,Example: Whiskey Analytics, Nearest Neighbors for Predictive Modeling, How Many Neighbors and How Much Influence? Geometric Interpretation, Overfitting, and Complexity Control. Issues with Nearest-Neighbor Methods. Some important Technical Details Relating to Similarities and neighbors. Clustering, Example: Whiskey Analytics Revisited, Hierarchical Clustering, Nearest Neighbors Revisited: Clustering Around Centroids. Understanding the Results of Clustering.
8 Hours

UNIT V
Decision Analytic Thinking I: What is a Good Model?: Evaluating Classifiers Plain Accuracyand its Problems, The confusion matrix, Problems with unbalanced Classes, Problems with Unequal Costs and Benefits. **Representing and Mining Text**: Why Text Is Important? Why Text Is Difficult? Representation, Bag of Words, Term Frequency, Measuring Sparseness: Inverse Document Frequency, Combining Them: TFIDF, Example: Jazz Musicians **Other Data Science Tasks and Techniques:** Co-occurrences and Associations: Finding Items That Go Together, Measuring Surprise: Lift and Leverage, Example: Beer and Lottery Tickets, Associations Among Facebook Likes, Profiling: Finding Typical Behavior, Link Prediction and Social Recommendation.
9 Hours

TEXT BOOKS		
1	Foster Provost and Tom Fawcett	Data Science for Business, Published by O'ReillyMedia, Inc. First Edition, July 2013.

REFERENCE BOOKS		
1	Rachel Schutt & Cathy O'Neil	Doing Data Science, O'Reilly Media, First Edition, October 2013.
2	Hector Cuesta	Practical Data Analysis, PACKT Publishing, First published: October 2013
3	Michael R. Berthold, Christian Borgelt, Frank Hijppner, Frank Klawonn	Guide to Intelligent Data Analysis, Springer-Verlag London Limited 2010.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of mathematics to explain the concept of data science, the available techniques in data science and its scope in business.
CO2	Develop a Decision tree based on supervised segmentation and predict the class for a given data set by selecting (through solving) the attribute for segmentation using the available techniques.
CO3	Analyze the given data set, and solve a problem by performing Classification using the basics of mathematics and data science.
CO4	Develop solutions to group entities in data set and apply it for the given real world data using the basic knowledge of similarity, neighbors and clustering.
CO5	Analyze the importance of mining text (social data) and formulate the association rules based on market basket analysis.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1			3			2	2			2	2
	CO2	3	2			3			2	2			2	2
	CO3	3	2			3			2	2			2	2
	CO4	3	2			3			2	2			2	2
	CO5	3	2			3			2	2			2	2

DEEP LEARNING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE26	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Provide the mathematical and computational demands of building neural networks
2.	Understand the concepts of deep learning
3.	Introduce dimensionality reduction techniques
4.	Apply deep learning techniques for real time applications

UNIT I

Machine Learning Basics

Learning algorithms: regression - classification - clustering, under fitting and Overfitting, Hyper parameters and validation sets, Estimators, bias and variance, Maximum likelihood estimation, Supervised and Unsupervised learning algorithms, Building a Machine learning algorithm.

9 Hours

UNIT II

Foundations of Deep Networks

Neural networks: Perceptron - Multilayer Feedforward Networks - Backpropagation learning, Activation functions: Linear - sigmoid - rectified linear and softmax, Loss functions, regularization, Deep networks: Architecture and design, Pretrained Networks - Deep Belief Networks - Generative Adversarial Networks.

9 Hours

UNIT III
Convolutional Neural Networks (Cnns)
Convolutional Operation, Motivation, Pooling layers, Fully connected layers, A complete CNN architecture: AlexNet - VGG - Inception - ResNet, Training a Convnet: weights initialization - batch normalization - hyperparameter optimization, Variants of CNN architecture.
8 Hours

UNIT IV
Sequence Modeling Using Recurrent Nets
Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep RNNs, Recursive NN, Challenge of long term dependencies, Long Short- Term Memory (LSTM) and other Gated RNNs.
8 Hours

UNIT V
Applications Of Deep Learning
Case studies (one in each) in Computer Vision, Speech Processing, Natural Language Processing.
8 Hours

TEXT BOOKS		
1	Ian Goodfellow, YoshuaBengio, Aaron Courville	Deep Learning, MIT Press, 2016.
2	Josh Patterson, Adam Gibson	Deep Learning: A Practitioner’s Approach, O’Reilly Media, 2017.

REFERENCE BOOKS		
1	Tom Mitchell	Machine Learning, McGraw Hill, 3rd Edition, 1997
2	Charu C. Aggarwal	Data Classification Algorithms and Applications, CRC Press, 2014.
3	Sandro Skansi	Introduction to Deep Learning: From Logical Calculus to Artificial Intelligence, Springer, 2018.
4	Tommaso Teofili	Deep Learning for Search, Manning Publications Company, 2018.

E-Resources:	
1	https://www.youtube.com/watch?v=aPfkYu_qiF4&list=PLyqSpQzTE6M9gCgajvQbc68Hk_ JKGBAYT&index=1

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Understand the fundamentals principles, theory and approaches for learning with deep neural networks.
CO2	Understand the importance of hyper parameter tuning, optimization and loss functions
CO3	Design and implement convolutional neural networks
CO4	Design and implement recurrent neural networks
CO5	Develop a real world application using deep learning networks

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1			3			3	2		2	2	3
	CO2	3	2			3			3	2		2	2	3
	CO3	3	2			3			3	2		2	2	3
	CO4	3	2			3			3	2		2	2	3
	CO5	3	2			3			3	2		2	2	3

MACHINE LEARNING

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE27	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Learn a spectrum of machine learning algorithms with a sound mathematical background.
2.	Understand technical know-how of applying these algorithms for different real-world applications.

UNIT I

Introduction

Review of Probability Theory and Linear Algebra, Probability densities, Expectations and covariance, Bayesian probabilities, Curve fitting, Bayesian curve fitting, Model selection, The Curse of Dimensionality, Decision Theory, Minimizing the misclassification rate, Minimizing the expected loss, The reject option, Inference and decision, Loss functions for regression.

Pattern recognition systems, design cycle, learning and adaptation.

9 Hours

UNIT II

Linear Models for Classification

Discriminant Functions, Two classes and multiple classes, Fisher linear discriminant, Probabilistic Generative Models, Maximum likelihood solution, error probabilities and internals, error bounds for normal densities, Bayes decision theory-discrete features.

9 Hours

UNIT III
Linear Models for Regression Linear Basis Function Models, The Bias-Variance Decomposition: Maximum likelihood and least squares, Geometry of least squares, Bayesian Linear Regression, Bayesian Model Comparison, Limitations of Fixed Basis Functions. Logistic regression, Multiclass logistic regression, Support Vector Machines.
8 Hours

UNIT IV
Neural Networks Neural Networks - Introduction, Early Models, Perceptron Learning, Feed-forward Network Functions, Network Training, Parameter optimization, Local quadratic approximation, Gradient descent optimization Error Back propagation.
8 Hours

UNIT V		
Unsupervised Learning Clustering: Agglomerative clustering, Batchelor and Wilkins algorithm, Graph-based clustering, k-means, adaptive hierarchical clustering, Gaussian mixture model.		
8 Hours		
TEXT BOOKS		
1	Alpaydin Ethem	Introduction to Machine Learning, MIT Press, 3rd Edition, 2014.
2	Christopher Bishop	Pattern Recognition and Machine Learning, Springer, 2010.
3	Richard O Duda, Peter E Hart,and David G Stock	Pattern Classification, John Wiley and Sons, reprint by Wiley India, 2007.

REFERENCE BOOKS		
1	S.Theodoridis and K. Koutroumbas	Pattern Recognition, Academic Press, 4th Ed., 2009.
2	Earl Gose, Richard Johnsonbaugh and Steve Jost	Pattern Recognition and Image Analysis, Prentice-Hall of India, 2003.

