ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: CEG Campus, Anna University.

Department: Electronics and Communication Engineering

Programme: B.E. Electronics and Communication Engineering

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I	-	-	3	11	-	-	7	1	**-**	**22**
II	-	-	12	11	-	-	-	1	**-**	**24**
III	14	-	-	4	-	-	1	2	**-**	**21**
IV	18	-	3	-	-	-	1	-	**1**	**23**
V	16	3	-	-	-	-	1	3	**-**	**23**
VI	-	3	-	-	11	3	2	3	**-**	**22**
VII	-	12	-	-	4	3	3	1	**-**	**23**
VIII	-	-	-	-	-	-	8	-	**-**	**8**
Total	48	18	18	26	15	6	23	11	**1**	**166**
% of Category	**28.9**	**10.9**	**10.9**	**15.6**	**9.0**	**3.6**	**13.9**	**6.6**	**0.6**	**100**

CATEGORY OF COURSES

PCC – Professional Core Course
PEC – Professional Elective Course Course
ETC – Emerging Technology Course
ESC – Engineering Science Course
HSMC – Humanities Science and Management
SDC – Skill Development Course

OEC – Open Elective Course **UC – University Course**

SLC – Self Learning Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

SEMESTER– I							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4.	ME23C01	Engineering Drawing & 3D Modelling	LIT	2-0-4	6	4	SDC
5.	CS23C04	Programming in C	LIT	2-0-4	6	4	ESC
6.	ME23C04	Maker space	LIT	1-0-4	5	3	SDC
7.	UC23H01	தமிழர்மரபு / Heritage of Tamils	T	1-0-0	1	1	UC
8.	-	NCC/NSS/NSO/YRC	L	0-0-2	2	-	UC
				TOTAL CREDITS		**23**	

***TCP –** Total Contact Period(s)

#**TYPE OF COURSE**

LIT –Laboratory Integrated Theory

T – Theory

L – Laboratory Course

IPW – Internship cum Project Work

PW – Project Work

CDP – Capstone Design Project

SEMESTER– II							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
3.	EC23C03	Electronic Devices	LIT	2-0-4	6	4	ESC
4.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
5.	EC23C06	Data Structures and Programming in C++	LIT	2-0-4	6	4	ESC
6.	EC23C04	Circuit Analysis	LIT	2-1-2	5	4	ESC
7.	UC23H02	தமிழரும் தொழில் நுட்பமும்/Tamils and Technology	T	1-0-0	1	1	UC
8.	-	Audit Course–I**	T	-	-	-	-
					TOTAL CREDITS	**24**	

SEMESTER– III							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	MA23C03	Linear Algebra and Numerical Methods	LIT	3-1-0	4	4	HSMC
2.	EC23301	Electromagnetic Fields	T	3-0-0	3	3	PCC
3.	EC23C13	Digital Electronics and System Design	LIT	3-0-2	5	4	PCC
4.	EC23302	Signals and Systems	T	3-0-0	3	3	PCC
5.	EC23C02	Analog Circuits Design	LIT	3-0-2	5	4	PCC
6.	EC23S01	Numerical and Signal Processing Practice through Python(Skill Development Course – 1)	L	0-0-2	2	1	SDC
7.	UC23U01	Universal Human Values	T	1-0-2	3	2	UC
					TOTAL CREDITS	**21**	

SEMESTER– IV							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23401	Digital Signal Processing	LIT	3-0-2	5	4	PCC
2.	EC23402	Transmission Lines	T	3-0-0	3	3	PCC
3.	EC23403	Analog and Baseband Communication	LIT	3-0-2	5	4	PCC
4.	EC23C05	Analog Electronic System Design	LIT	3-0-2	5	4	PCC
5.	EC23C10	Computer Architecture and Organization	T	3-0-0	3	3	PCC
6.	EC23C11	Control Systems	T	3-0-0	3	3	ESC
7.	EC23S02	PCB Design Using Cad Tools for Electronic Systems (Skill Development Course – 2)	L	0-0-2	2	1	SDC
8.	EC23L01	Self Learning Course	T	1-0-0	1	1	SLC
9.	-	Audit Course – II**	T	-	-	-	UC
10.	-	NCC/NSS/NSO/YRC level 2	L	0-0-2	2	-	UC
					TOTAL CREDITS	**23**	

SEMESTER– V							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23501	Antenna and Wave Propagation	LIT	3-0-2	5	4	PCC
2.	EC23502	Digital Communication	LIT	3-0-2	5	4	PCC
3.	EC23C21	Microprocessors and Microcontrollers	LIT	3-0-2	5	4	PCC
4.	EC23503	Communication Networks	LIT	3-0-2	5	4	PCC
5.	-	Professional Elective - I	T	3-0-0	3	3	PEC
6.	-	Industry Oriented Course I/ Summer Internship- I#	T	1-0-0	1	1	SDC
7.	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
					TOTAL CREDITS	**23**	

SEMESTER– V							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23D01	Capstone Ideation	CDP	0-0-4	4	2	SDC
2	EC23S03	Design Skills (Skill Development Course)	CDP	1-0-2	3	2	SDC
(OR)							
1.	-	Honours Elective – I*				3	
2.	-	Honours Elective – II*				3	
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – I				3	
2.	-	Minor Elective – II				3	

SEMESTER– VI							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23C14	Digital VLSI Design	LIT	3-0-2	5	4	ETC
2.	EC23601	Wireless Communications	LIT	3-0-2	5	4	ETC
3.	-	Professional Elective - II	T	3-0-0	3	3	PEC
4.	EC23602	Machine Learning	T	3-0-0	3	3	ETC
5.	-	Open Elective - I	T	3-0-0	3	3	OE
6.	EC23S04	RTL Design and Synthesis (Skill Development Course – 3)	L	0-0-2	2	1	SDC

SEMESTER– VI							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
7.	-	Industry Oriented Course II	T	1-0-0	1	1	SDC
8.	EC23U02	Sustainability Course	T	3-0-0	3	3	UC
			TOTAL CREDITS			**22**	
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23L02	Self Learning Course	CDP	1-0-0	1	1	SDC
2.	EC23S05	Fabrication Skills (Skill Development Course)	CDP	0-0-4	4	2	SDC
3	EC23D02	Capstone Project Phase I - (Proof of Concept Implementation & Validation)	CDP	0-0-6	6	3	SDC
(OR)							
1.	-	Honours Elective – III*				3	
2.	-	Honours Elective – IV*				3	
Courses for Minor Degree							
1.	-	Minor Elective – III				3	
2.	-	Minor Elective – IV				3	

SEMESTER– VII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23701	Millimeter Wave and Optical Communication	LIT	3-0-2	5	4	ETC
2.	-	Professional Elective - III	T	3-0-0	3	3	PEC
3.	-	Professional Elective - IV	T	3-0-0	3	3	PEC
4.	-	Professional Elective - V	T	3-0-0	3	3	PEC

SEMESTER– VII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
5.	-	Professional Elective - VI	T	3-0-0	3	3	PEC
6.	-	Open Elective - II	T	3-0-0	3	3	OE
7.	EC23702	Mini Project	L	0-0-4	4	2	SDC
8.	EC23703	Industry Oriented Course III/ Summer Internship- II***	T	1-0-0	1	1	SDC
9.	EC23U01	Indian Standards	T	1-0-0	1	1	UC
				Total Credits		**23**	
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23D03	Capstone Project Phase II - (Product Development – Publication / Patent Submission)	CDP	0-0-16	16	8	SDC
(OR)							
1.	-	Honours Elective – V*				3	
2.	-	Honours Elective – VI*				3	
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – V				3	
2.	-	Minor Elective – VI				3	

SEMESTER– VIII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23801	Project Work / Internship cum Project Work	L	0-0-16	16	8	SDC
TOTAL CREDITS						**8**	

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI	Vertical VII	Vertical VIII
Signal and Image Processing	**Semiconductor Chip Design**	**Wireless Communication Technologies**	**RF Technologies**	**Embedded Systems**	**Computational Intelligence**	**Sensor Technologies and IoT**	**Biomedical Technologies**
Advanced Digital Signal Processing	CMOS Analog IC Design	5G Wireless Communication Networks	Microwave Electronics	PIC Microcontrollers	Soft Computing	Introduction to MEMS and NEMS	Biomedical Instrumentation
Digital Speech Processing	VLSI Testing and Design for Testability	Space Time Wireless Communication	Passive RF and Microwave Integrated Circuits	Advanced Microcontrollers	Bio-inspired Computing	Sensors Actuators and Interface Electronics	Biomedical Assist Devices
Principles of Digital Image Processing	Data Converters	IoT Enabled Systems Design	Electronic warfare	Real Time Embedded Systems	IoT Enabled Systems Design	IoT Enabled Systems Design	Radiological Equipment
DSP Architecture and Programming(I)	VLSI Signal Processing	Cryptography and Network Security	Electro Magnetic Interference and Compatibility in Electronic Systems	Operating Systems	Operating Systems	Introduction to Nano Electronics	Brain Computer Interface and its Applications
VLSI Signal Processing	RF Microelectronics	Cognitive Radio Networks	Advanced Antennas	IoT Enabled Systems Design	Pattern Recognition	Industrial IoT and Industry 4.0 (I)	Soft Computing and its Applications
Digital Control Engineering	VLSI Physical Design Automation	Satellite Communication	Radar Technologies	Parallel and Distributed Processing	Digital Speech Processing	Wireless Sensor Network Design	Measurements And Instrumentation
Multimedia Compression and Networks	Clock and Power Management Circuits	Optical Wireless Communications	RF Microelectronics	Robotics	Robotics	Fiber Optic Sensors	Bio-inspired Computing

	Optoelectronics	Digital Switching and Networking	Satellite Communication	Foundation Skills In Integrated Product Development		Optoelectronics	Principles of Digital Image Processing
	Signal Integrity (I)	Adhoc and Wireless Sensor Networks		Electronic System prototyping (l)			Medical image analysis
	Electro Magnetic Interference and Compatibility in Electronic Systems	Radar Technologies		Measurements And Instrumentation			Introduction to Biomimicry
	Introduction to Nano Electronics						
	Introduction to SoC Design						
(I)-Lab Integrated Course							

*For Honours Degree students can select elective courses from any of the vertical listed in the above table.

ELECTIVE LIST FOR MINOR DEGREE: MINORS IN ELECTRONIC SYSTEMS

S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	EC23044	Introduction to Electronic Devices and Circuits	T	3-0-0	3	3	PEC
2.	EC23045	Introduction to Digital Electronics (I)	T	2-0-2	4	3	PEC
3.	EC23046	Fundamentals of Electromagnetics	T	3-0-0	3	3	PEC
4.	EC23047	Introduction to Communication Engineering	T	3-0-0	3	3	PEC
5.	EC23048	Wireless Communication technologies	T	3-0-0	3	3	PEC
6.	EC23049	Introduction to Internet of Things and Embedded systems	T	3-0-0	3	3	PEC
7.	EC23050	Electronic System Development (I)	T	2-0-2	4	3	PEC

VERTICAL 1: SIGNAL AND IMAGE PROCESSING							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	EC23001	Advanced Digital Signal Processing	T	3-0-0	3	3	PEC
2.	EC23002	Digital Speech Processing	T	3-0-0	3	3	PEC
3.	EC23003	Principles of Digital Image Processing	T	3-0-0	3	3	PEC
4.	EC23004	DSP Architecture and Programming(I)	T	2-0-2	4	3	PEC
5.	EC23C19	VLSI Signal Processing	T	3-0-0	3	3	PEC
6.	EC23005	Digital Control Engineering	T	3-0-0	3	3	PEC
7.	EC23006	Multimedia Compression and Networks	T	3-0-0	3	3	PEC

VERTICAL 2: SEMICONDUCTOR CHIP DESIGN							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	EC23007	CMOS Analog IC Design	T	3-0-0	3	3	PEC
2.	EC23008	VLSI Testing and Design for Testability	T	3-0-0	3	3	PEC
3.	EC23C12	Data Converters	T	3-0-0	3	3	PEC
4.	EC23C19	VLSI Signal Processing	T	3-0-0	3	3	PEC
5.	EC23009	RF Microelectronics	T	3-0-0	3	3	PEC
6.	EC23010	VLSI Physical Design Automation	T	3-0-0	3	3	PEC
7.	EC23011	Clock and Power Management Circuits	T	3-0-0	3	3	PEC
1.	EC23012	Optoelectronics	T	3-0-0	3	3	PEC
2.	EC23013	Signal Integrity (I)	T	2-0-2	4	3	PEC
3.	EC23014	Electro Magnetic Interference and Compatibility in Electronic Systems	T	3-0-0	3	3	PEC
4.	EC23C17	Introduction to Nano Electronics	T	3-0-0	3	3	PEC
5.	EC23015	Introduction to SoC Design	T	3-0-0	3	3	PEC