E-RESOURCES	
1	https://www.youtube.com/@machinelearning-sudeshnasa3607/videos, Prof. Sudeshna Sarkar, IITKGP https://www.youtube.com/watch?v=jGwO_UgTS7I&list=PLoROMvodv4rMiGQp3WXShtMGgzqpfVfbU
2	https://www.youtube.com/watch?v=jGwO_UgTS7I&list=PLoROMvodv4rMiGQp3WXShtMGgzqpfVfbU, Stanford Online, Prof. Andrew N G

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Classify machine learning algorithms and approaches.
CO2	Use Bayesian decision theory to determine the discriminant function for a two class problem.
CO3	Apply linear regression models to predict the value of a continuous valued output given a training data consisting of univariate/multivariate input features.
CO4	Apply learning algorithms based on logistic regression, Support Vector Machines to predict discrete valued output given a training data comprising of features and corresponding class labels.
CO5	Apply algorithms based on neural networks to perform simple learning tasks like speech recognition, digit recognition, optical character recognition and similar cognitive applications.
CO6	Apply unsupervised learning algorithms to learn patterns from given training set of unlabeled data points.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1			3			3	2		1	2	3
	CO2	3	2	2		3			3	2		1	2	3
	CO3	3	2	3		3			3	2		1	2	3
	CO4	3	2	3		3			3	2		1	2	3
	CO5	3	2	2		3			3	2		1	2	3
	CO6	3	2	2		3			3	2		1	2	3

COMPUTER VISION

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE28	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	To understand fundamental concepts of computer vision providing an overview of the current methodologies and techniques.
2.	To explore the theory behind fundamental computer vision tasks using mathematical framework.

UNIT I

Image Formation and Processing: Introduction to basic conepts of Image, Point Operators-Pixel transforms, Color transforms, Histogram Equalization, Application – Tonal Adjustment, Linear Filtering – Separable filtering, Neighborhood Operators – Non-linear filtering, Bilateral filtering, Geometric transformations – Parametric transformations, Mesh-based warping, Application – Feature-based morphing.

9 Hours

UNIT II

Image Descriptors and Features: Boundary descriptors, Region feature descritors, Principal Component as Feature descriptor, Object Boundary and Shape Representations, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Design Patterns.

8 Hours

UNIT III

Geometric Camera Models and Multiview Geometry: Pinhole Cameras, Three Geometric problems, Homogeneous coordinates, Extrinsic Parameters, Intrinsic Parameters, Applications, Two-view geometry, The

Essential matrix, The fundamental matrix, Two-view Reconstruction, Rectification, Multiview Reconstruction, Applications.
8 Hours

UNIT IV
Depth Estimation and Motion Estimation: Stereopsis: Reconstruction, Depth from Stereo, Epipolar geometry, Sparse Correspondence, 3D curves and profiles, Local models, Sub-pixel estimation, Multi-view stereo, Monocular Depth Estimation, 3D Vision, Virtual View Synthesis, Motion Estimation-Hierarchical motion estimation, Parametric motion, Optical flow
8 Hours

UNIT V
Machine Learning for Computer Vision: Computer vision problems, Types of model, Example of Regression and Binary Classification, Applications, Modeling complex data densities, Normal classification model, Regression models: Linear regression, Non-linear regression, Classification models: Logistic regression, Unsupervised Learning – Clustering, Applications .
9 Hours

TEXT BOOKS		
1	Richard Szeliski	Computer Vision: Algorithms and Applications, Springer, 2010.
2	Simon J.D. Prince	Computer vision: Models, Learning and Inference, Cambridge University Press, 2012.

REFERENCE BOOKS		
1	David A Forsyth Jean Ponce	"Computer Vision – A Modern Approach", PHI Learning, 2009.
2	Rafael C. Gonzalez and Richard E. Woods	"Digital Image Processing", Pearson Education, 2018.
3	Richard Hartley, Andrew Zisserman	"Multiple View Geometry in Computer Vision," Cambridge University Press, 2004

E-RESOURCES	
1	https://onlinecourses.nptel.ac.in/noc19_cs58/preview

Course Outcomes:

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

CO1	Analyze fundamental image formation techniques required for computer vision.
CO2	Identify and choose various techniques for feature extraction for further analysis
CO3	Analyze geometric concepts of camera and multiview geometry
CO4	Analyze various depth estimation and motion estimation techniques
CO5	Identify Machine Learning and Neural Network concepts and develop Computer Vision applications
CO6	Use modern engineering tools to develop algorithms for computer vision applications

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	3			1							3	1
	CO2	3	3			1							3	1
	CO3	3	3			1							3	1
	CO4	3	3			1							3	1
	CO5	3	3	1		2							3	2
	CO6	3	3	1		2			1	1		2	3	2

III. MICROELECTRONICS:

LOW POWER VLSI DESIGN

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE29	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Learn various techniques for designing low power circuits and systems.
2.	Describe issues related at architectural, logic, circuit and device levels and some of the techniques to overcome these difficulties.

UNIT I

Introduction: Need for Low power VLSI chips, Charging and discharging capacitance, Short circuit currents in CMOS circuit, CMOS leakage current, Static current, Basic Principles of low power design, Sources of dissipation in Digital Integrated circuits, Emerging low power approaches, Dynamic dissipation in CMOS, Effects of V_{dd} and V_t, constraints on V_t reduction, Transistor sizing and optimal gate oxide thickness.

9 Hours

UNIT II

Power estimation, Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.

8 Hours

UNIT III
Low Power Circuit Techniques: Introduction to Power consumption in circuits, Flip flops and latches, logic, High Capacitance nodes.
8 Hours

UNIT IV
Logical Level Power Optimization: gate reorganization, local restructuring, signal gating, logic encoding, state machine encoding, pre-computation logic.
8 Hours

UNIT V
Architecture and system: Power and Performance management, Switching activity reduction, Parallel Architecture with voltage reduction, Flow graph Transformation. **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew.
9 Hours

TEXT BOOKS		
1	Gary K. Yeap	Practical Low Power Digital VLSI Design, Springer Science & Business Media, 2012.
2	Rabaey, Pedram	Low Power Design Methodologies, Springer science, 2012.

REFERENCE BOOKS		
1	Kaushik Roy, Sharat C. Prasad	Low-Power CMOS VLSI Circuit Design, Wiley publication, 2009.

E-Resources:	
1	https://www.youtube.com/watch?v=ruClwamT-R0&list=PLB3F0FC99B5D89571 &index=1

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Demonstrate the technique for computing the power dissipation and power issues in VLSI circuits.
CO2	Analyze various approaches of power dissipation at different levels of abstraction through simulation for power efficient circuit design.
CO3	Explore the power consumption in sequential circuits, design power efficient driver circuit for high capacitive loads.
CO4	Apply reorganization technique to design power efficient circuits.
CO5	Provide architectural solution to achieve power efficiency and issues related with clock distribution.
CO6	Demonstrate capability of self-learning and communication skills through presentation.

Course Articulation Matrix

		POs											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	1										2	
	CO2	3	1										2	
	CO3	3	2										2	
	CO4	3	2										2	
	CO5	3	2										2	
	CO6	3	2			2			2	2		2	2	2

ANALOG AND MIXED MODE VLSI DESIGN

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE30	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Learn fundamentals of data converters, along with various ADC & DAC architecture.
2.	Describe issue related to non-linear analog circuits.
3.	Learn sub-microns CMOS circuit design issues at low & High frequency.

UNIT I

Data converter fundamentals: Analog versus Digital Discrete Time Signals, Converting Analog Signals to Data Signals, Sample and Hold Characteristics, DAC Specifications, ADC Specifications, Mixed-Signal Layout Issues.

7 Hours

UNIT II

Data Converters Architectures: DAC Architectures, Digital Input Code, Resistors String, R-2R Ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, Pipeline DAC, ADC Architectures, Flash, 2-Step Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC.

12 Hours

UNIT III

Non-Linear Analog Circuits: Basic CMOS Comparator Design (Excluding Characterization), Analog Multipliers, Multiplying Quad (Excluding Stimulation), Level Shifting (Excluding Input Level shifting For Multiplier).

8 Hours

UNIT IV
Data Converter SNR: Improving SNR Using Averaging (Excluding Jitter & Averaging onwards), Decimating Filters for ADCs (Excluding Decimating without Averaging onwards), Interpolating Filters for DAC, Band pass and High pass Sync filters.
8 Hours

UNIT V
Sub-Microns CMOS circuit design: Process Flow, Capacitors and Resistors, MOSFET Switch (upto Bidirectional Switches), Delay elements, adder Elements, Analog Circuits MOSFET Biasing (upto MOSFET Transition Frequency).
7 Hours

TEXT BOOKS		
1.	R. Jacob Baker, Harry W Li, David E Boyce	CMOS Circuit Design, Layout and simulation, John Wiley publication, 1998.
2.	R. Jacob Baker	CMOS- Mixed Signal Circuit Design, (Vol II of CMOS: Circuit Design, Layout and Stimulation), John Wiley India Pvt. Ltd, 2009.