VERTICAL 3: WIRELESS COMMUNICATION TECHNOLOGIES							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	EC23C15	5G Wireless Communication Networks	T	3-0-0	3	3	PEC
2.	EC23016	Space Time Wireless Communication	T	3-0-0	3	3	PEC
3.	EC23017	IoT Enabled Systems Design	T	3-0-0	3	3	PEC
4.	EC23018	Cryptography and Network Security	T	3-0-0	3	3	PEC
5.	EC23019	Cognitive Radio Networks	T	3-0-0	3	3	PEC
6.	EC23020	Satellite Communication	T	3-0-0	3	3	PEC
7.	EC23021	Optical Wireless Communications	T	3-0-0	3	3	PEC
8.	EC23022	Digital Switching and Networking	T	3-0-0	3	3	PEC
9.	EC23023	Adhoc and Wireless Sensor Networks	T	3-0-0	3	3	PEC
10.	EC23024	Radar Technologies	T	3-0-0	3	3	PEC

VERTICAL 4: RF TECHNOLOGIES							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	EC23025	Microwave Electronics	T	3-0-0	3	3	PEC
2.	EC23026	Passive RF and Microwave Integrated Circuits	T	3-0-0	3	3	PEC
3.	EC23027	Electronic warfare	T	3-0-0	3	3	PEC
4.	EC23014	Electro Magnetic Interference and Compatibility in Electronic Systems	T	3-0-0	3	3	PEC
5.	EC23028	Advanced Antennas	T	3-0-0	3	3	PEC
6.	EC23024	Radar Technologies	T	3-0-0	3	3	PEC
7.	EC23009	RF Microelectronics	T	3-0-0	3	3	PEC
8.	EC23020	Satellite Communication	T	3-0-0	3	3	PEC

VERTICAL 5: EMBEDDED SYSTEMS							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	EC23029	PIC Microcontrollers	T	3-0-0	3	3	PEC
2.	EC23030	Advanced Microcontrollers	T	3-0-0	3	3	PEC
3.	EC23031	Real Time Embedded Systems	T	3-0-0	3	3	PEC
4.	EC23032	Operating Systems	T	3-0-0	3	3	PEC
5.	EC23017	IoT Enabled Systems Design	T	3-0-0	3	3	PEC
6.	EC23033	Parallel and Distributed Processing	T	3-0-0	3	3	PEC
7.	EC23034	Robotics	T	3-0-0	3	3	PEC
8.	EC23C22	Foundation Skills In Integrated Product Development	T	3-0-0	3	3	PEC
9.	EC23035	Electronic System prototyping (l)	T	1-0-4	5	3	PEC
10.	EC23036	Measurements And Instrumentation	T	3-0-0	3	3	PEC

VERTICAL 6: COMPUTATIONAL INTELLIGENCE							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	EC23037	Soft Computing	T	3-0-0	3	3	PEC
2.	EC23C20	Bio-inspired Computing	T	3-0-0	3	3	PEC
3.	EC23017	IoT Enabled Systems Design	T	3-0-0	3	3	PEC
4.	EC23032	Operating Systems	T	3-0-0	3	3	PEC
5.	EC23038	Pattern Recognition	T	3-0-0	3	3	PEC
6.	EC23002	Digital Speech Processing	T	3-0-0	3	3	PEC
7.	EC23034	Robotics	T	3-0-0	3	3	PEC

VERTICAL 7: SENSOR TECHNOLOGIES AND IOT							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	EC23C16	Introduction to MEMS and NEMS	T	3-0-0	3	3	PEC
2.	EC23039	Sensors Actuators and Interface Electronics	T	3-0-0	3	3	PEC
3.	EC23017	IoT Enabled Systems Design	T	3-0-0	3	3	PEC
4.	EC23C17	Introduction to Nano Electronics	T	3-0-0	3	3	PEC
5.	EC23040	Industrial IoT and Industry 4.0 (I)	T	2-0-2	4	3	PEC
6.	EC23C01	Wireless Sensor Network Design	T	3-0-0	3	3	PEC
7.	EC23041	Fiber Optic Sesors	T	3-0-0	3	3	PEC
8.	EC23012	Optoelectronics	T	3-0-0	3	3	PEC

VERTICAL 8: BIOMEDICAL TECHNOLOGIES							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	EC23C09	Biomedical Instrumentation	T	3-0-0	3	3	PEC
2.	EC23C07	Biomedical Assist Devices	T	3-0-0	3	3	PEC
3.	BM23C02	Radiological Equipment	T	3-0-0	3	3	PEC
4.	EC23C08	Brain Computer Interface and its Applications	T	3-0-0	3	3	PEC
5.	EC23C18	Soft Computing and its Applications	T	3-0-0	3	3	PEC
6.	EC23036	Measurements And Instrumentation	T	3-0-0	3	3	PEC
7.	EC23C20	Bio-inspired Computing	T	3-0-0	3	3	PEC
8.	EC23003	Principles of Digital Image Processing	T	3-0-0	3	3	PEC
9	EC23042	Medical image analysis	T	3-0-0	3	3	PEC
10	EC23043	Introduction to Biomimicry	T	3-0-0	3	3	PEC

OPEN ELECTIVE COURSES							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23901	Automotive Electronics	T	3-0-0	3	3	OEC
2.	EC23902	Electronics Engineering	T	3-0-0	3	3	OEC
3.	EC23903	Wireless Technologies	T	3-0-0	3	3	OEC
4.	EC23904	Microcontroller Programming	T	3-0-0	3	3	OEC
5.	EC23905	Consumer Electronics	T	3-0-0	3	3	OEC
6.	EC23906	Principles of Modern Communication System	T	3-0-0	3	3	OEC
7.	EC23907	Computer Vision and Machine Learning	T	3-0-0	3	3	OEC
8.	EC23908	Robotics and its Applications	T	3-0-0	3	3	OEC

EN23C01 **FOUNDATION ENGLISH** **L T P C**

2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION 6

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: 6

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION 6

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: 6

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION 6

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: 6

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST 6

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: 6

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS 6

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab assessment

Listening

Speaking

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS 9+3

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS 9+3

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem

3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E/B.Tech Programmes) **3 0 2 4**

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS **9+6**

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS **9+6**

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

4. Non-uniform bending -Determination of Young's modulus of the material of the beam.
5. Uniform bending -Determination of Young's modulus of the material of the beam
6. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS **9+6**

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

7. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
8. Melde's string experiment - Standing waves.
9. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS **9+6**

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance

angle – Fiber optic communication – Fiber sensors – Fiber lasers.

10. Laser - Determination of the width of the groove of the compact disc using laser.
    Laser Parameters
    Determination of the wavelength of the laser using grating
11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre - Determination of Numerical Aperture and acceptance angle
    -Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

14. Photoelectric effect – Determination of Planck's constant.
15. Black Body Radiation (Demonstration)
16. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3: Conceptualize and visualize the oscillations and sound.
CO4: Grasp optical phenomenon and their applications in real life.
CO5: Appreciate and evaluate the quantum phenomenon.
CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

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

ME23C01	ENGINEERING DRAWING AND 3D MODELLING	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

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

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT i: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES 6+12

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT II PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING 6+12

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches,

UNIT III 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS 6+12

Free hand sketching – I & III angle projections of engineering parts and components

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT IV SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS 6+12

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane ('On the axis' and 'from the axis' conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT V LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN 6+12

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

Total: 90 Hours

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members

Question pattern suggestion: Part – A (Either or type) (5 × 16 = 80) & Part – B (Compulsory) (1 × 20 = 20)

COURSE OUTCOME:-

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

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD softwares

CO4: Determine the true shape of a sectioned solid and draft the assemble parts accordingly

CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

TEXTBOOKS:

1. Engineering Drawing" by N S Parthasarathy and Vela Murali
2. Engineering Drawing and Graphics with Auto CAD" by Venugopal K

REFERENCE BOOKS:

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal
3. "Engineering Drawing With Auto CAD" by B V R Gupta
4. "Engineering Drawing" by P S Gill
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe
6. "Engineering Drawing" by M B Shah
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy
9. "CAED : Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B
10. "Computer-Aided Engineering Drawing" by Subrata Pal

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

CS23C04	PROGRAMMING IN C	L T P C 2 0 4 4

UNIT I BASICS OF C PROGRAMMING 6+12

Introduction to programming paradigms –- Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

PRACTICALS

1. Designing programs with algorithms/flowchart
2. Programs for i/o operations with different data types

SUGGESTED ACTIVITIES:

- EL - Programs using integer type, arithmetic operators and basic input/output.
- EL - Programs using other data types and operators.
- EL: Programs using else-if, switch

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6+12

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

PRACTICALS

1. Programs using various operators
2. Programs using decision making and branching statements
3. Programs using for, while, do-while loops and nested loops.
4. Programs using arrays and operations on arrays.
5. Programs implementing searching and sorting using arrays
6. Programs implementing string operations on arrays

SUGGESTED ACTIVITIES:

- EL: Programs using while, for,do-while, break, continue, enum.
- EL - Programs using arrays and operations on arrays.
- EL - Programs implementing string operations on arrays.
- EL - Programs using functions.

UNIT III FUNCTIONS AND POINTERS 6+12

Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation

PRACTICALS

1. Programs using functions
2. Programs using recursion
3. Programs using pointers & strings with pointers
4. Programs using Dynamic Memory Allocation

SUGGESTED ACTIVITIES:

- EL - Programs using recursion.
- EL - Programs using pointers and arrays, address arithmetic.
- EL - Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- EL - Programs using Pointers and strings.

UNIT IV STRUCTURES AND UNION 6+12

Storage classes, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef , bit fields , enumerated data types, Union.

PRACTICALS

1. Programs using Structures
2. Programs using Unions
3. Programs using pointers to structures and self-referential structures.

SUGGESTED ACTIVITIES:

- EL - Programs using structures and arrays.
- EL - Programs using Pointers to structures, Self-referential structures.

UNIT V MACROS AND FILE PROCESSING 6+12

Preprocessor directives – Simple and Conditional macros with and without parameters - Files - Types of file processing: Sequential and Random access – File operations – read, write & seek.

PRACTICALS

1. Programs using pre-processor directives & macros
2. Programs to handle file operations
3. Programs to handle file with structure

SUGGESTED ACTIVITIES:

- EL - Programs using file operations in real-world applications

TOTAL: 90 (30+60) PERIODS

TEXT BOOKS:

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCE BOOKS:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.

5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C'" McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

COURSE OUTCOMES:

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

CO1: Write simple C programs using basic constructs.

CO2: Design searching and sorting algorithms using arrays and strings.

CO3: Implement modular applications using Functions and pointers.

CO4: Develop and execute applications using structures and Unions.

CO5: Illustrate algorithmic solutions in C programming language using files.

Total Hours: 90 (30+60)

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	3	2	1	-	-	-	2	-	3	1	2	2
2	2	1	1	3	2	1	-	-	-	-	-	3	1	2	2
3	2	2	1	3	2	1	-	-	3	-	3	3	1	2	2
4	2	1	1	3	2	1	-	-	3	-	3	3	1	2	2
5	2	3	1	3	2	1	-	-	-	2	3	3	1	2	2

1 - low, 2 - medium, 3 – high

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E). Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.

5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

UC23H01 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **மொழி மற்றும் இலக்கியம்**: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**:
3

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

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**: **3**

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

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்**: **3**

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

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**: **3**

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

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

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

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

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

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	(NAVAL WING) NCC Credit Course Level – I	L T P C 2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C**
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02 PROFESSIONAL COMMUNICATION L T P C

2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab Assessment

Group discussion (Peer assessment)

Listening

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022

2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.

2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.

3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.

4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.
Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.
CO2 :Apply Laplace transform techniques in solving linear differential equations.
CO3 :Apply Fourier series techniques in engineering applications.
CO4 :Understand the Fourier transforms techniques in solving engineering problems.
CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

EC23C03 **ELECTRONIC DEVICES** **L T P C**

2 0 4 4

UNIT I ELECTRONIC STATES 6L

Quantum free electron theory - Fermi distribution and energy – Density of states– Energy bands in solids – Conductors – Semiconductors – Insulators —- Electron effective mass – properties of conduction and valence bands.

UNIT II CARRIERS AND DOPING 6L

Intrinsic concentration – intrinsic Fermi level – n and p type doping – density of carriers in extrinsic semiconductors – extrinsic semiconductor Fermi energy level – degenerate and non-degenerate semiconductors – Direct and Indirect band gap semiconductors.