REFERENCE BOOKS		
1.	B Razavi	Design of Analog CMOS Integrated Circuits, First Edition, McGraw Hill, 2005.
2.	P E Allen and D R Holberg	CMOS Analog Circuit Design, 2^{nd} Edition, Oxford University Press, 2002.

E-Resources:	
1	https://www.youtube.com/watch?v=ZcTTkCWnQNg&list=PL2135D8A0F7441AE1
2	https://www.youtube.com/watch?v=oia9paQF06k&list=PLG4LDxYH2oQqN5f_eGRCUveQ6xkTPWZd

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the concepts of data conversion.
CO2	Compare different data converter architectures.
CO3	Design comparator, Analog multipliers and level shifters.
CO4	Improve signal to noise ratio of data converters by filtering
CO5	Design circuits by using submicron CMOS devices.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2										2	
	CO2	2	2			1							2	
	CO3	2	2			1							2	
	CO4	2	2										2	
	CO5	2	1										1	
	AVG.	2	2			1							2	

ASIC DESIGN

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE31	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Classify ASICs and describe various design methodologies used in the implementation of integrated circuits.
2.	Estimate logical efforts and logical efficiency of logic cell and compute the design economics in the IC design process.
3.	Design arithmetic circuits in terms of data path elements.
4.	Formulate a process involved in VLSI testing and verification.
5.	Explore the basic techniques involved in VLSI backend design.

UNIT I

Introduction to ASICS: Full Custom with ASIC, Semi custom ASICS, Standard Cell based ASIC, Gate array based ASIC, Channeled gate array, Channelless gate array, structured gate array, Programmable logic device, FPGA design flow, ASIC cell libraries.

Design methodology: Structure Design, Strategy, Hierarchy, Regularity, Modularity, and Locality.

8 Hours

UNIT II

ASIC library Design: Logical effort: practicing delay, logical area and logical efficiency logical Paths, multi stage cells, optimum delay, optimum no. of stages, library cell design.

Design Economics: Nonrecurring and recurring engineering Costs, Fixed Costs, Schedule, Person power, example.

8 Hours

UNIT III
Data logic cells: Data Path Elements, Adders, Multiplier, Arithmetic Operator, I/O cell, Cell Compilers. **Programmable ASIC**: programmable ASIC logic cell, ASIC I/O cell.
8 Hours
UNIT IV
VLSI System Testing & Verification: Introduction, Logic verification, Basic digital debugging hints, Manufacturing tests, test programs, logic verification principles, Test benches and Harnesses, regression testing, silicon debug principles Manufacturing test principles, fault modules. Observability and controllability, fault coverage, ATPG, Delay Fault Testing, design for testability, adhoc testing, scan design Built in self test.
9 Hours

UNIT V
ASIC Construction Floor planning and placement and routing: Physical Design, CAD Tools, System Partitioning, Estimating ASIC size, partitioning methods. Floor planning tools, I/O and power planning, clock planning, placement algorithms, iterative placement improvement, Time driven placement methods. Physical Design flow global Routing, Local Routing, Detail Routing, Special Routing, Circuit Extraction and DRC**.**
9 Hours

TEXT BOOKS		
1.	M.J.S. Smith	Specific Integrated Circuits, Pearson Education, 2016
2.	Neil H.E.Weste, Davir Harris	CMOS VLSI Design: A Circuits and system perspectives, Addison Wesley - Pearson Education, 3rd Edition, 2010

REFERENCE BOOKS		
1.	Jose E.France, Yannis Tsividis	Design of Analog-Digital VLSI Circuits for Telecommunication and signal processing, Prentice Hall, 1994.
2.	S. Y. Kung, H. J. Whilo House, T. Kailath	VLSI and Modern Signal Processing, Prentice Hall, 1985.
3.	Jose E. France, Yannis Tsividis	Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing, Prentice Hall, 1994.

E-Resources:	
1	https://www.youtube.com/watch?v=oZSv68esbgI
2	https://www.youtube.com/watch?v=4cPkr1VHu7Q

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Classify different types of ASICs and explain design techniques used in implementation of integrated circuits.
CO2	Estimate logical efforts, path delays, logical efficiency of logic cell and design economics involved in ICs Design.
CO3	Compare various programmable ASIC technologies and also analyze arithmetic circuits.
CO4	Analyze process involved in logic verification and testing of a VLSI design.
CO5	Investigate different techniques involved in physical design using CAD tools.

Course Articulation Matrix

		PO's											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	2	1										1	
	CO2	2	2	1		2			2	2		2	1	
	CO3	2	2										1	
	CO4	2	2	1									1	
	CO5	2	2	1	1	2			2	2		2	1	
	AVG	2	2	1	1	2			2	2		2	1	

VLSI TESTING AND VERIFICATION

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE32	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Learn various fault detection and fault modeling techniques in digital circuits.
2.	Discuss different algorithms for fault detection in memories, combinational and sequential circuits.
3.	Understand various verification tools and simulators.

UNIT I

Introduction to Testing: Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends Affecting Testing.

Faults: Faults in logic circuits, Breaks, Transistors Stuck-Open and Stuck-On or Stuck-Open Faults in CMOS, Basic concepts of fault detection.

Fault modelling: Fault equivalence, Fault collapsing and fault dominance.

9 Hours

UNIT II

Test Generation for Combinational Logic Circuits: Test Generation Techniques for Combinational Circuits: Truth table and Fault matrix method, Path sensitization method, D-Roth algorithm, PODEM and FAN.

8 Hours

UNIT III
Design of Testable Sequential Circuits: Ad Hoc Design Rules for Improving Testability, Design of Diagnosable Sequential Circuits, The Scan-Path Technique for Testable Sequential Circuit Design, Level-Sensitive Scan Design, Random Access Scan Technique, Partial Scan, Testable Sequential Circuit Design Using Nonscan Techniques.
8 Hours

UNIT IV
Built-In Self Test: Test Pattern Generation for BIST, Output Response Analysis, Circular BIST, BIST Architectures-BILBO **Memory Testing:** Functional RAM testing with March tests, Testing RAM Neighbourhood Pattern Sensitive Faults (NPSF), Testing RAM technology and layout related faults.
8 Hours

UNIT V
Importance of Design Verification: The importance of verification, Reconvergence model, Formal verification, Assertion based verification, Equivalence checking, Model checking, Functional verification. **Verification Tools:** Linting tools: Limitations of linting tools, linting verilog source code, linting VHDL source code, linting OpenVera and e-source code, code reviews. **Simulators:** Stimulus and response, Event based simulation, cycle based simulation, Co-simulators, verification intellectual property: hardware modellers, waveform viewers.
9 Hours

TEXT BOOKS		
1	Parag K. Lala	An Introduction to Logic Circuit Testing, Morgan and Claypool Publishers, 2009.
2	M. L. Bushnell and V. D. Agrawal	Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Springer Science & Business Media., 2004.
3	Janick Bergeron	Writing test benches: functional verification of HDL models, 2nd Edition, Kluwer Academic Publishers, 2003.

REFERENCE BOOKS		
1	M. Abramovici, M.A. Breuer and A.D. Friedman	Digital Systems Testing and Testable Design, John Wiley Publications, 2012.

E-Resources:	
1	https://www.youtube.com/watch?v=tP9nh1g14E8&t=1015s
2	https://archive.nptel.ac.in/courses/106/105/106105161/
3	https://nptel.ac.in/courses/117105137
4	https://nptel.ac.in/courses/106103016

Course Outcomes:

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

CO1	Analyze and model faults in logic circuits
CO2	Develop test patterns for combinational logic circuits using various algorithms
CO3	Design testable sequential circuits
CO4	Construct test pattern for BIST and design test algorithms for memory
CO5	Analyze different verification tools and simulators
CO6	Demonstrate capability of self learning, team work and communication skills through presentation

Course Articulation Matrix

		POs											PSOs	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	2										2	
	CO2	3	2										2	
	CO3	3	2										2	
	CO4	3	1										2	
	CO5	2	2										2	
	CO6	3	2			2			2	2		2	2	2

SMART MATERIALS AND SMART SYSTEMS

Contact Hours/ Week:	3+0+0	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Sub. Code:	SECE33	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Introduce smart materials and systems in miniaturization.
2.	Understand the overview of physical and chemical techniques for thin film deposition.
3.	Describe various aspects of electronic devices and circuits.
4.	Understand working principles of characterization tools.
5.	Understand case studies of microsystems integrated with electronics.