UNIT III PN DIODE AND BIPOLAR JUNCTION TRANSISTOR 6L, 36P

PN junction diode, current equations, V-I characteristics, Zener Diode, Bipolar Junction Transistor- bipolar transistor action, minority carrier distribution, Ebers Moll Model, Hybrid-pi model, large signal switching characteristics, SiGe and hetro-junction, Applications of Diodes.

PRACTICALS:

- Characteristics of PN Junction Diode
- Zener diode Characteristics & Regulator using Zener diode
- Clipper and Clamper
- Common Emitter input-output Characteristics
- Common Base input-output Characteristics
- Common Collector input-output characteristics

UNIT IV FIELD EFFECT TRANSISTORS 6L,6P

Two terminal MOS structures, threshold voltage and charge distribution, capacitance-voltage characteristics, MOSFET structures, I-V relationships, transconductance and substrate effects, non-ideal effects, MOSFET scaling, threshold voltage modification due to short and narrow channel effects.

PRACTICALS:

- MOSFET Characteristics

UNIT V SPECIAL SEMICONDUCTOR DEVICES 6L,18P

SCR, DIAC, TRIAC, IGBT, LED, LCD, Photo transistor, Opto Coupler, Solar cell, MESFET, -Varactor diode –Tunnel diode- LASER diode, UJT, LDR

PRACTICALS:

- SCR Characteristics
- UJT Characteristics
- Half wave Rectifier and Full wave rectifier Characteristics

L+P :30 + 60 : 90 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of electronic states and energy band structure formation
CO2: Recognize the importance of carrier concentration and doping in semiconductors

CO3: Understand the operation and characteristics of PN junction and BJTs.
CO4: Comprehend the characteristics of the field effect transistors and special semiconductor devices.
CO5: Practically derive the semiconductor devices characteristics and analyse.

TEXT BOOKS:

1. R.F.Pierret. Semiconductor Device Fundamentals. Pearson, 2006
2. D.Neamen and D.Biswas. Semiconductor physics and devices. McGraw Hill Education, 2017

REFERENCE BOOKS:

1. N.Garcia, A. Damask and S.Schwarz. Physics for Computer Science Students. SpringerVerlag, 2012.
2. Umesh Mishra and Jasprit Singh. Semiconductor Device Physics and Design. Springer, 2008.
3. Nandita Dasgupta and Amitava Dasgupta. Semiconductor Devices: Modelling and Technology. PHI Learning Pvt. Ltd. 2004
4. F.H. Mitchell, ‘ Introduction to Electronics Design” Prentice Hall of India Pvt. Lt, 1995.
5. Robert L. Boylestad, Louis Nashelsky “ Electronic devices and circuit theory” , Pearson, 2009

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1						2	2	1		
CO2	3	1						2	2	1		
CO3	2	2	1	1				2	2	1		
CO4	2	2	1	1				2	2	1		
CO5	1	2	1	1				2	2	1		
Average	2.2	1.6	1	1				2	2	1		

CY23C01 ENGINEERING CHEMISTRY L T P C

3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion-measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery,

hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 – O_2$ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1’ = Low; ‘2’ = Medium; ‘3’ = High

EC23C06	DATA STRUCTURES AND PROGRAMMING IN C++	L	T	P	C
		2	0	4	4

UNIT I DATA ABSTRACTION & OVERLOADING 6L, 14P

Overview of C++ – Structures – Class Scope and Accessing Class Members – Reference Variables – Initialization – Constructors – Destructors – Member Functions and Classes – Friend Function – Dynamic Memory Allocation – Static Class Members – Container Classes and Integrators – Proxy Classes – Overloading: Function overloading and Operator Overloading.

PRACTICALS:

- C++ Program to Implement Constructors and Destructors.
- C++ Program to implement Member Functions, Classes and Friend Functions.
- C++ Program to Implement Dynamic Memory Allocation and Overloading.

UNIT II INHERITANCE & POLYMORPHISM 6L,9P

Base Classes and Derived Classes – Protected Members – Casting Class pointers and Member Functions – Overriding – Public, Protected and Private Inheritance – Constructors and Destructorsin derived Classes – Implicit Derived – Class Object To Base – Class Object Conversion – Composition Vs. Inheritance – Virtual functions – This Pointer – Abstract Base Classes and Concrete Classes – Virtual Destructors – Dynamic Binding.

PRACTICALS:

- C++ Program to Implement Various Inheritances.
- C++ Program to Implement Virtual Functions and Dynamic Binding.

UNIT III LINEAR DATA STRUCTURES 6L,14P

Asymptotic Notations: Big-Oh, Omega and Theta – Best, Worst and Average case Analysis: Definition and an example – Arrays and its representations – Stacks and Queues – Linked lists – Linked list based implementation of Stacks and Queues – Evaluation of Expressions – Linked list based polynomial addition.

PRACTICALS:

- C++ Program to Implement Various Operations on Arrays and Linked Lists.
- C++ Program to Implement Various Operations on Stacks and Queues using Array and Linked List.
- C++ Program to Evaluate the Infix Expressions by converting into Prefix and Postfix Expressions.

UNIT IV NON-LINEAR DATA STRUCTURES 6L, 14P

Trees – Binary Trees – Binary tree representation and traversals – Threaded binary trees – Binarytree representation of trees – Application of trees: Set representation and Union-Find operations – Graph and its representations – Graph Traversals – Connected components. Standard template library.

PRACTICALS:

- C++ Program to Implement Binary Tree Traversal and Graph Traversal Algorithm.
- C++ Program to Implement the Single Source Shortest Path Algorithm and All Pair Shortest Path Algorithm.

- C++ Program to find the Minimal Spanning Tree for a Graph.

UNIT V SORTING & SEARCHING 6L, 9P

Insertion sort – Merge sort – Quick sort – Heap sort – Linear Search – Binary Search.

PRACTICALS:

- C++ Program to Implement Linear Search and Binary Search Algorithms.
- C++ Program to Implement Insertion Sort, Merge Sort, Quick Sort and Heap Sort Algorithms.

L+P : 30 +60 = 90 PERIODS

COURSE OUTCOMES:

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

CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world
CO2: Select and realize suitable data structure for specific Application.
CO3: Compare and realize Linear and nonlinear data structures for different application.
CO4: Implement different searching and sorting techniques.
CO5: Identify and realize connected components in trees.

TEXT BOOKS:

1. Deitel and Deitel, " C++, How To Program", Fifth Edition, Pearson Education, 2005
2. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, Fundamentals of Data Structures in C++, 2nd edition, Universities Press Pvt Ltd., Hyderabad, 2007.

REFERENCE BOOKS:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Addison-Wesley, 2007.
2. Bhushan Trivedi, "Programming with ANSI C++, A Step-By-Step approach", Oxford University Press, 2010.
3. Goodrich, Michael T., Roberto Tamassia, "David Mount. " Data Structures and Algorithms in C++", 7th edition, Wiley. 2004.

ARTICULATION MATRIX:

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

EC23C04	CIRCUIT ANALYSIS	L	T	P	C
		2	1	2	4

UNIT I DC CIRCUIT ANALYSIS 9L, 6P

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis & Mesh analysis for independent and dependent sources. Super Mesh, Super Node.

PRACTICALS:

- Verification of Mesh Analysis for DC Circuits.
- Verification of Nodal Analysis for DC Circuits.

UNIT II NETWORK THEOREM AND DUALITY 9L, 6P

Principle of Linearity. Superposition Theorem, Reciprocity Theorem, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer Theorem for dependent and independent sources. Delta-Wye Conversion. Duals, Dual circuits.

PRACTICALS:

- Verification of Thevenin, Maximum Power Transfer Theorems for DC Circuits.
- Verification of Super Position & Norton Theorems for DC Circuits.

UNIT III SINUSOIDAL STEADY STATE ANALYSIS 9L, 6P

Sinusoidal Steady – State analysis, Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

PRACTICALS:

- Verify mesh and nodal analysis for AC circuits using EDA Tools.
- Determine phasor relationship, real power (P), reactive power (Q), apparent power (S) and
  power factor in AC circuits using EDA Tools.

UNIT IV TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9L, 6P

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

PRACTICALS:

- Study of DC transients in RL and RC circuits.
- Determination of Resonant Frequency of Series & Parallel RLC Circuits.

UNIT V TOPOLOGY & COUPLED CIRCUITS 9L, 6P

Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.

PRACTICALS:

- Simulation and verification of coupling coefficient and number of turns in coil using EDA Tools.
- Simulation and verification of self and mutual inductance of coupled circuits using EDA Tools.

L+T+P :30+15+30 PERIODS

TEXT BOOKS:

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis",Mc Graw Hill education, 9th Edition, 2018.
2. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.

REFERENCES:

1. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", Mc Graw- Hill, 2 nd Edition, 2003.
2. D.R.Cunningham, J.A. Stuller, "Basic Circuit Analysis", Jaico Publishing House, 2005.
3. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7 th Edition, 2009.
4. Charles.K.Alexander, Mathew N.O.Sadiku," Fundamentals of Electric Circuits", McGraw Hill, 5th Edition, 2012.
5. John O Mallay, Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011.

COURSE OUTCOMES:

CO1: Ability to apply, construct and validate the basic laws for DC and AC circuits Analysis.

CO2: Ability to apply, construct and validate Network Theorems in DC and AC circuits.

CO3: Ability to design, analyse and implement AC circuits for phase relationship and power calculation.

CO4: Ability to design and analyse first and second order AC circuits.

CO5: Ability to implement and analyse inductively coupled circuits and analyse two port networks.

ARTICULATION MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	3	2	1	1				2	2	1		
CO 2	3	3	2	2				2	2	1		
CO 3	3	3	3	3				2	2	1		
CO 4	3	3	3	3				2	2	1		
CO 5	3	3	3	2				2	2	1		
	3	2.8	2.4	2.2				2	2	1		

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**
1 0 0 1

அலகு I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்**: **3**
சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

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

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

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

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 TAMILS AND TECHNOLOGY L T P C
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

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

UNIT III MANUFACTURING TECHNOLOGY 3

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

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
கல்வியியல் பணிகள் கழகம்).

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

MA23C03	LINEAR ALGEBRA AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand Vector spaces and its basis and dimension.
- To understand the linear maps between vector spaces and their matrix representations.
- To understand the diagonalizatition of a real symmetric matrix.
- To understand Inner product spaces and its projections.
- To understand numerical techniques for solving linear systems, eigenvalue problems and generalized inverses.

UNIT I VECTORSPACES 9+3

Vector Spaces – Subspaces – Linear Combinations - Linear Span – Linear Dependence - Linear Independence – Bases and Dimensions.

UNIT II LINEAR TRANSFORMATIONS 9+3

Linear Transformation – Null Space, Range Space - Dimension Theorem - Matrix representation of Linear Transformation – Eigenvalues and Eigenvectors of Linear Transformation – Diagonalization of Linear Transformation – Application of Diagonalization in Linear System of Differential Equations.

UNIT III INNER PRODUCT SPACES 9+3

Inner Products and Norms - Inner Product Spaces - Orthogonal Vectors – Gram Schmidt Orthogonalization Process – Orthogonal Complement – Least Square Approximations.

UNIT IV NUMERICAL SOLUTION OF LINEAR SYSTEM OF EQUATIONS 9+3

Solution of Linear System of Equations – Direct Methods: Gauss Elimination Method – Pivoting, Gauss Jordan Method, LU Decomposition Method and Cholesky Decomposition Method - Iterative Methods: Gauss-Jacobi Method, Gauss-Seidel Method and SOR Method.

UNIT V NUMERICAL SOLUTION OF EIGENVALUE PROBLEMS AND GENERALISED INVERSES 9+3

Eigen Value Problems: Power Method – Inverse Power Method – Jacobi's Rotation Method - QR Decomposition - Singular Value Decomposition Method.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Linear independence/dependence of vectors
2. Computation of eigenvalues and eigenvectors
3. Diagonalization of Linear Transformation
4. Gram Schmidt Orthogonalization Process
5. Solution of algebraic and transcendental equations
6. Matrix Decomposition methods (LU / Cholesky Decomposition)

7. Iterative methods of Gauss-Jacobi and Gauss-Seidel
8. Matrix Inversion by Gauss-Jordan method
9. Eigen values of a matrix by Power method and by Jacobi's method
10. QR decomposition method
11. Singular Value Decomposition Method

OUTCOMES:

CO1: Solve system of linear equations using matrix operations and vector spaces using Algebraic methods.
CO2: Understand the linear maps between vector spaces and its utilities.
CO3: Apply the concept of inner product of spaces in solving problems.
CO4: Understand the common numerical methods and how they are used to obtain approximate solutions
CO5: Analyse and evaluate the accuracy of common numerical methods.