UNIT I

Basics of Smart materials

Smart materials, structures and Systems, Integrated Microsystems, Specialized material for Microsystems, Application of smart materials and Microsystems.

8 Hours

UNIT II

Fabrication Technology

Thermal oxidation, Thin film deposition, Doping, Lithography, Etching, Silicon micromachining, Advanced processes for microfabrication, Metalization.

8 Hours

UNIT III
Semiconductor Devices Metal-semiconductor junctions, Schottky vs. Ohmic junctions, Band gap diagrams, I-V Characteristics, p-n junctions, Equlibrium and under bias (forward and reverse), Band Diagrams, I-V characteristics, Junction breakdown, Heterojunctions, The Bipolar Junction transistor, Electronic Amplifiers.
9 Hours
UNIT IV
Thin film Characterization Overview of thin film characterization, Imaging techniques: Scanning electron microscopy (SEM), AFM, Structural properties: X-ray diffraction (XRD), Electrical properties: Resistance/resistivity –four point probe, Vander Pauw, Mechanical properties: Stress-curvature measurements.
9 Hours

UNIT V
Actuators and Sensors Silicon Capacitive Accelerometer, Conductometric Gas sensor, Portable Blood Analyzer, Smart materials and Systems, Integration of Micro and smart systems, CMOS First, MEMs First, Case studies of integrated microsystem.
8 Hours

TEXT BOOKS		
1	S.M.Sze	Semiconductor devices: Physics and Technology, 2nd edition, Wiley, 2008.
2	G.K. Ananthasuresh, K.J. Vinoy,, S. Gopalakrishnan, K. N. Bhat, V.K. Aatre	Micro and Smart Systems, Wiley, 2011.

REFERENCE BOOKS		
1	M. V. Gandhi and B. S. Thompson	Smart Materials and Structures, Springer 1992.

E-Resources:	
1	https://nptel.ac.in/courses/112108092

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe smart materials used in electronic engineering.
CO2	Analyse different techniques used for fabrication of devices.
CO3	Design circuits for microsystem and smart systems.
CO4	Identify the characterization tool for a device.
CO5	Integrate sensors with microsystem and smart systems.
CO6	Demonstrate capability of self-learning and communication skills through presentation.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1										2	
	CO2	3	2										2	
	CO3	3	2										2	
	CO4	3	2										2	
	CO5	3	2										2	
	CO6	3	2	2					2	2		2	2	2
	AVERAGE	3	2	2					2	2		2	2	2

COMPOUND SEMICONDUCTOR DEVICES AND APPLICATIONS

Contact Hours/ Week:	3+0+0	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Sub. Code:	SECE34	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the properties of III-V compound semiconductors.
2.	Know the fabrication technics of GaAs and related semiconductor devices.
3.	Learn design techniques of schottky, MESFET and various RF and MW solid state devices.
4.	Understand photonic devices and GaN power devices.

UNIT I

Introduction to GaAs and related materials

Unit1: Properties of III-V compounds-Density of states in 2-, 1- and 0-dimensions, conduction processes, optical processes, recombination, absorption and radiations in semiconductors.

7 Hours

UNIT II

Fabrication heterostructures

Bulk single crystal growth (Bridgeman and LEC)-Wafer fabrication and specification, Epitaxy (MBE and OMVPE) of single crystal layers, heterostructures and dissimilar materials, quantum wells, superlattices, quantum wires and quantum dots, doping techniques, emerging III-V materials (GaN).

8 Hours

UNIT III
Schottky, MESFET and MW devices Metal (Schottky) and ohmic contact techniques. GaAs metal-semiconductor field effect transistor (GaAs MESFET): introduction, structure, equivalent circuits, current saturation, effect of source and drain resistance, gate resistance and application of GaAs MESFET. Physics, operation and technology of RF and microwave solid state devices- schottky, IMPATT, TRAPATT, PIT, tunnel and GUNN diodes.
9 Hours
UNIT IV
HEMT, HBTs and GaN power devices High electron mobility transistor (HEMT)-structure, energy band line-up, equivalent circuit, HEMPT noise, psedomarphic HEMT and applications, resonant tunneling diodes, heterojunction bipolar transistor (HBTs), GaN power devices.
9 Hours

UNIT V
Photonic devices : light emitting diodes (LEDs), solar cells, photodetectors, lasers. photoelectronic integration of compound semiconductor devices: heterojunction phototransistor (HPT) and light amplifying optical switch (LAOS). Reliability and degradation GaAs and related devices-FETs, HBTs, LEDs and lasers.
9 Hours

TEXT BOOKS		
1	Pallab Bhattacharya	Semiconductor optoelectronic devices, Pearson, 2nd Edition, 2017.
2	V Swaminathan and A. T. Macrander	Material aspects of GaAs and InP based structures, Printice Hall, Englewood Cliffs, NJ, 1991.

3	Joseph Man	GaAs integrated circuits, Macmillan publishing company, Now York (1988).
4	Sitesh Kumar Roy and MonojitMitra	Microwave semiconductor devices, Printice-Hall of India Private Ltd., New Delhi, 2003.

REFERENCE BOOKS		
1	M. J. Howes and D. V. Morgan	ED., Reliability and Degradation-semiconductor devices and circuits, John Wiley &Sons, New York, 1981.
2	S. K. Ghandhi,	VLSI fabrication principals-Silicon and GaAs, John Wiley & Sons, New York, 2008.

E-Resources:	
1	https://www.youtube.com/watch?v=o3mpbZ_FRd0

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe different III-V compound semiconductors, electrical and optical properties.
CO2	Apply fabrication techniques to homo and heterojunction devices.
CO3	Describe the technology used in RF and MW devices.
CO4	Design HEMT, HBTs and GaN power devices.
CO5	Analyse reliability and degradation of GaAs and related devices.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	2										2	1
	CO2	2	2										2	1
	CO3	2	2										2	1
	CO4	2		2									2	1
	CO5	2		2									2	1
	AVG	2	2	2									2	1

SYSTEM VERILOG

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE35	SEE Marks:	50

Course objectives:
This course will enable students to:

1.	Understand System Verilog Language Fundamentals
2.	Design Synthesizable Digital Systems
3.	Develop and Utilize Testbenches for Verification
4.	Importance of System Verilog Assertions
5.	Apply Advanced Verification Techniques

UNIT I

Overview of HDL: Introduction to System Verilog Overview and History Key features and advantages Differences from Verilog Applications in design and verification Data Types and Literals, Built-in data types, User-defined data types: typedef, enum, struct, union. Constants and literals, Operators: Arithmetic, logical, relational, bitwise, Reduction and shift operators, Operator precedence and associativity.

8 Hours

UNIT II

Procedural and Behavioral Modeling : Procedural Blocks, Initial and always blocks, Procedural assignments: blocking vs. non-blocking, Sensitivity lists, control Flow Statements, Conditional statements: if-else, case, unique case, Looping constructs: for, while, do-while, repeat, forever, foreach, Tasks and Functions: Differences between tasks and functions, Declaring and using tasks and functions, Arguments, return values, and scope.