TEXT BOOKS:

1. Faires, J.D. and Burden, R., "Numerical Methods", Brooks/Cole (Thomson Publications), Fourth Edition, New Delhi, 2012.
2. Friedberg, S.H., Insel, A.J. and Spence, E., "Linear Algebra", Pearson Education, Fifth Edition, New Delhi, 2018.
3. Williams, G, "Linear Algebra with Applications", Jones & Bartlett Learning, First Indian Edition, New Delhi, 2019.

REFERENCES:

1. Bernard Kolman, David R. Hill, "Introductory Linear Algebra", Pearson Education, First Reprint, New Delhi, 2010.
2. Gerald, C.F, and Wheatley, P.O., "Applied Numerical Analysis", Pearson Education, Seventh Edition, New Delhi, 2004.
3. Kumaresan, S., "Linear Algebra – A geometric approach", Prentice – Hall of India, Reprint, New Delhi, 2010.
4. Richard Branson, "Matrix Operations", Schaum's outline series, Mc Graw Hill, New York, 1989.
5. Strang, G., "Linear Algebra and its applications", Cengage Learning, New Delhi, 2005.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

EC23301	ELECTROMAGNETIC FIELDS	L	T	P	C
		3	0	0	3

UNIT – I INTRODUCTION 9L,

Electromagnetic model, Units and constants, of vector algebra, Rectangular, cylindrical and spherical coordinate systems, Line, surface and volume integrals, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stoke's theorem

UNIT – II STATIC ELECTRIC FIELD 9L,

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Electrostatic energy, Poisson's and Laplace's equations, Capacitance of various geometries (parallel plate, cylindrical and spherical), Current density and Ohm's law, Electromotive force and Kirchhoff's voltage law, Equation of continuity and Kirchhoff's current law.

UNIT – III STATIC MAGNETIC FIELD 9L,

Lorentz force equation, Law of no magnetic monopoles, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity and relative permeability, Magnetic circuits, behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torque

UNIT – IV TIME VARYING FIELDS AND MAXWELL EQUATIONS 9L,

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields

UNIT – V PLANE EM WAVES IN ISOTROPIC MEDIA 9L,

Plane waves in lossless media, Plane waves in lossy media (low-loss dielectrics and good conductors), Group velocity, Electromagnetic power flow and Poynting vector, Normal incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Ability to understand the vector calculus and basic EM theorems
2. Ability to the understand the basic laws and concepts of static electric field
3. Ability to the understand the basic laws and concepts of static magnetic field.
4. Ability to the understand the Maxwells equation and nature of time varying fields
5. Ability to the understand the nature of plane waves incident on different media.

REFERENCES:

1. Cheng D.K., Field and wave electromagnetics, Pearson Education, Second Edition 1989. (Unit I to V).
2. Griffiths D.J, Introduction to Electrodynamics, Pearson Education, Fourth Edition 2013.
3. Notaros B.M, Electromagnetics, Pearson, New Jersey, 2011
4. Hayt W.H and Buck J.A, Engineering electromagnetics, McGraw-Hill (India), seventh Edition, 2006.
5. Sadiku M.N.O and Kulkarni S.V, Principles of electromagnetics, Oxford (Asian Edition), Sixth Edition, 2015.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1		1		1		1		1
CO2	3	3	3	2		1		1		1		1
CO3	3	3	3	2		1		1		1		1
CO4	3	3	3	2		1		1		1		1
CO5	3	3	3	2		1		1		1		1
Average	3	3	3	1.8		1		1		1		1

EC23C13	DIGITAL ELECTRONICS AND SYSTEM DESIGN	L	T	P	C
		3	0	2	4

UNIT – I BASIC CONCEPTS IN DIGITAL SYSTEM DESIGN 9L, 4P

Review of number systems – Representation - Conversions, Review of Boolean algebra - Theorems, Canonical forms and Standard forms -Implementation of Boolean expressions using universal gates, Simplification of Boolean expressions, Karnaugh map, Tabulation methods.

PRACTICALS:

Verification of logic expressions

UNIT – II DESIGN OF COMBINATIONAL CIRCUITS 9L, 16P

Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Building Encoders with basic size, Priority Encoder, Multiplexer, Demultiplexer.

PRACTICALS:

- Design and verification of adders / subtractors.
- Design and verification of BCD adder, BCD to seven segment display decoder.
- Design and implementation of multiplexers / demultiplexers.
- Design and implementation encoders / decoders.

UNIT – III DESIGN OF SYNCHRONOUS SEQUENTIAL CIRCUITS 9L, 10P

Latches, Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, State minimization, State assignment, Counters, Ripple Counters, Ring Counters, Shift registers, Universal Shift Register. Use cases

PRACTICALS:

- Design of counters – 4-bit ripple counter / ring counter.
- Design of universal shift register.

UNIT – IV DESIGN OF ASYNHRONOUS SEQUENTIAL CIRCUITS 9L

Analysis - Stable and unstable states, Cycles and races, Design of Fundamental mode sequential circuits - State reduction, Race free assignments, Hazards and its types, Design of Hazard free circuits. Use cases

UNIT – V MOS LOGIC FAMILY AND PLDs 9L

MOS Logic families and parameters - Propagation delay, Fan-in and Fan-out, Noise Margin, Implementation of Inverter, NAND, NOR using CMOS logic, Realization of combinational logic/sequential logic design, using standard ICs, PLDs - PROM, PLA, PAL and CPLD.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

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

1. Ability to apply Boolean algebra and simplification procedure in digital logic systems.
2. Ability to design combinational digital circuits using logic gates.
3. Ability to analyze and design synchronous sequential circuits.
4. Ability to analyze and design asynchronous sequential circuits.
5. Ability to design digital circuits using MOS and PLDs.

REFERENCES:

1. M. Morris Mano and Michael D. Ciletti, 'Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, 6e', Pearson, 6th Edition, 2018.
2. Charles H. Roth, Jr. and Larry L. Kinney, 'Fundamentals of Logic Design', Cengage Learning, 7th Edition, 2014.
3. William I. Fletcher, "An Engineering Approach to Digital Design - softcover", Prentice- Hall of India, 2015.
4. Floyd T.L., "Digital Fundamentals", 11th Edition by Pearson Education, 2020.
5. John. F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 5th Edition, 2018.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3						1	1	1		
CO2	3	1	2					1	1	1		
CO3	3	3	3	2				1	1	1		
CO4	3	3	3	2				1		1		
CO5	2	2	2	2				1		1		
Average	2.8	2.4	2.5	2				1	1	1		

EC23302	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

UNIT – I CLASSIFICATION OF SIGNALS AND SYSTEMS 9L

Continuous time signals (CT signals)- Discrete time signals (DT signals) – Step, Ramp, Pulse, Impulse, Exponential - classification of CT– periodic and aperiodic signals, random signals, Energy & Power signals - CT systems, Classification of systems.

UNIT – II SPECTRAL ANALYSIS OF CONTINUOUS TIME SIGNALS 9L

Fourier series, Fourier transforms: properties – Spectral analysis of continuous time signals- Frequency response of continuous time LTI systems.

UNIT – III CHARACTERIZATION OF CONTINUOUS TIME LTI SYSTEMS 9L

Differential Equation - impulse response, convolution integrals- Laplace transform: properties and application in continuous time signal and system analysis

UNIT – IV SAMPLING 9L

Baseband Sampling of CT signals– spectral analysis of sampled signals –analysis of Aliasing effects due to under-sampling - Types of samplers: ideal sampling, natural sampling, flat top sampling -distortion analysis

UNIT – V ANALYSIS OF CONTINUOUS TIME RANDOM SIGNALS 9L

Basics of Probability, Random variables, statistical averages, correlations, Central limit Theorem, Random Process, Stationary Processes, Power Spectral Density, Ergodic Processes, Gaussian Process, Transmission of a Random signal through an LTI filter, Output of a linear system with gaussian input.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Ability to classify signals and systems based on various characteristics and decomposition for easier analysis.
2. Ability to determine analyze frequency components of signals and frequency response of the systems.
3. Ability to determine and analyze the causality and stability LTI systems from their impulse responses
4. Ability to convert the CT signals into DT signals and analyze, the effect of sampling and frequency content of DT signals.
5. Ability to analyze the processing of random signals with LTI systems.

REFERENCES:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, Indian Reprint,2007.
2. B. P. Lathi, "Principles of Linear Systems and Signals", Oxford, 2nd Edition,2009.
3. H P Hsu, "Signals and Systems", Schaum's Outlines, Tata McGrawHill,2006.
4. S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley,2003
5. P.Ramakrishna Rao, "Signals and Systems", Tata Mc Graw Hill Publications, 2nd Edition, 2008.
6. Dward W. Kamen, Bonnie S. Heck, "Fundamentals of Signals and Systems, Using the Web and MATLAB", Pearson, Indian Reprint, 3rd Edition,2007.
7. John Alan Stuller, "An Introduction to Signals and Systems", Thomson,2007.
8. M.J.Roberts, "Signals & Systems, Analysis, using Transform methods MATLAB", Tata McGraw Hill (India),2007.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1					1		1		
CO2	3	2	1					1		1		
CO3	3	3	1					1		1		
CO4	3	2	1					1		1		
CO5	3	3	1					1		1		
Average	3	2.4	1					1		1		

EC23C02	ANALOG CIRCUITS DESIGN	L	T	P	C
		3	0	2	4

UNIT – I BIASING OF DISCRETE BJT AND MOSFET 9L

DC Loadline, operating point, Various biasing methods for BJT-Design-Stability-Bias compensation, Thermal stability, DC bias analysis of MOSFET circuits.

UNIT – II DISCRETE BJT AMPLIFIERS 9L,20P

Small signal Analysis of Common Emitter-AC Loadline, Voltage swing limitations, Common Collector and common base amplifiers – Differential amplifiers- CMRR- Darlington Amplifier-Multi stage amplifiers-Cascode Amplifier.

PRACTICALS:

- Frequency Response characteristics of CE amplifier.
- Frequency Response characteristics of CB amplifier.
- Design of CC Amplifier for a specific output impedance.
- Design of Differential Amplifiers and its CMRR measurement.

UNIT – III DISCRETE MOSFET AMPLIFIERS 9L

Small signal Analysis of amplifiers- Common source amplifier, Voltage swing limitations, Small signal analysis of Source follower and Common Gate amplifiers, Cascode amplifiers, Differential amplifiers

UNIT – IV FREQUENCY ANALYSIS OF BJT AND MOSFET AMPLIFIERS 9L,6P

Short circuit current gain, cutoff frequency–fα, fβ of BJT, Unity Gain Bandwidth of BJT and MOSFET, Low frequency analysis , Miller effect, High frequency analysis of single stage BJT and MOSFET amplifiers.

PRACTICALS:

- Frequency response characteristics of Cascode amplifier.

UNIT – V IC MOSFET Amplifiers 9L,4P

IC biasing Current steering circuits for IC amplifiers- current mirrors, - current sources- PMOS and NMOS current sources, Cascode current source, Wilson current source. Amplifier with resistive load, active load - Depletion load, Differential amplifiers with active load.

PRACTICALS:

- Spice simulation of CS, CG, and CD configuration of MOSFET amplifiers with various active load configurations.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

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

1. Choose appropriate biasing circuits for BJT and MOSFET discrete amplifiers
2. Design and analyze single stage and multistage BJT amplifiers
3. Analyze the characteristic of MOSFET amplifiers, the effect of source and load.
4. Analyze the high frequency response of BJT and MOSFET amplifiers
5. Design and analyze IC MOSFET amplifiers

REFERENCES:

1. Donald .A. Neamen, "Micro Electronics: Circuit Analysis and Design", 4th Edition, Tata McGraw Hill, 2021.
2. Adel.S.Sedra, KennethC.Smith, "Micro Electronic Circuits: Theory and Applications",7th Edition,Oxford University Press,2017
3. Behzad Razavi,"Design of Analog CMOS Integrated Circuits",Tata McGraw Hill,2017.
4. Paul Gray, Hurst, Lewis, Meyer, "Analysis and Design of Analog Integrated Circuits", John Willey & Sons, 5th Edition,2009.
5. Millman.J, HalkiasC.C and Chetan Parikh "Integrated Electronics-", 2nd Edition, McGraw Hill,2017.
6. Paul Horowitz, Winfield Hill, “The Art of Electronis”,Cambridge University Press, 3rd Edition,2015(Reference for Lab).

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3				1	1	1		
CO2	3	3	3	3				1	1	1		
CO3	3	3	3	3				1	1	1		1
CO4	3	3	3	3				1	1	1		
CO5	3	2	2	2				1	1	1		1
Average	3	2.8	2.8	2.8				1	1	1		1

EC23S01	NUMERICAL AND SIGNAL PROCESSING PRACTICE THROUGH PYTHON	L	T	P	C
		0	0	2	1

Introduction to Python – Data types – Variables - Functions–-Flow Control and branching statements - Manipulating Strings-Accepting User Input-Lists-Tuples-Dictionaries-Reading and Writing Files-Modules-Debugging-Introduction to Numpy – Matplotlib- Scipy.

LIST OF PRACTICAL EXERCISES:

1. Getting Started with Python and using the Plot command
2. Load data from files and Plotting data
3. Getting Started with Lists
4. Getting started with for, If, While loops
5. Getting started with files and arrays
6. Statistics using Python
7. Linear combination of vectors and Computation of determinant, rank of a matrix
8. Lower - Upper Decomposition of vectors
9. Gauss-Seidel Method
10. Solve Systems of Linear Equations in Python
11. Eigenvalues and eigenvectors in Python
12. Generation of basic sequences using Python
13. Spectral analysis of signals
14. Sampling of continuous-time signals

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

1. Develop and execute simple Python programs.
2. Apply the best features available in Python to solve the situational problems
3. Develop code for numerical methods computation using Python
4. Generate and analyse the basic signals using Python

REFERENCES:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021
2. Qingkai Kong, Timmy Siauw and Alexandre M.Bayen, “Python Programming and Numerical Methods”, Elsevier Academic Press, 2021
3. Fatos Tunay Yarman Vural, and Emre Akbas, “Signals and Systems: Theory and Practical Explorations with Python”, John Wiley, 2024

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	-	2	2
CO2	3	3	3	3	2	-	-	-	-	-	2	2
CO3	3	3	3	3	3	-	-	-	-	-	1	2
CO4	3	3	3	3	3	2	-	-	-	-	1	1
Average	3	3	3	3	2.75	0.5	-	-	-	-	1.5	1.75

UC23U01 UNIVERSAL HUMAN VALUES L T P C

1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Introduction (3L,6P)

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

Module II: Harmony in the Human Being (3L,6P)

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

Module III: Harmony in the Family and Society (3L,6P)

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude*

as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Module IV: Harmony in the Nature and Existence (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

Module V: Implications of Harmony on Professional Ethics (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

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

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.

8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

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

EC23401	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	2	4

UNIT – I CLASSIFICATION OF DT SIGNALS AND SYSTEMS 9L,8P

Discrete time signals (DT signals) – Step, Ramp, Pulse, Impulse, Exponential - classification of DT signals – periodic and aperiodic signals, random signals, Energy & Power signals - DT systems, Classification of systems, , Convolution sum: Linear and Circular, Overlap-add & overlap-save methods

PRACTICALS:

- Generation of sequences
- Linear and Circular Convolutions

UNIT – II SPECTRAL ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS 9L,3P

Introduction to discrete Fourier series, DTFT: properties and Spectral analysis of discrete time signals- - DFT and its properties, FFT algorithms & its applications, Frequency response of discrete time LTI systems.

PRACTICALS:

- Spectral analysis of signals using DFT

UNIT – III CHARACTERIZATION OF DISCRETE TIME LTI SYSTEMS 9L,3P

Difference Equations-Impulse response-Z-transform& its ROC: properties and application in discrete time signal and system analysis.

PRACTICALS:

- Pole Zero analysis of Discrete Time systems

UNIT – IV DESIGN OF INFINITE IMPULSE RESPONSE FILTERS 9L,6P

Transfer functions of continuous time systems (analog filters).Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method-Realization structures for IIR filters – direct, cascade, parallel forms.

PRACTICALS:

- IIR filter design
- Frequency response of IIR system

UNIT – V DESIGN OF FINITE IMPULSE RESPONSE FILTERS 9L,10P

Design of linear phase FIR filters windowing and Frequency sampling methods - Realization structures for FIR filters – Transversal and Linear phase structures- Comparison of FIR & IIR.

PRACTICALS:

- FIR filter design
- Frequency response of FIR system
- Signal Processing based Mini Project

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to apply the concepts of Discrete Fourier transform
2. Ability to design and analyze IIR filter
3. Ability to design and analyze FIR filter
4. Ability to analyze performance degradation of digital signal processing systems due to finite precision
5. Ability to analyze the system with multiple sampling rates

REFERENCES:

1. A.V.Oppenheim, R.W. Schafer and J.R. Buck, "Discrete Time Signal Processing", Pearson, 8th Indian Reprint,2004.
2. John G Proakis and Manolakis, “Digital Signal Processing Principles Algorithms and Applications”, Pearson, 4thEdition,2007.
3. I.C.Ifeachor and B.W. Jervis, "Digital Signal Processing A Practical Approach", Pearson,2002.
4. M.H.Hayes, "Digital Signal Processing", Schaum’s outlines, Tata McGraw Hill, 2007.
5. S.K. Mitra," Digital Signal Processing", A Computer Based approach, Tata McGraw-Hill,1998.
6. D.J. De Fatta, J.G.Lucas and W.S. Hodgkiss, "Digital Signal Processing A system Design Approach", John Wiley & sons, Singapore,1988
7. P.P.Vaidyanathan, Multirate Systems & Filter Banks, Prentice Hall, Englewood cliffs, NJ,1993.
8. Tarun Kumar Rawat, “Digital Signal Processing’, Oxford University Press, 2015

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			3	1		1	1	1		
CO2	3	3	3		3	1		1	1	1		
CO3	3	3	3		3	1		1	1	1		
CO4	3	2			3	1		1	1	1		
CO5	3	2			3	1		1	1	1		
Average	3	2.4	3		3	1		1	1	1		

EC23402	TRANSMISSION LINES	L	T	P	C
		3	0	0	3

UNIT – I TRANSMISSION LINE FUNDAMENTALS 9L

General theory of Transmission lines - the transmission line general solution - The infinite line - the distortionless line – Transmission line Loading - Input and transfer impedance - Reflection factor and reflection loss, insertion loss – Introduction to planar transmission lines: Strip line, Slot line and Microstrip line.

UNIT – II PASSIVE FILTERS 9L

Symmetrical networks: Characteristic impedance and propagation constant - Filter fundamentals: pass and stop bands - Design of filters: constant k - lowpass, high pass, bandpass, bandstop, m-derived sections - lowpass, high pass, bandpass filters – composite filters

UNIT – III LINE AT RADIO FREQUENCY & IMPEDANCE MATCHING 9L

Transmission line equations at radio frequencies – Input impedance of the dissipation-less line - Open and short circuited lines – Reflection Phenomena – Standing waves – λ/8, λ/4 & λ/2 lines – λ/4 Impedance transformers, Stub Matching – Single and Double Stub – Smith Chart and Applications.

UNIT – IV WAVEGUIDES 9L

General Wave behaviors along uniform Guiding structures, Transverse Electromagnetic (TEM) waves, Transverse Magnetic (TM) waves, Transverse Electric (TE) waves, TM and TE waves between parallel plates, TM and TE waves in Rectangular wave guides – Circular wave guides.

UNIT – V PLANAR TRANSMISSION LINES AND SIGNAL INTEGRTY ISSUES 9L

Mutual Inductance and Capacitance - Transmission line reflections – Lattice diagram – Time domain reflectometry – Coupled Wave Equations - Coupled Line Analysis - Modal Analysis - Crosstalk Minimization - Classic Conductor Model for Transmission models – Removal of Common Mode Noise – Jitter analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Comprehend the working of lossy and lossless transmission lines at radio frequencies.
2. Apply the knowledge of filter theory in the design of passive filters.
3. Solve transmission line problems using Smith chart
4. Analyze electric and magnetic field components in waveguides
5. Identify and resolve crosstalk in high-speed transmission lines

REFERENCES:

1. John D Ryder, "Networks lines and fields", Prentice Hall of India, 2005.
2. Stephen H. Hall, Howard L. Heck, "Advanced Signal Integrity For High-Speed Digital Designs", John Wiley & Sons, 2009
3. E.C.Jordan and K.G. Balmain, “Electromagnetic Waves and Radiating Systems”, PrenticeHall of India, 2011.
4. Bhag Singh Guru &Hüseyin R. Hiziroglu, “Electromagnetic Field Theory Fundamentals”,Second edition Cambridge University press, 2005
5. R. K. Shevgaonkar, “Electromagnetic Waves”, Tata McGraw Hill Publications, 2006
6. G.S.N Raju "Electromagnetic Field Theory and Transmission Lines", Pearson EducationIndia, First edition, 2005.
7. Reinmut K Hoffman, “Handbook of Microwave Integrated Circuits”, Artech House, 1987.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2					1		1		1
CO2	3	3	3					1		1		3
CO3	3	3	3					1		1		1
CO4	3	2	3					1		1		1
CO5	3	3	3					1		1		3
Average	3	2.6	2.8					1		1		1.8

EC23403	ANALOG AND BASEBAND COMMUNICATION	L	T	P	C
		3	0	2	4

UNIT – I AMPLITUDEMODULATION 9L,5P

Review of Fourier and Hilbert Transforms-Amplitude Modulation – AM, DSBSC, SSBSC, VSB–Spectral analysis of modulated signal, Detectors- Envelope, coherent Detection, Noise figure and Noise Temperature, Noise in cascaded systems, Noise performance in AM (qualitative treatment only).

PRACTICALS:

- Spectral analysis of AM signals over modulation index.

UNIT – II ANGLEMODULATION 9L,5P

Angle modulation and demodulation: Narrow band, Wideband FM - Spectral analysis of modulated signal, Frequency Discriminator, Superheterodyne receiver principle, Noise performance in FM (qualitative treatment only).

PRACTICALS:

- Spectral analysis of FM signals over modulation index

UNIT – III PULSE MODULATION 9L,10P

Schematic of digital communication systems, Sampling - Quantization – Uniform and non-uniform quantization – Quantization noise– Speech Coders: Companding laws of speech signals, PCM, DPCM, ADPCM, DM, ADM.

PRACTICALS:

- Evaluation of SQNR vs number of bits
- Encoding & decoding of signals using DM

UNIT – IV INFORMATIONTHEORY 9L,5P

Measure of information – Entropy – Source coding theorem – Discrete memoryless channels –lossless, deterministic, noiseless, BEC, BSC – Mutual information – Channel capacity – Statement of Shannon- Hartley law - Source Coding: Shannon-Fano coding, Huffman Coding.

PRACTICALS:

- Encoding and decoding using Shannon Fano and Huffman algorithms

UNIT – V BASEBAND WAVEFORMS OF DIGITAL SIGNALING 9L,5P

Line codes–RZ, NRZ,Manchester, Binary N-zero substitution codes–PSDs, ISI –Nyquist Criterion- Pulse shaping –Correlative coding- Eye pattern,

PRACTICALS:

- Generation and spectral analysis of NRZ, RZ and Manchester coded signals

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

- Ability to develop and analyse communication system using amplitude modulation
- techniques
- Ability to develop and analyse communication systems using angle modulation techniques
- Ability to analyze pulse modulation schemes.
- Ability to understand the basics of Information Theory and source coding schemes
- Ability to understand and analyze digital base band signaling techniques

REFERENCES:

1. S.Haykin, "CommunicationSystems",JohnWiley,4th Edition,2007
2. J.G.Proakis,M.Salehi,"FundamentalsofCommunicationSystems",Pearson Education 2006
3. HP Hsu, Schaum Outline Series, "AnalogandDigitalCommunications",TMH2006
4. B. P. Lathi, "Modern Digital and Analog Communication Systems", Oxford University Press,3rd Edition,2007
5. B. Sklar, "Digital Communications Fundamentals and Applications", Pearson Education 2nd Edition,2007.
6. D.Roody.J.Coolen,"ElectronicCommunications",PHI,4th Edition,2006.
7. V. Chandra Sekar, "Analog Communication" ,Oxford University Press, 2012.

ARTICULATION MATRIX:

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

EC23C05 ANALOG ELECTRONIC SYSTEMS DESIGN

L	T	P	C
3	0	2	4

UNIT – I FEEDBACK AMPLIFIERS AND STABILITY 9L,3P

Basic feedback concepts – Properties of Negative feedback – Feedback topologies– Analysis of feedback amplifiers – stability analysis on amplifier – Gain and Phase-margins- Frequency compensation.

PRACTICALS:

- Design and Analysis of negative Feedback amplifiers

UNIT – II OPERATIONAL AMPLIFIERS 9L

IC fabrication technology-Design of Op Amp- specifications, slew rate, and methods of improving slew rate. Linear and Nonlinear Circuits using operational amplifiers and their analysis, Inverting and Noninverting Amplifiers, Differentiators, Integrator, Voltage to Current converters, Log and Antilog amplifiers.