8 Hours

UNIT III

Advanced Data Types and Constructs : Arrays and Queues, Fixed-size arrays, Dynamic arrays, Queues: declaration and operations, Array methods: find, sort, shuffle, Structures and Unions, Packed and unpacked

structures, Unions and their applications, Packages and Interfaces: Defining and using packages, Importing and exporting package contents, Introduction to interfaces and their benefits.
8 Hours

UNIT IV
Assertions and Functional Coverage : System Verilog Assertions (SVA): Introduction to assertions Immediate assertions, Concurrent assertions, Assertion properties and sequences Functional Coverage Introduction to coverage concepts Cover groups and cover points Cross coverage Writing and analyzing coverage reports.
9 Hours

UNIT V
Object-Oriented Programming (OOP) and Test benches : Classes and OOP Concepts Introduction to OOP in System Verilog Defining classes and objects Constructors and methods Inheritance, polymorphism, and encapsulation Building Testbenches, Testbench architecture and components. Writing effective testbenches, Simulation and debugging techniques.
9 Hours

TEXT BOOKS		
1	Stuart Sutherland, Simon Davidmann, and Peter Flake	System Verilog for Design: A Guide to Using System Verilog for Hardware Design and Modeling 2ND edition, 2006, Springer-Verilag, New York.
2	Chris Spear and Greg Tumbush	System Verilog for Verification: A Guide to Learning the Test bench Language Features, 3rd Edition, 2012, Springer.
3	Harry Foster, Adam Krolnik, and David Lacey	Assertion-Based Design, 2nd Edition, 2003, Kluwer Academic Publishers.
4	Srikanth Vijayaraghavan and Meyyappan Ramanathan	A Practical Guide for System Verilog Assertions, 2005, Springer.

REFERENCE BOOKS		
1	Joseph Cavanagh	Digital Design and Verilog HDL Fundamentals, 2008, Taylor and Francis.

E-RESOURCES	
1	https://onlinecourses.nptel.ac.in/noc21_ee97/preview
2	https://www.youtube.com/watch?v=y2sOUY5FlfM&list=PL40xmtPvboRs6Ng_1Q_V-1MdJH50A6Ulz

Course Outcomes:

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

CO1	Develop the system Verilog code using data types for digital design
CO2	Select the suitable abstraction level for digital design verification
CO3	Develop system verilog code using arrays and queues
CO4	Verify digital design using assertion method
CO5	Analyze and verify the functionality of digital circuits/systems using test benches

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2			1							1	1
	CO2	3	2			1							1	
	CO3	2	2			1							1	1
	CO4	3	2			2							1	

IV. EMBEDDED SYSTEMS:

SYSTEM PROGRAMMING & OPERATING SYSTEM

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE37	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand basics of OS concepts and techniques, which can be easily transported to the newer OS.
2.	Articulate the various management systems of OS.

UNIT I

Assemblers, Compilers and Interpreters: Elements of Assembly language programming, a simple assembly scheme, Pass structure for assemblers, Design of Two pass assemblers, A single pass Assembler for IBM PC, Compilers, Aspects of Compilation, Memory Allocation, Compilation of Control Structures, Code Optimization, Interpreters.

9 Hours

UNIT II

INTRODUCTION AND OVERVIEW OF OPERATING SYSTEMS: Operating system, Goals of an O.S, Operation of an O.S, Resource allocation and related functions, O.S and the computer system, Classes of operating systems, Batch processing system, Multi programming systems, Time sharing systems, Real time operating systems, distributed operating systems.

9 Hours

UNIT III
STRUCTURE OF OS: Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel based operating systems, and Microkernel based operating systems. **PROCESS MANAGEMENT:** Process concept, Programmer view of processes, OS view of processes, Interacting processes, Threads.
8 Hours

UNIT IV
MEMORY MANAGEMENT: Memory allocation to programs, Memory allocation preliminaries, Contiguous and noncontiguous allocation to programs, **VIRTUAL MEMORY:** Virtual memory basics, Virtual memory using paging, Demand paging, Page replacement, Page replacement policies.
8 Hours

UNIT V
FILE SYSTEMS: File system and IOCS, Files and directories, Overview of I/O organization, Fundamental file organizations, Interface between file system and IOCS, Allocation of disk space, Implementing file access. **SCHEDULING:** Fundamentals of scheduling, Long-term scheduling, Medium and short term scheduling, Real time scheduling.
8 Hours

TEXT BOOKS		
1	D.M.Dhamdhere,	Systems Programming and Operating Systems, Tata McGraw Hill-Second Revised Edition 2011 (UNIT 1)
2	D.M. Dhamdhare	Operating Systems - A Concept based Approach, TMH, 3rd Ed, 2010.

REFERENCE BOOKS		
1	Operating System Concepts	A Sliberschatz and P B Galvin, Addison Wesley 1998
2	Modern operating system	Andrew.S.Tannenbaum Ed 3. PHI. 2008.

E-Resources:	
1	https://onlinecourses.nptel.ac.in/noc21_cs39/preview

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Understand the parallel computer architecture and processing techniques.
CO2	Realize shared memory and scalable multiprocessors
CO3	Design interconnection of the topologies network
CO4	Develop and apply knowledge of distributed system organization and communication.
CO5	Understand the file structure and its coordination

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2										2	
	CO2	3	2										2	
	CO3	3	2										2	
	CO4	3	2										2	
	CO5	3	2										2	

ADVANCED COMPUTER ARCHITECTURE

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE38	SEE Marks:	50

Course objectives:
This course will enable students to:

1.	Learn multiprocessors and multicomputer.
2.	Compare the performance issues related to parallel processing.

UNIT I

Parallel computer models: The state of computing, Multiprocessors and multi computers, Multi-vector and SIMD computers.

8 Hours

UNIT II

Program and network properties: Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism, Program partitioning and scheduling, Grain Size and latency, Program flow mechanisms, Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms.

9 Hours

UNIT III

Principles of Scalable Performance: Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.

8 Hours

UNIT IV

Advanced processors: Advanced processor technology, Instruction-set Architectures, CISC Scalar Processors (VAX 8600, Motorola MC 68040) RISC Scalar Processors (SPARC, Intel i860) Superscalar Processors (IBM RS/6000), VLIW Architectures, Vector and Symbolic processors.

9 Hours

UNIT V
Pipelining: Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline Design, Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction.
8 Hours

TEXT BOOKS		
1	Kai Hwang	Advanced computer architecture, TMH, Edition 3, 2003.
REFERENCE BOOKS		
1	Kai Hwang and Zu	Scalable Parallel Computers Architecture, MGH. 1998.
2	M.J Flynn	Computer Architecture, Pipelined and Parallel Processor Design, Narosa Publishing. 1st Edition, 1995.
3	D.A.Patterson And J.L.Hennessy	Computer Architecture: A quantitative Approach, Morgan Kauffmann, Edition V, Feb., 2002. 2011

E-RESOURCES	
1	https://nptel.ac.in/courses/106103206
2	https://nptel.ac.in/courses/106102229
3	https://onlinecourses.nptel.ac.in/noc21_cs95/preview
4	https://www.digimat.in/nptel/courses/video/106102229/L01.html
Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the various parallel computing models like multiprocessors and multicomputers, multi-vector and SIMD computers.
CO2	Identify and analyse the program and network properties to improve the performance.

CO3	Analyze the principles of scalable performance such as performance metrics and measures, parallel processing applications, speedup performance laws.
CO4	Analyze and compare the advanced processor technology.
CO5	Design linear and nonlinear pipeline processors.

Course Articulation Matrix

	POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2											1	
	CO2	2	2										1	
	CO3	2	1										1	
	CO4	2	2										1	
	CO5	3	2										2	

PARALLEL PROCESSING & DISTRIBUTED SYSTEMS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE39	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Acquire core knowledge of parallel computer architecture and processing techniques, which can be easily, transported to practical design.
2.	Demonstrate the basic knowledge of distributed system organization and communication.
3.	Articulate the course fundamental principles and concepts.

UNIT I

Part A: Parallel processing

Introduction: Development history, Parallel Architecture, Convergence of Parallel Architectures, Fundamental Design Issues.

Parallel programming & its Performance: The Parallelization Process, Partitioning for Performance Factors from the Processors' Perspective.

9 Hours

UNIT II

Shared memory multiprocessor: Introduction, Cache Coherence, Memory Consistency, Design Space for Snooping Protocols.

Scalable Multiprocessors: Scalability, Bandwidth Scaling, Realizing Programming models.