UNIT – III SIGNAL CONDITIONING CIRCUITS AND POWER AMPLIFIERS 9L,18P

Barkhausen criteria for oscillator – Analysis of RC oscillators- Phase shift and Wein bridge oscillators – LC oscillators – Colpitts, Hartley- Ring Oscillators. Multivibrator- Monostable, Astable and Bistable, Comparator, Schmitt trigger, Power Amplifiers-Class A, Class B, class AB and class C.

PRACTICALS:

- Design and analysis of RC Phase shift oscillator
- Design and analysis of Hartley and Colpits
- Design and analysis of Wien Bridge Oscillator using OP-AMP
- Design and analysis of Schmitt trigger using OPAMP (3)
- Design and analysis of Waveform generators using OPAMP
- Spice simulation of Class A and Class B Power Amplifiers.

UNIT – IV SPECIAL FUNCTION ICs 9L,6P

Instrumentation amplifier, astable and monostable multivibrator using Timer IC 555, ADCs - specifications Flash type - Successive Approximation type DAC - specifications - weighted resistor type, R-2R Ladder type, PLL-Operation of the basic PLL, application of PLL.

PRACTICALS:

- Design and analysis of Voltage Controlled Oscillator using PLL IC(4)
- Design and analysis of Astable and Monostable Multivibrators using Timer IC

UNIT – V TUNED AMPLIFIERS 9L,3P

Basic principles of Tuned circuits – Inductor losses – Use of transformers –frequency analysis of Single tuned amplifier and Synchronous tuned amplifiers & Stagger tuned amplifiers.

PRACTICALS:

- Design and analysis of single Tuned amplifier.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to design negative feedback amplifiers and analyze stabilization techniques
2. Ability to apply and design linear and Non-Linear analog circuits using Op Amp.
3. Ability to analyze and realize signal conditioning circuits, power amplifiers and converters.
4. Ability to select ICs and design circuits for real time applications
5. Ability to analyze RC, LC oscillators and tuned amplifiers

REFERENCES:

1. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7th Edition, 2014.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2007
3. Ramakant A Gayakwad, “Op-amps and Linear Integrated Circuits”, Pearson, 4th Edition, 2015.
4. Jacob Millman and Herbert Taub, “Pulse, Digital, and Switching Waveforms: Devices and Circuits for their Generation and Processing”, McGraw-Hill, International Student Edition, 1965.
5. Donald. A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
6. Millman J. and Halkias C, "Integrated Electronics", Mc Graw Hill, 2001.
7. Robert F. Coughlin, Fredrick F. Driscoll, “Operational Amplifiers and Linear Integrated Circuits” Prentice Hall, 6th Edition, 2001.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	2	-	1	-	1	-	1
CO2	2	2	3	2	2	-	-	1	-	1	-	1
CO3	3	2	3	2	2	1	-	1	-	1	-	1
CO4	2	2	3	2	2	-	-	1	-	1	-	1
CO5	3	3	2	3	2	2	-	1	-	1	-	1
Average	2.6	2.4	2.6	2.4	2	1	-	1	-	1	-	1

EC23C10	COMPUTER ARCHITECTURE AND ORGANIZATION	L	T	P	C
		3	0	0	3

UNIT – I COMPUTING AND COMPUTERS

Evolution of Computers, VLSI Era, buses, bus control, bus interfacing, bus arbitration, System Design methodology: Gate level, Register Level , Processor Level, CPU Organization, Data Representation, Fixed Point Numbers, Floating Point Numbers

UNIT – II DATA PATH DESIGN 9L

Fixed Point Arithmetic, Addition, Subtraction, Multiplication and Division, Combinational and Sequential ALUs, Carry look ahead adder, Robertson algorithm, Booth‘s algorithm, Modified booth‘s Algorithm, Restoring and non- restoring division algorithm, Floating Point Arithmetic, Coprocessor.

UNIT – III CONTROL DESIGN AND PIPELINING DESIGN 9L

Hardwired Control, Microprogrammed Control, Multiplier Control Unit, CPU Control Unit, Pipeline Techniques- Linear pipeline processors, non- linear pipeline processors, Instruction pipeline design, Pipeline Performance, Arithmetic pipeline design.

UNIT – IV MEMORY ORGANIZATION 9L

Memory hierarchy technology, Memory types- RAM,ROM, MOS- static and dynamic RAM cell, Virtual Memory: Address translation-TLB-page operation-Demand paging, Multicore architecture, Cache memory system-Mapping function, Cache write/updating, Cache coherence, Performance characteristics of two level memories

UNIT – V RISC AND CISC PROCESSORS 9L

Characteristics of RISC and CISC – RISC example -MIPS RX00- architecture- Instruction format, instruction set, programming. CISC example- Motorola 680X0-Architecture, Instruction format, instruction set, programming. Superscalar processors, vector processors, nano programming.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to acquire fundamental knowledge in computer architecture and organization
2. Ability to design data path for arithmetic algorithms
3. Ability to analyze control unit design and pipelining concepts
4. Ability to understand cache and virtual memory characteristics.
5. Ability to differentiate RICS and CISC architectures.

REFERENCES:

1. John P.Hayes, “Computer architecture and Organisation”, Tata McGraw-Hill, Third edition, 1998.
2. V.Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, “ Computer Organisation”, V edition, McGraw-Hill Inc, 1996.
3. Kai Hwang, Naresh Jotwani, "Advanced computer Architecture", Parallelism, Scalability, Programmability, Tata McGraw Hill, 3rd Edition, 1993.
4. A.P.Godse and D.A.Godse “Computer Organization and Architecture” Technical Publications, 2021
5. Morris Mano, “Computer System Architecture”, Prentice-Hall of India, 2000
6. Behrooz Paraami, “Computer Architecture, From Micrprocessor to Supercomputers”, Oxford University Press, Sixth impression 2010.
7. P.Pal Chaudhuri, , “Computer organization and design”, 2 nd Ed., Prentice Hall of India, 2007
8. Miles J. Murdocca and Vincent P. Heuring, “Principles of Computer Architecture”, Prentice Hall, 2000
9. William Stallings, “Computer Organisation and Architecture, Designing for Performance”, Pearson Education, Eighth Edition 2010.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2						1	1	1		
CO2	2	3	2					1	1	1		
CO3	2	3	3	2				1	1	1		
CO4	2	3	3	2				1	1	1		
CO5	2	2	2	2				1	1	1		
Average	2.2	2.6	2.5	2				1	1	1		

EC23C11	CONTROL SYSTEM	L	T	P	C
		3	0	0	3

UNIT – I COMPONENTS OF THE CONTROL SYSTEM 7L

Terminology and Basic Structure-Feed forward and Feedback control theory Electrical and Mechanical Transfer Function Models-Block Diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system

UNIT – II TIME RESPONSE WITH SYSTEM DESIGN 8L

Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI, PID control systems

UNIT – III FREQUENCY RESPONSE WITH SYSTEM ANALYSIS 12L

Closed loop frequency Response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation.

UNIT – IV STABILITY ANALYSIS 9L

Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

UNIT – V CONTROL SYSTEM ANALYSIS 9L

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to comprehend the systems components and their representation using various control system
2. Ability to compute the steady state response using various time domain parameters for various system
3. Ability to analyze the frequency response characteristics for both open loop and closed loop system
4. Ability to analyze the stability of various system using Routh Hurwitz Root locus techniques
5. Ability to illustrate the state space model of various control system Ability to Compute the transfer function of different physical systems.

REFERENCES:

1. M. Gopal, “Control System – Principles and Design”, Tata McGraw Hill, 4th Edition, 2012
2. J. Nagrath and M. Gopal, “Control System Engineering”, New Age International Publishers, 7th Edition, 2021
3. K. Ogata, “Modern Control Engineering”, PHI, 5th Edition, 2012.
4. S. K. Bhattacharya, “Control System Engineering”, Pearson, 3rd Edition, 2013.
5. Benjamin. C. Kuo, “Automatic Control Systems”, Prentice Hall of India, 10th Edition,2017.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3						1		1		3
CO2	3	3						1		1		3
CO3	3	3						1		1		3
CO4	3	3						1		1		3
CO5	3	3						1		1		3
Average	3	3						1		1		3

EC23S02	PCB DESIGN USING CAD TOOLS FOR ELECTRONIC SYSTEMS	L	T	P	C
		0	0	2	1

PCB Design Flow and EDA Tools – PCB Terminologies – PCB Mounting Technologies - Overview of PCB Design and Fabrication Standards - PCB Placement and Routing Generic Rules - Generation of Gerber files

LIST OF PRACTICAL EXERCISES:

1. Design a single-layer PCB to create a circuit that blinks an LED at a controlled rate
2. using a timer IC.
3. Design a single-layer PCB for Audio Amplifier circuits
4. Design an LDR Sensor Module using Op-Amp.
5. Design a PCB for Rectangular Microstrip Patch Antenna
6. Customized Atmega Microcontroller Board Design.
7. Design a double layer Printed Circuit Board (PCB) for Home Automation System.
8. Design a general-purpose multi-layer Printed Circuit Board (PCB) for IoT application.
9. Design a PCB for 500W converter / inverter power system.
10. Design a PCB for Micro-strip/ Band Pass and Band Stop filter.

SOFTWARE REQUIRED:

1. Altium Designer/Proteus PCB Design Suite/ KiCAD EDA Tools/EasyEDA/Any other equivalent /Open Source.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

1. Design a multipage circuit schematic using active and passive components
2. Place and Interconnect the Through-Hole (TH) components and Surface Mount Devices (SMD) in the layout by following the PCB standards
3. Design a single, double and multi-layer PCB layout & Generate the Gerber File for PCB fabrication by calculating the trace width of the interconnect in the layout.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	1		1	1		1
CO2	3	3	3	2	3	2	1		1	1		1
CO3	3	3	3	2	3	2	1		1	1		1
Avg	3	3	3	2	3	2	1		1	1		1

EC23501	ANTENNAS AND WAVE PROPAGATION	L	T	P	C
		3	0	2	4

UNIT – I FUNDAMENTALS OF RADIATION 9L, 4P

Antenna parameters - Gain, efficiency, Directivity, Effective aperture, Radiation Resistance, Bandwidth, Beam width, Radiation from oscillating dipole and half wave dipole

PRACTICALS:

- Design of half-wavelength dipole antenna and study the impedance and radiation properties.

UNIT – II ANTENNA ARRAYS 9L, 6P

Two element array, N-element linear array, Pattern multiplication, Broadside and end fire array, Array synthesis: Binomial array, Tschebyscheff array, planar array antennas.

PRACTICALS:

- Construction of an N element array using half-wavelength dipole antenna and study the radiation pattern shaping (Broadside and end-fire pattern).

UNIT – III APERTURE ANTENNAS 9L, 8P

Huygens' principle, radiation from rectangular aperture, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, parabolic reflector antennas, lens antennas, Microstrip Patch Antennas: Radiation mechanism, Design and Feeding Techniques.

PRACTICALS:

- Design of a pyramidal horn antenna.
- Design of a rectangular microstrip patch and conduct investigation on bandwidth and radiation properties

UNIT – IV WIDEBAND AND SPECIAL ANTENNAS & ANTENNA MEASUREMENTS 9L, 12P

Frequency Independent Antennas: Rumsey's principle, LPDA, Helical Antennas, Reconfigurability in Antennas, Antennas for Wearable, Automotive applications Measurements: Network analyzer, Test Ranges, Antenna Gain, Radiation pattern and polarization

PRACTICALS:

- Design of a planar log-periodic dipole array.
- Design of a frequency reconfigurable microstrip patch antenna and study the frequency tuning properties
- Study and Demonstration of antenna measurements using Vector Network Analyzer and Anechoic chamber

UNIT – V WAVE PROPAGATION 9L

Modes of propagation, Structure of atmosphere, Ground wave propagation, Tropospheric propagation, Troposcatter propagation, Sky wave propagation – Virtual height, critical frequency , Maximum usable frequency – Skip distance.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Comprehend antenna parameters and the radiation mechanism of simple antennas to complex antenna structures
2. Design antennas for given specifications and perform array synthesis.
3. Elaborate the radiation mechanism of aperture antennas
4. Acquire knowledge on the operation of antennas designed for specific applications and the measurement procedures
5. Understand the propagation of radio waves in the atmosphere

REFERENCES:

1. John D Kraus, “Antennas for all Applications”, Mc Graw Hill, 5th Edition, 2005.
2. R.E.Collin, “Antennas and Radiowave propagation”, Mc Graw Hill, 1985.
3. Constantine.A.Balanis, "Antenna Theory Analysis and Design", Wiley student edition,3rdEdition, 2009.
4. Annapurna Das and Sisir K Das, Microwave Engineering, Tata McGraw Hill Publishing Company Ltd., New Delhi, Second Edition, 2009
5. Edward C.Jordan and Keith G.Balmain, "Electromagnetic Waves and Radiating Systems",Prentice Hall of India, 2006
6. S. Drabowitch, "Modern Antennas", Springer Publications, 2nd Edition, 2007
7. Robert S.Elliott, "Antenna theory and Design", Wiley student edition, 2010.
8. H.Sizun, "Radio Wave Propagation for Telecommunication Applications", First IndianReprint, Springer Publications, 2007

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			3	2						3
CO2	3	3	3	3	3							2
CO3	2	3	3	3	3	2						3
CO4	3	3	3	3	3	2						3
CO5		2		2		2						2
Avg	2.75	2.6	3	2.75	3	2						2.6

EC23502	DIGITAL COMMUNICATION	L	T	P	C
		3	0	2	4

UNIT – I SIGNAL REPRESENTATION AND DETECTION 9L, 5P

Geometric representation of digital modulation signals – Gram Schmidt's Orthogonalization, MAP and ML detection – Correlator and matched filter detec tion

PRACTICALS:

- Basis Signal generation using Gram Schmidt's Orthogonalization

UNIT – II ERROR CONTROL CODING TECHNIQUES 9L, 5P

Channe lcoding theorem – Linear block codes – Hamming codes – Cyclic codes – Convolutional codes – Viterbi decoding

PRACTICALS:

- Error control coding schemes – Linear and Cyclic codes

UNIT – III BANDPASSSIGNALING 9L, 5P

Generation and detection of BPSK, BFSK, QPSK-BER and Power spectral Density Comparison- Structure of non-coherent receivers- generation and detection of BFSK, DPSK, Overview of QAM, MSK

PRACTICALS:

- Modulation Schemes BPSK, BFSK, QPSK

UNIT – IV MULTIPLEXING, MULTIPLE ACCESS AND SYNCHRONIZATION 9L, 10P

Multiplexing - FDM, TDM (E and T lines), Multiple Access: TDMA, FDMA, CDMA, SDMA, Synchronization: Carrier, frame and symbol synchronization techniques.

PRACTICALS:

- Time Division Multiplexing
- Synchronization techniques

UNIT – V SPREADSPECTRUM ANDITSAPPLICATIONS 9L, 5P

Spread Spectrum - Direct Sequence and Frequency Hopping Spread Spectrum Systems, Processing gain and Jamming Margin Analysis, Applications of spread spectrum - CDMA cellular system, GPS and WLAN.

PRACTICALS:

- Spread spectrum communication- DSSS

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to understand geometric representation of signals and their detection
2. Ability to apply error control coding schemes and analyze its performance
3. Ability to understand and analyze pass band signaling schemes and its spectral and BER characteristics
4. Ability to analyze multiplexing, multiple access and synchronization techniques
5. Ability to understand and analyze spread spectrum techniques

REFERENCES:

1. Simon Haykin ,"Digital Communications", JohnWiley,2015.
2. B. Sklar, "Digital Communication Fundamentals and Applications", Pearson Education, 2nd Ed
3. HPH su, SchaumOutlineSeries"AnalogandDigitalCommunications",TMH2006
4. J.GProakis,"DigitalCommunication",TataMcGrawHillCompany,5thEdition,2008
5. B. P. Lathi, "Modern digital and Analog Communication Systems", Oxford University Press,3rd Edition, 2007.
6. Theodore S. Rappaport, “Wireless Communications-Principles and Practice”, 2nd Edition, Pearson Education India.

ARTICULATION MATRIX:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P10**	**P11**	**P12**
CO1	3	3	1	2	1			1		1		1
CO2	3	3	1	2	1			1		1		1
CO3	3	3	1	2	1			1		1		1
CO4	3	3	1	2	1			1		1		1
CO5	3	3	1	2	1			1		1		1
Average	3	3	1	2	1			1		1		1

EC23C21	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	2	4

UNIT – I 8- BIT and 16 - BIT MICROPROCESSOR 9L, 3P

8085 Architecture, Interrupts, Instruction set, Timing diagrams, 8086 Architecture - Minimum and Maximum mode configurations, Instruction set, Addressing modes, Assembly Language Programming, Memory and I/O interfacing.

PRACTICALS:

- Programs for 8 /16-bit Arithmetic, Sorting and Searching operations in 8085 and 8086.

UNIT – II PERIPHERALS AND INTERFACING 9L, 9P

Programmable Peripheral Interface (8255), Keyboard Display Controller (8279), Programmable Timer Controller (8254), Programmable Interrupt Controller (8259), Serial Communication Interface (8251), ADC0808 and DAC0808 Interface.

PRACTICALS:

- 7 segment display with 8085 or 8086 using 8255 interface.
- Stepper and DC motor control using 8085 or 8086 microprocessor.
- Interfacing ADC, DAC with 8085 or 8086 microprocessor.

UNIT – III MICROCONTROLLER 9L

8051 – Architecture, Special Function Registers (SFRs), I/O Ports, Timers / Counters, Interrupts, Serial communication, Instruction set, Addressing modes, Assembly language programming.

UNIT – IV MICROCONTROLLER BASED SYSTEM DESIGN 9L, 6P

Display Interfacing - matrix display, (16x2) LCD, Sensor and Relay, interfacing Stepper Motor, interfacing DC Motor Speed Control using PWM, RTC and EEPROM interface using I2C protocol.

Sensor and Actuator interfacing with 8051 microcontrollers

PRACTICALS:

- Configuring and programming Timer and Interrupts in 8051 microcontrollers.
- Data transmission and reception using UART in 8051 microcontrollers.

UNIT – V 32- BIT ARM PROCESSOR 9L, 12P

RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, Barrel Shifter, ARM processor modes and families, Pipelining, ARM instruction set and its Assembly language/Embedded C Programming.

PRACTICALS:

- Interfacing LED, LCD, Switch and 4x4 Keypad with ARM processor.
- Interfacing Sensor and Actuator with ARM processor.

- Configuring and Programming of Timers/Counters and Interrupts in ARM Processor.
- UART and SPI Interfacing using ARM processor.
  Interfacing RTC and EEPROM with 8051 or ARM processor.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to understand the features and components of 8-bit and 16-bit microprocessors**.**
2. Ability to develop assembly language programme and interface peripherals with microprocessors.
3. Ability to understand the 8051 architecture and the methodology to configure and program peripherals.
4. Ability to understand the ARM architecture and the methodology to configure and program peripherals.
5. CO5: Ability to design, develop and troubleshoot a simple microprocessor or microcontroller based systems.

REFERENCES:

1. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with 8085”, Penram International Publishing reprint, 6th Edition, 2017.
2. Douglas V. Hall, “Microprocessor and Interfacing, Programming and Hardware”, Tata McGraw Hill, Revised 2nd Edition 2006, 11th reprint 2015.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, “The 8051 Microcontroller and Embedded Systems”, 2nd Edition, Pearson Education 2008. 12th impression 2018.
4. Krishna Kant, “Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096’’, PHI, 2007, 7th Reprint, 2015.
5. Kenneth J. Ayala and Dhananjay V. Gadre, “The 8051 Microcontroller and Embedded systems using Assembly and C, Ist Edition, Cengage Learning, 2010.
6. Kenneth J. Ayala., “The 8051 Microcontroller, 3rd Edition, Thompson Delmar Learning’, 2012
7. A.K. Ray, K.M. Bhurchandi, “Advanced Microprocessor and Peripherals’’, Tata McGraw-Hill, 2nd Edition, 2010.
8. Barry B. Brey, “The Intel Microprocessors Architecture, Programming and Interfacing’’, Pearson Education, 2007, 2nd impression, 2010.
9. N.Sloss, Dominic Symes, Chris Bright, ”ARM System Developer’s Guide, Designing and Optimizing system software”, Andrew 2014 Edition, Morgan Kaufmann Publishers.
10. Lyla B Das, Embedded Systems-An Integrated approach, Pearson Education India.

CO /PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	1				1		1		
CO2	2	1		1				1		1		
CO3	3	3	2	1	1			1		1		
CO4	2	2	2	1				1		1		
CO5	3	3	3	3	2	1		1		1		
Avg	2.2	2	2.33	1.4	1.5	1		1		1		

EC23503	COMMUNICATION NETWORKS	L	T	P	C
		3	0	2	4

UNIT – I NETWORK FUNDAMENTALS AND PHYSICAL LAYER 9L, 8P

Communication Network Evolution and Recent Trends, OSI reference model - layers and duties. TCP/IP reference model – layers and duties. Physical layer - general description, characteristics, signaling media types, topologies, examples physical layer (RS 232 C , ATM, MPLS). Interconnection devices - Repeaters, Hubs, Routers/switches and Gateways.

PRACTICALS:

1. Network Performance analysis of LAN.
2. Study of Configuring Switches

UNIT – II DATA LINK LAYER 9L, 7P

Logical link control Functions: - Framing, Flow control, Error control: CRC, LLC protocols:- HDLC, P to P. Medium access layer: - Random access, Controlled access, Channelization, IEEE standards: - 802.3, 802.4 and 802.5. Wireless LAN : 802.11

PRACTICALS:

1. Performance Studies of LLC Protocols
2. Performance Studies of Random MAC Protocols

UNIT – III NETWORK LAYER 9L, 7P

Overview of Internetworking, Interconnection issues, Circuit switching, packet switching, message switching. Internet protocols; IPV4, IPV6, ARP, RARP, ICMP, VPN. Network Routing Algorithms: - Distance vector routing, OSPF, Dijikstra‘s and Bellman Ford algorithm.

PRACTICALS:

1. Design and implement IPv4 address allocation for an organization using packet tracer.
2. Performance analysis of Routing Protocols

UNIT – IV TRANSPORT LAYER 9L, 4P

Process-to- process delivery: - TCP –services, segment format, TCP connections, state transitions diagram, UDP-flow control and SCTP, Congestion control algorithms.

PRACTICALS:

1. Performance analysis of TCP and UDP protocol.

UNIT – V APPLICATION LAYER 9L, 4P

Application protocols: WWW, HTTP, FTP, DNS and TELNET, Network management protocol: SNMP. Overview of security and security attacks.

PRACTICALS:

1. Performance evaluation of various cryptographic algorithm

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to describe the role of layered communication network architecture and solutions
2. Ability to understand and analyze the performance of data link layer
3. Ability to understand, design and analyze the performance of network layer and Routing protocols
4. Ability to understand and analyze the transport layer protocols
5. Ability to understand the application layer protocol and the importance of security to networks

REFERENCES:

1. Perlman, Radia (1999). Interconnections: Bridges, Routers, Switches, and Internetworking Protocols (2 ed.). Addison-Wesley Professional Computing Series. ISBN 978-0-201-63448-8.
2. Behrouz. A. Forouzan , "Data Communication and Networking", Tata McGraw Hill, 5th Edition 2007.
3. Tanenboum, A.S, "Computer Networks", Prentice Hall Of India, 6th Edition , 2022.
4. Behrouz. A. Forouzan , " TCP /IP protocol suite", Tata McGraw Hill, 4th Edition 2010.
5. James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down Approach”,
6. Seventh Edition, Pearson Education, 2017.
7. Stallings .W., "Data and Computer Communication", Prentice Hall of India, 10th Edition, 1996
8. Keshav.S. An Engineering Approach To Computer Networking, Addision – Wesley,1999
9. J.E.Flood, Telecommunication Switching, Traffic and networks, Pearson Education, 1st Edition,2006

ARTICULATION MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 1 1	PO 12
CO1	3	3	1	1	1			1	1	1		1
CO2	3	3	2	1	1			1	1	1		1
CO3	3	3	3	2	1			1	1	1		1
CO4	3	3	1	1	1			1	1	1		1
CO5	3	3	1	1	1			1	1	1		1
Average	3	3	1.6	1.2	1			1	1	1		1

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.
4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

EC23C14	DIGITAL VLSI DESIGN	L	T	P	C
		3	0	2	4

UNIT – I MOS TRANSISTOR PRINCIPLES 9L, 10P

MOS operating modes, Pass transistors, Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Elmore‘s constant.

PRACTICALS:

1. **CMOS inverter design and performance analysis**
   - Plot VTC curve for CMOS inverter and thereon plot dVout vs. dVin and determine transition voltage and gain. Calculate VIL, VIH, NMH, NML for the inverter.
   - Plot VTC for CMOS inverter with varying VDD.
   - Plot VTC for CMOS inverter with varying device ratio.
   - Redesign the inverter for symmetrical transient response and minimum propagation delay to for a given load capacitance. Perform transient analysis of CMOS inverter with no load and with load and determine tpHL, tpLH,
   - Perform AC analysis of CMOS inverter with fanout 0 and fanout 1.