8 Hours

UNIT III
Interconnection Network Design: Introduction, Organizational Structure, Interconnection Topologies. **Latency Tolerance:** Introduction, Overview of Latency Tolerance, Latency Tolerance in a Shared Address Space, Block Data Transfer in a Shared Address Space.
9 Hours
UNIT IV
Part B: Distributed systems **Introduction:** Characterization, System models, Networking & Internetworking introduction, Types of networks. **Interprocess communication:** Client server communication, group communication, communication between distributed objects (Excluding Java examples).
8 Hours

UNIT V
Distributed File structure, File service architecture, name services, clock events and process state, global states. **Coordination:** Distributed mutual exclusion, Election, Replication introduction, Fault tolerant services.
8 Hours

TEXT BOOKS		
1	D. Culler, J.P. Singh, and A. Gupta;	Parallel computer architecture: A hardware/software approach. Elesvier 2000.
2	G. Coulouris, J. Dollimore, and T. Kindberg,	Distributed Systems: Concepts and Designs, Fourth Edition, Pearson Education Ltd., 2005.

REFERENCE BOOKS		
1	Hesham El-Rewini	Advanced computer architecture and parallel processing. John Wiley & Sons, 2005.
2	Sukumar Ghosh	Distributed Systems: An Algorithmic Approach, CRC Press, 2006.

E-Resources:	
1	https://onlinecourses.nptel.ac.in/noc21_cs39/preview

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the parallel computer architecture and processing techniques.
CO2	Realize shared memory and scalable multiprocessors
CO3	Design interconnection of the topologies network
CO4	Develop and apply knowledge of distributed system organization and communication.
CO5	Explain the file structure and its coordination

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3											2	
	CO2	3											2	
	CO3	3											2	
	CO4	3											2	
	CO5	3											2	

SENSORS FOR BIOMEDICAL APPLICATIONS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE40	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Provide the basic understanding of measurement, insight of resistive sensors and its applications in real life.
2.	Familiarize the characteristics, working principle and application of smart sensors.
3.	Provide the basic understanding of bioelectrical signals and its measurement.
4.	Impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life.
5.	Familiarize the concepts of wearable antennas.

UNIT I

Introduction to sensors: Functional Elements of a Measurement System and Instruments, Applications and Classification of Instruments, General concepts and terminology of Sensor systems, Transducers classification-sensors and actuators, General input-output configurations, Static and dynamic characteristics of measurement system, Sensors and their characteristics, sensor technologies, Resistive sensors- strain gages , light dependent resistor (LDR), resistive gas sensors, capacitive sensors-variable capacitor, differential capacitor.

8 Hours

UNIT II
Smart sensors: Accelerometers: Characteristics and working principle, Types- Capacitive, Piezoresistive, piezoelectric; Diaphragm Pressure Sensor –resistive & capacitive type (micro press sensor). Integrated and Smart sensors, Overview of various smart sensors: Digital temperature sensor (DS1621, TMP36GZ), Humidity sensor (DHT11, DHT22, and FC28), IR sensor (FC51), Gas sensor (MQ2, MQ8), Pressure sensors (BMP180), Accelerometers (ADXL335), Structural health monitoring sensors, Introduction to MEMS and Flexible sensors.
8 Hours
UNIT III
Bio-electric signals and sensors: ECG signal origin, parameters and Characteristics, EMG signal and recording, measurement of heart rate, pulse rate, blood pressure, blood oxygen sensing, blood flow, blood glucose, Plethysmography, sensors for ECG, EMG, EEG and optical sensor for blood flow measurement, strain sensor for monitoring physiological signals, body movement, motion sensors for fall detection and PD(Parkinson's disease) patients.
8 Hours

UNIT IV
Introduction to wearable technology: Introduction to world of wearable (WOW), Role of wearable, The Ecosystem enabling Digital Life, Ethics and standards, Attributes of wearables, Taxonomy for wearables, Challenges and opportunities, future and research roadmap, Textiles and Clothing, Wearable applications, Wearable Bio and Chemical Sensors: Introduction, System Design, Micro needle Technology, Types of Sensors, Challenges in Chemical Biochemical Sensing: Sensor Stability, Interface with the Body, Textile Integration, Power Requirements, Applications: Personal Health, Sports Performance, Safety and Security.
9 Hours

UNIT V
Wearable antennas for communication systems: Introduction, Background of textile antennas, Design rules for embroidered antennas, Characterizations of embroidered conductive, textiles at radio frequencies, Applications of embroidered antennas, wideband wearable printed dipole antennas, Wearable loop antenna with ground plane, wearable antennas in vicinity of human body, wearable antenna arrays.
9 Hours

TEXT BOOKS		
1	A.K. Sawhney	Electrical and Electronic Measurements and Instrumentation", DhanpatRai, 2015.
2	R.S.Khandpur	Biomedical instrumentation: Technology and applications", Tata McGraw-Hill Publishing, 1st edition 2004.
3	Edward Sazonov	Wearable Sensors: Fundamentals, Implementation and Applications, Neuman Academic Press, 1st Edition, 2014.
4	Tilak Das	Electronic Textiles: Smart Fabrics and Wearable Technology, Woodhead Publishing; 1st edition, 2015.
REFERENCE BOOKS		
1	L. Cromwell, FJ Weibell and EA Pfeiffer	Biomedical instrumentation and measurements, Prentice-Hall Inc., New Jersey, USA, 2nd edition, 1980.
2	Albert Sabban	Novel wearable antennas for communication and medical systems, CRC press, 2018.
3	Subhas C. Mukhopadhyay	Wearable Electronics Sensors-For Safe and Healthy Living, Springer International Publishing, 2015.

E-Resources:	
1	https://nptel.ac.in/courses/108/108/108108147/
2	https://www.coursera.org/lecture/wearable-technologies/introduction-to-wearable-technology-e0kP5
3	http://digimat.in/nptel/courses/video/108108147/L01.html

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of measurements to identify the sensor characteristics which can be employed for real life applications.
CO2	Classify the special purpose sensors required for the development of smart sensors.
CO3	Analyze bioelectrical signals and measure physiological parameters.
CO4	Describe the taxonomy of the wearable devices and its design constraints for measuring physical and biological signals.
CO5	Realize the concepts of wearable antennas for communication systems.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	1						2	2			2	2
	CO2	3	2						2	2			2	2
	CO3	3	2						2	2			2	2
	CO4	3	2						2	2			2	2
	CO5	3	2						2	2			2	2
	AVERAGE	3	2						2	2			2	2

APPLIED EMBEDDED SYSTEMS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE41	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the implementation and applications of the embedded system.
2.	Discuss the common controllers used to build the embedded system.
3.	Learn the various software development approaches and an operating system services required.

UNIT I

Introduction:

An embedded system, Processors embedded into a system, Embedded hardware units and devices in a system, Embedded software in a system, Examples of embedded systems, Embedded system on chip (SoC) and use of VLSI circuits design technology, Complex systems design and processors, Design process in embedded system, Formalism of system design, Design process and design examples, Classification of embedded systems, Skills required for an embedded system designer.

8 Hours

UNIT II

Embedded controller (PIC)

CPU architecture and instruction sets: Hardware architecture and pipelining, program memory consideration, Register file structure and Addressing modes, CPU register, Instruction set, Loop time subroutine

Timer2 and Interrupts: Timer2 use interrupt logic, Timer2 Scalar Initialization.

External interrupts and Timers: Timer0 Compare/capture mode, Timer1/CCP programmable period scalar. Timer1 and sleep mode, PWM O/P Port B change interrupts.
8 Hours

UNIT III
Low Power embedded controller: Low Power embedded systems, Key differentiating factors between different MSP430 families. Target applications. MSP430 RISC CPU architecture**,** Compiler friendly features, Instruction set, Clock system, Reset system, Memory subsystem. On chip peripherals. Watchdog Timer, Comparator, Op-Amp, Basic Timer, Real Time Clock (RTC), ADC, DAC, SD16. Using the Low power features of MSP430. Low power modes, Clock request feature, Low power programming and Interrupt.
9 Hours

UNIT IV
PROGRAM MODELING CONCEPTS Program models, Data flow graph models, State machine programming models for event controlled programs, Modeling of multiprocessor systems, UML modeling. **Embedded RTOS** Inter process communication, Process Management, Timer Functions, Event Functions, Memory management, Device, File, and IO Subsystems Management, Interrupt Routines in RTOS environment and handling of interrupt source calls by RTOS, Introduction to Real Time Operating System, Basic Design Using a Real Time Operating System, RTOS Task Scheduling Models, Latency, Response Times, Deadline as Performance Metric, Latency and Deadlines as Performance Metric in Scheduling Models For Periodic, Sporadic and Aperiodic Tasks, CPU Load as Performance Metric, Sporadic Task Model Performance Metric. OS security issues.
9 Hours

UNIT V
Devices and communication buses: Serial communication devices, wireless devices, Networked embedded system, wireless and mobile system protocols. **Case Studies of applications:** Design of RTC, Wireless sensor network with Chipcon RF interfaces.
8 Hours

TEXT BOOKS		
1		**Embedded Systems: Architecture and Programming** Raj Kamal, TMH. 2011.
2	John B Pitman	Design with PIC Microcontrollers, Pearson Education Asia, edition 2002.
3	John Davies	MSP430 Microcontroller Basics, Elsevier, 2010.

REFERENCE BOOKS		
1	PIC microcontroller	Mid range reference manual
2	MSP430 user's guide	User's guide

E-RESOURCES	
1	https://nptel.ac.in/courses/108102169
2	https://nptel.ac.in/courses/108102045

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the engineering knowledge to develop an embedded application.
CO2	Analyze and evaluate the common embedded controllers and their peripherals.

CO3	Design the programming models of embedded systems and implement on the RTOS platforms.
CO4	Evaluate various software models and metrics relevant to embedded system application.
CO5	Build and evaluate the different classes of embedded system using common hardware and software development platforms and environment.

Course Articulation Matrix

		POs											PSOs	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	1										2	
	CO2	3	2										3	
	CO3	3	3			1						1	3	1
	CO4	3	3			1						1	3	1
	CO5	3	3			1			1	1		1	3	1

REAL TIME SYSTEMS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE42	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	To understand fundamental concepts of real time systems and its architectural requirements.
2.	To learn the various RTS development methodologies and real time operating system.
3.	To articulate the practical constraints of real-time system design for various applications.

UNIT I

Introduction to real-time systems: RTS Definition, Classification of Real-time Systems, Time constraints, Classification of Programs

Computer control concepts: Sequence Control, Loop control, Supervisory control, Centralised computer control, Distributed system, Human-computer interface, Benefits of computer control systems.

8 Hours

UNIT II

Computer hardware requirements: Introduction, Single chip microcontroller, Specialized processors, Process-related Interfaces, Communications Languages for real time applications: Introduction to the languages for RTS, Syntax layout and readability, Modularity and Variables, Control Structure, Exception Handling, Overview of real-time languages.

8 Hours

UNIT III
Design of RTSs: Introduction, Specification documentation, Preliminary design, Single-program approach, Foreground/ background, Multi-tasking approach, Mutual exclusion.
8 Hours
UNIT IV
RTS development methodologies: Introduction, Yourdon Methodology, Requirement definition for Drying Oven, Hatley and Pirbhai Method. Fault tolerance techniques: Introduction, Definitions, what causes Failures, Fault types, Detection and Containment, Redundancy, Integrated Failure Handling.
9 Hours

UNIT V
Real time operating systems: Introduction, Real-time multi-tasking OS, Scheduling strategies, Priority Structures, Task management, Scheduler and real-time clock interrupt handles, Memory Management, Code sharing, Resource control, Task co-operation and communication, Mutual exclusion, Data transfer, Liveness, Minimum OS kernel.
9 Hours

TEXT BOOKS		
1	Stuart Bennet	Real - Time Computer Control- An Introduction, Pearson Education., 2^{nd} Edn. 2005.
2	C. M. Krishna, Kang. G. Shin	Real Time Systems, Mc Graw Hill, India, 1997.

REFERENCE BOOKS		
1	Phillip. A. Laplante	Real-Time Systems Design and Analysis, PHI, 2nd edition, 2005.
2	Raj Kamal	Embedded Systems, Tata Mc Graw Hill, India, 2008.

E-RESOURCES	
1	https://onlinecourses.nptel.ac.in/noc21_cs98/preview

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the basics of real time systems and its architecture.
CO2	Analyse the computer hardware requirement and communication languages for real time application.
CO3	Design different approaches of Real Time System.
CO4	Develop various methods of Real Time System and analyse fault tolerance techniques
CO5	Explain the elements of RTOS.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3											2	
	CO2	3	2										2	
	CO3	3	2	2		2							2	2
	CO4	3	2	2		2							2	2
	CO5	3	2	2									2	

EMBEDDED SYSTEM DESIGN

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE43	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Exhibit the knowledge of representing the hardware and software in unified way.
2.	Formulate the problems and choose suitable design, processor technology and integrating the embedded system.
3.	Develop a supplement to design a software architecture in real time digital systems.

UNIT I
Introduction: Overview, Optimizing the Metrics, Processor Technology, Design Technology **Custom Single Purpose Processors:** Custom Single Purpose Processors design, optimizing Program, FSMD, data path & FSM.
8 Hours

UNIT II
General purpose processors and ASIP's: Software and operation of general purpose processors, Programmer's View, Development Environment, ASIP's, Microcontrollers, DSP. **Standard Peripherals:** Timers and Applications, PWM's & Application, UART, Stepper Motor Controls, A/D Converters.
8 Hours

UNIT III
Memory: Different types of ROM's & RAM's, Cache System. **Interfacing:** Introduction to Interfacing, Interrupts and DMA, Communication: serial Protocols, Parallel Protocols, Wireless Protocols.
10 Hours
UNIT IV
Interrupts: Basics, Shared Data Problem, Interrupt latency, **Introduction to Real Time Operating System**: Tasks and states, scheduler, tasks and data, shared data problem, reentrancy, Semaphores and shared data, semaphores problem, semaphore variants.
8 Hours

UNIT V
Real Time Operating System Services: Message Queues, Mail boxes, and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS environment.
8 Hours

TEXT BOOKS		
1	Frank Vahid and Tony Givargis	Embedded system Design, John Wiley, 2002.
2	David E Simon	An Embedded Software Primer, Pearson Education, 1999.

REFERENCE BOOKS		
1	Tammy Noergaard	Embedded Systems Architecture – A Comprehensive Guide for Engineers and Programmers, Elsevier Publication, 2005.

TEXT BOOKS	
1	https://www.youtube.com/watch?v=TP1_F3IVjBc&list=PLJ5C_6qdAvBEUjcu1ka0QY9G-zoOlXqCL
2	https://www.youtube.com/watch?v=docZGkYbruw&list=PLJ5C_6qdAvBEUjcu1ka0QY9G-zoOlXqCL&index=3

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of digital system fundamentals to describe the importance of embedded computing systems and their unique Characteristic features, processor and design technology.
CO2	Design custom single purpose processor, analyze the FSMD, FSM and optimize the processor.
CO3	Identify and contrast the features of the general purpose processors and ASIP's processor design technologies, and illustrate the standard peripherals used to improve the productivity of the embedded system.
CO4	Design memory and the communication protocols in building an embedded system.
CO5	Apply the knowledge of software architecture to describe the difference between various embedded system architectures and the interrupt mechanism for embedded software design.
CO6	Analyse the typical RTOS services for embedded system software and apply the various intercommunication and scheduling strategies for building the embedded system software.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3											3	
	CO2	2	2	1		1			1					
	CO3	2	2										2	
	CO4	2	2										2	
	CO5	3	1	1					1					1
	CO6	2	2										2	

SYSTEM ON CHIP

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE44	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the fundamentals of designing System-on-Chip and system architecture.
2.	Apply these fundamentals to design different real-world System on Chip Devices.

UNIT I
Introduction to the Systems Approach: System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, an approach for SOC Design, System Architecture and Complexity.
8 Hours
UNIT II
Processors: Introduction, Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. **Buffers:** Minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.
9 Hours

UNIT III
Memory Design for SOC : System-on-Chip and Board-Based Systems, SoC External Memory DDR, Flash, SoC Internal Memory: Placement, Size of Memory, Scratchpads and Cache Memory, SoC (On-Die) Memory Systems, Board-based (Off-Die) Memory System, Interaction between processor and memory.
9 Hours
UNIT IV
Interconnect architectures for SoC : Bus architecture, SOC Standard buses, Analytic bus models, Beyond the bus: Network on Chip (NOC) with switch interconnects, NOC examples, Layered Architecture and NIU, Evaluating Interconnect networks C.
8 Hours
UNIT V
Applications of SoCs : SOC Design approach, Applications of SoC for AES, Image processing, Video and 3D graphics.
8 Hours

TEXT BOOKS		
1	Michael J. Flynn and Wayne Luk	Computer System Design System-on-Chip Wiley India Pvt. Ltd
2	Steve Furber	ARM System on Chip Architecture, Addison Wesley Professional, 2nd Edition, 2000

REFERENCE BOOKS		
1	Michael Keating, Pierre Bricaud	Reuse Methodology Manual for System on Chip designs, Kluwer Academic Publishers, 2nd edition, 2008.
2	Ricardo Reis	Design of System on a Chip: Devices and Components, 1st Edition, 2004.

E-RESOURCES	
1	https://onlinecourses.nptel.ac.in/noc21_ee09/preview
2	https://archive.nptel.ac.in/courses/117/106/117106093/

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Learn the System on Chip design, Architecture and complexity in designing
CO2	Apply the design concepts for Processors and interconnect architecture
CO3	Recognize the type of memory required to design System on a Chip device
CO4	Identify interconnect architectures required for the design of SoC
CO5	Design a modern System-on-a-Chip Device

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	3	2										3	
	CO2	3	2	1		2								1
	CO3	3	2										2	
	CO4	3	2	1		2			1	1				1

AUTOMOTIVE ELECTRONICS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE45	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Understand the fundamentals of automotive electronics for vehicles.
2.	Acquire the technical knowledge of applying these fundamentals to commercial vehicles.
3.	Analyse the future trend of automotive electronics.

UNIT I

Basics of Electronics in Automotive: Overview automotive electronics, Motoronic Engine management system. Chassis Control domain- Traction control system, Anti Braking System, adaptive cruise control system, Occupant Safety system. Body electronics domains- Lighting, window, central locking electric system.

8 Hours

UNIT II

Vehicle system architecture: Hardware architecture, software architecture, Network architecture.

Control theory: open loop control, closed loop control- case study fuel control system, speed control system, Steering components.

8 Hours

UNIT III

Automotive networking: OSI and Autosar standards, basics of vehicle automotive system networking, Bus system: Requirements, classification, CAN, LIN, MOST, Bluetooth, Flex-ray, Coupling systems.

8 Hours

UNIT IV
Automotive sensors and measurements: Features of vehicle sensors**,** classification, smart sensors- Position sensors, Speed and RPM sensors, Pressure sensors, flow sensors, wave propagation sensors, image sensors. **Automotive MCUs for vehicular control:** Power MCU, NXP automotive MCU case study.
9 Hours

UNIT V
Automotive Diagnostics: Electronic Control System Diagnostics, Service Bay, Diagnostic Tool, On-board Diagnostics, Model-Based Sensor Failure Detection, Expert Systems in Automotive Diagnosis. **Future trends of Automotive Electronics:** Electric Vehicles, Hybrid Vehicles, Augmentation, and Autonomous driving assistance. **Case study:** Contemporary commercial automotive vehicle.
9 Hours

TEXT BOOKS		
1	Robert Bosch Gmbh (Ed.)	Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, John Wiley& Sons Inc., 5th edition, 2007.
2	Hillier	Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics, 5th Edition, Nelson Thrones, 2007.
3	William B. Ribbens	Understanding Automotive Electronics, 5th Edition, Butterworth, Heinemann Woburn, 1998.
4	STM Reference Manual	SPC58 2B Line - 32 bit Power Architecture automotive MCU.
5	NXP Reference manual	S32K3 Microcontrollers, 2022 edition.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the basic Vehicular design and the basic electronics block associated with.
CO2	Analyse the vehicular architecture and design the control systems involved in automotive principles.
CO3	Analyse and apply the networking principles in automotive electronics
CO4	Analyse the measurement tools and Controller architecture involved in design of automotive vehicles.
CO5	Analyze the future trends and design an automotive electronics based vehicle.

Course Articulation Matrix

		POs											PSOs	
		1	2	3	4	5	6	7	8	9	10	11	1	2
COs	CO1	2	1										1	
	CO2	2	2	2									2	
	CO3	2	2	2									2	
	CO4	2	2	2									2	
	CO5	2	1										1	
	AVG	2	2	2									2	

AUTOMOTIVE EMBEDDED SYSTEMS

Contact Hours/ Week:	: 3+0+0	Credits:	3
Total Lecture Hours:	: 42	CIE Marks:	50
Sub. Code:	: SECE46	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Equip students with the knowledge and skills to develop embedded systems for automotive applications.
2.	Develop model-based design workflow for embedded algorithms.

UNIT I

Embedded System Overview:

Embedded Systems in Context to Automotive, Embedded System Development Process, Building blocks of Embedded Systems, Characteristics of Automotive Embedded Systems, Role of Processors / Microcontrollers in Automotive, Criteria for selecting microcontrollers in Automotive, Concept of Build process of Embedded Application, Debugging Tools.

8 Hours

UNIT II

Introduction to ARM Microcontroller:

Overview of ARM and RISC Design Philosophy, concept of ARM cortex M-series Microcontroller, Advanced Microcontroller Bus Architecture, Introduction to STM32H7xxx Microcontroller – Features, Architecture, Memory Organization, Pin Diagram, and I/O configuration.

8 Hours

UNIT III
Embedded Application Design: Basic Data Types Arrays, Pointers, Storage classes, Passing Data to Functions Caller vs Callee, Structure and Bitfields, Passing Structure to Functions, Enums and Typedefs, Bit-wise Operators and Macros. Understanding the concept of HAL library and its role in embedded c programming**.**
8 Hours
UNIT IV
Interfacing Applications and Interrupts: GPIO programming with external devices (LED, Switch, Motor control) using HAL, Configuring ADC registers, Programming timers and related control registers, applications of timer in time-sharing system, Concept of compare/capture modes, and applications of timers in PWM control, Interrupt programming with Hal – Interrupt priorities. Communication Protocol – UART.
9 Hours

UNIT V
Model-Based Design, Code Generation and Simulation-Based Testing: V-cycle and MBD Workflow, Programming with MATLAB (m-script), Simulink Modelling of Dynamic Systems, State flow Modelling, Model Architecture, Data Management. The architecture of an embedded application, Introduction to Auto-Code Generation, System specification, generating code, Data structures in generated code, Verification, and Validation in MBD, Simulink-based Testing (Creating Test Harness), verifying generated code.
9 Hours

TEXT BOOKS		
1	Shujen Chen, Eshragh Ghaemi, Muhammad Ali Mazidi	STM32 ARM Programming for Embedded Systems, Microdigitaled , 2018.
2	Matlab model based design tool box	Documentation by MATLAB on Model-based Design

REFERENCE BOOKS		
1	Yifeng Zhu	E-book: Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C
2	Donald Norris	E-book: Programming with STM32: Getting Started with the Nucleo-Board and C/C++
3	Andrew N. S Loss, Dominic Symes, Chris Wright.	E-book: ARM System Developer's Guide
4	Michael Barr and Anthony J. Massa.	E-book: Programming Embedded Systems in C and C++

E-RESOURCES	
1	https://www.udemy.com/course/embedded-systems-bare-metal-programming/
2	https://www.youtube.com/playlist?list=PL0XvCDGTtp12wpZ9QyFNfsEs3DjJnJMuD
3	https://www.edx.org/course/embedded-systems-essentials-with-arm-getting-started
4	https://in.mathworks.com/help/ecoder/ug/generating-code-using-embedded-coder.html
5	https://www.mathworks.com/videos/automatic-code-generation-for-embedded-control-systems-106530.html

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze Microcontroller architecture and its role in Automotive systems.
CO2	Design application code using proper language constructs and related coding guidelines for given system specifications.
CO3	Design the code using efficient software architecture, data types, qualifiers, and interrupts.
CO4	Analyze interfacing applications with external devices along with interrupt concept.
CO5	Formulate and analyze Model-based Design workflow in Automotive Industry.
CO6	With the Embedded Coder environment, develop Embedded Code from a Simulink Model.

Course Articulation Matrix

		POs											**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
COs	**CO1**	3	2										3	
	CO2	3	3			1							3	1
	CO3	3	3			1							3	1
	CO4	3	3			1							3	1
	CO5	3	3	1		2							3	2
	CO6	3	3	1		2			1	1		2	3	2