2. **Use Layout editor**
   - Draw layout of a minimum size inverter using transistor from CMOS process library. Use Metal 1 as interconnect line between inverters.
   - Run DRC, LVS and RC extraction. Make sure there is no DRC error.
   - Extract the netlist. Use extracted netlist and obtain tPHL tPLH for the inverter using Spice.
   - Use a specific interconnect length and connect and connect three inverters in a chain. Extract the new netlist and obtain tPHL and tPLH of the middle inverter.
   - Compare new values of delay times with corresponding values obtained in part ‘c’.

UNIT – II COMBINATIONAL LOGIC CIRCUITS 9L

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, Ratioed logic, Pass transistor Logic, Transmission CPL, DCVSL, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NORA logic, Stick diagram, Layout diagrams, Logical Effort.

UNIT – III SEQUENTIAL LOGIC CIRCUITS 9L, 10P

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory architectures, 6T SRAM, 1Tand 3T DRAM.

PRACTICALS:

Design the schematic of 3T/6T RAM Sequential logic and verify its functionality

UNIT – IV DESIGNING ARITHMETIC BUILDING BLOCKS 9L, 10P

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters

PRACTICALS:

- Design the schematic of Adder/Multiplier combinational circuit and verify its functionality

UNIT – V IMPLEMENTATION STRATEGIES 9L

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect. ASIC Design flow

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to analyze MOS devices and inverter
2. Ability to design and analyze combinational logic
3. Ability to design and analyze Sequential logic
4. Ability to design and analyze data path cells
5. Ability to design digital logic using FPGA

REFERENCES:

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, “Digital Integrated circuits: A Design Perspective”, Prentice Hall of India, 2nd Edition, 2003.
2. N.Weste, K.Eshraghian, “Principles of CMOS VLSI DESIGN”, A system Perspective, 2nd Edition, Addision Wesley, 2004.
3. A.Pucknell, Kamran Eshraghian, “BASIC VLSI DESIGN”, Prentice Hall of India, 3rd Edition, 2007.
4. M.J. Smith, “Application Specific Integrated Circuits”, Addisson Wesley, 1997.
5. R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, Prentice Hall of India, 2005.

Articulation matrix:

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

EC23601	WIRELESS COMMUNICATIONS	L	T	P	C
		3	0	2	4

UNIT – I WIRELESS CHANNELS 9L, 8P

Electromagnetic Wave Propagation Mechanisms: Reflection, Diffraction, Scattering - Large scale path loss models: Free Space, Two-Ray and Log Normal Shadowing - Link Budget design – Small scale fading: Delay Spread; Coherence bandwidth, Doppler spread; Coherence time - Fading due to delay spread – Fading due to Doppler spread – Level Crossing Rate – Average Fade Duration, Small Scale fading Channel Model- Rayleigh and Rician Channels

PRACTICALS:

1. Characterization of Wireless Channels (Simulation/Experiment)
2. Link budget analysis

UNIT – II CELLULAR CONCEPTS 9L

Cellular concepts: Frequency reuse, channel assignment, interference & system capacity - hand off strategies - Trunking theory & grade of service – Coverage and capacity improvement - Multiple Access techniques - FDMA, TDMA, CDMA – Capacity calculations– Wireless standard: Overview of 1G, 2G, 3G, 4G, 5G & Beyond 5G.

UNIT – III SIGNALLING WAVEFORMS 9L, 6P

QPSK, Offset-QPSK, π/4-DQPSK, QAM Principle, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR reduction techniques: Clipping, PTS & SLM.

PRACTICALS:

1. Performance Studies of Adaptive Modulation and Coding
2. SDR Implementation / Simulation of Multicarrier Modulation - OFDM

UNIT – IV EQUALIZATION & DIVERSITY 9L, 8P

Equalisation – Adaptive equalization, Linear equalization: Zero Forcing and LMS - Non-Linear equalization: DFE and MLSE- Diversity: Micro and Macro diversity - Error probability in fading channels with diversity reception: Selection Diversity, MRC and EGC - Rake receiver.

PRACTICALS:

1. Equalization Techniques for Wireless Channels
2. Diversity Techniques for Wireless Channels

UNIT – V MIMO SYSTEM 9L, 8P

MIMO systems – array gain, spatial multiplexing, multiplexing gain and their trade-offs – SVD Precoding – MIMO Capacity- Static channels: Channel Known at Transmitter: Water filling Algorithm, Channel Unknown at Transmitter: Uniform Power Allocation – Fading channels: Channel Known at Transmitter: Water-Filling Algorithm, Channel Unknown at Transmitter: Ergodic Capacity and Capacity with Outage – STBC: Alamouti scheme.

PRACTICALS:

1. Simulation / Implementation of Space Time Block Codes
2. Cellular Network Modeling of 5G systems

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to characterize the wireless channel & evolve system design specifications
2. Ability to design cellular systems based on resource availability & traffic demands
3. Ability to design & analyses suitable signalling schemes for fading channels
4. Ability to evaluate multipath mitigation technique for wireless channel & system under consideration
5. Ability to apply & evaluate the multiple antenna concepts for capacity & performance gains

REFERENCES:

1. Rappaport,T.S., “Wireless communications”, Pearson Education, 3rd Edition, 2010.
2. Andreas.F. Molisch, “Wireless Communications”, John Wiley – India, 2ndEdition 2012.
3. Goldsmith, A., ‘Wireless Communications’, Cambridge University Press, 2005.
4. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press, 2005.
5. Upena Dalal, “Wireless Communication”, Oxford University Press, 2009
6. Van Nee, R. and Ramji Prasad, “OFDM for wireless multimediaVan Nee, R. and Ramji Prasad, “OFDM for wireless multimedia communications”, Artech House, 2000
7. Simon Haykins & Michael Moher, “Modern Wireless Communications”, Pearson Education, 2007.
8. Vijay. K. Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers, 2007

ARTICULATION MATRIX:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	3			1		1		
CO2	3	3	2		1			1		1		
CO3	3	3	2	1	3			1		1		
CO4	3	3	2	1	3			1		1		
CO5	3	3	3		2			1		1		
Average	3	2	2	1	3			1		1		

EC23602	MACHINE LEARNING	L	T	P	C
		3	0	0	3

UNIT – I MACHINE LEARNING PRELIMINARIES 9L

Linear Algebra – Arithmetic of matrices, Norms, Probability theory – probability distribution, conditional probability, Information theory, Structured Probabilistic models - Maximum Likelihood estimation- Regression and Classification

UNIT – II DATA PRE-PROCESSING 9L

Data characteristics, Pre-processing, Multivariate analysis, Dimensionality Reduction- Principal Component Analysis, LDA

UNIT – III SUPERVISED LEARNING 9L

Artificial neuron and its Mathematical model, Feed forward Neural Networks - Backpropagation algorithm, Generalized Delta rule, Stochastic gradient descent algorithm, Radial Basis Function Neural Networks, Support vector Machines – Structural Risk Minimization - Kernel Types

UNIT – IV UNSUPERVISED LEARNING 9L

Clustering - K-means Clustering, Mixture Densities – Expectation Maximization algorithm, Hierarchical Clustering, Spectral Clustering, Naïve Bayes, Self-organizing Maps

UNIT – V DEEP LEARNING MODELS 9L

Convolutional neural networks, Transfer Learning Models, Deep belief networks, Recurrent neural networks, Deep Generative models

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Ability to understand the mathematical concepts of machine leaning models
2. Ability to analyze the given dataset for designing a neural network based solution.
3. Ability to develop proficiency in the back propagation algorithm for training multilayer feedforward neural networks
4. Ability to develop clustering methods for complex data analysis
5. Ability to learn deep learning algorithms and architecture for real-world applications

REFERENCES:

1. C. M. Bishop, Pattern Recognition and Machine Learning, Springer , 2013
2. S. Haykin, Neural Networks - A Comprehensive Foundation, Pearson Education, India
3. Goodfellow,I., Bengio.,Y., and Courville, A., (2016), Deep Learning, The MIT Press
4. Freeman J.A., D.M. Skapura, “Neural Networks: Algorithms, Applications and Programming Techniques”, Addison-Wesley, Reading, Mass, (1992)
5. N. Crisristianini, J. S-TAYLOR (2000), An Introduction to Support Vector Machines and Other Kernel- based Learning Methods, Cambridge University Press, 1st Edition.
6. S.N. SIVANANDAM, S.N. DEEPA (2018), Principles of Soft Computing, Wiley India,

2018, 3rd Edition.
7. S Sridhar, M Vijayalakshmi, " Machine Learning", Oxford University Press, 2021.
8. R.O. Duda, P. E. Hart, D. G. Stork, Pattern Classification, John Wiley and Sons
9. Charniak, E. (2019), Introduction to deep learning, The MIT Press
10. Satish Kumar, Neural Networks: A Classroom approach, Tata McGraw Hill
11. B. S. Cholkopf, A. J. Smola (2001), Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond, The MIT Press, 2001, 1st Edition.
12. Luger George F and Stubblefield William A, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Pearson Education, 2002.

Articulation Matrix: (Along with Blooms level)

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

EC23S04	RTL DESIGN AND SYNTHESIS	L	T	P	C
		0	0	2	1

LIST OF PRACTICAL EXERCISES:

1. Design and synthesis of Combinational circuits and verify with Switches and LEDs.
   i. Half adder, Full adder, Ripple carry adder and carry look ahead adder.
   ii. Adder/subtractor, Comparator and Code converter
   iii. Mux/Demux, Decoder/Encoder and Priority encoder
2. Design and synthesis of Sequential circuits and verify using internal clock / chip scope / ILA.
   i. Flip-flops, Counters and Shift registers
   ii. Sequence detector using Mealy/Moore state machines.
3. Design and synthesis of Booth multiplier and Division algorithms and verify with Switches and 7-Segment LEDs.
4. Design of 4-tap FIR Filter and verify with real time signals.
5. Design and synthesis of a digital clock and verify with internal clock, Switches and LCD.
6. Develop an SoC based block design with Hard/Soft core Processor and the existing IP cores such as FFT/ XADC/ PLL.
7. Create a IP core for ALU with Verilog/VHDL/ HLS and develop an SoC based block design with Hard/Soft core Processor and the created IP core.

HARDWARE/ SOFTWARE REQUIRED:

1. Language Used: VHDL/ Verilog/ System Verilog/System C
2. Xilinx Vivado Design suite and Basys-3 FPGA/Zynq FPGA Boards
3. Altera Quartus II Design suite and DE2/DE2-115 Boards

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

1. Understand the concepts of digital circuits applied to VLSI design.
2. Implement and verify digital circuits with hardware description languages, EDA tools and FPGA-based hardware setups
3. Simulate and synthesize the digital circuits and analyze the timing issues of both combinational and sequential circuits.
4. Develop an SoC based design and implement IP cores based on HDL/ HLS.
5. Gain knowledge on project planning, development of FPGA based prototype

REFERENCES:

1. Roger Woods, John McAllister, Gaye Lightbody and Ying Yi, “FPGA-based implementation of Signal Processing Systems”, Second Edition, A John Wiley and Sons, Ltd., 2017.
2. Pong P. Chu, RTL Hardware Design using VHDL Coding for Efficiency, Portability, and Scalability, Wiley Interscience Publication, 2006.
3. Peter J.Ashenden, The Designer’s Guide to VHDL, Third Edition, Elsevier, 2008.

ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	3			1	1	1		
CO2	3	3	3	2	3			1	1	1		
CO3	3	3	3	2	3			1	1	1		
CO4	3	3	3	2	3			1	2	1		
CO5	3	2	3	1	3			1	2	1		
	3	2.6	2.8	1.6	3			1	1.4	1		

EC23702	MINI PROJECT	L	T	P	C
		0	0	4	2

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1 Formulate and analyze problem.
2. Design and conduct experiments to verify
3. Develop working model
4. Analyze the results and provide solution for the identified problem
5. Prepare project report and make presentation.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	1	1	1	1	1	1
CO2	3	3	3	2	1	1	1	1	1	1	1	1
CO3	3	3	3	2	1	1	1	1	1	1	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1
Average	2.4	2.4	2.4	1.8	1	1	1	1	1	1.4	1	1

EC23701	MILLIMETER WAVE AND OPTICAL COMMUNICATION	L	T	P	C
		3	0	2	4

UNIT – I MILLIMETER WAVE PROPAGATION 9L, 6P

Millimeter wave characteristics, applications and challenges, Radio wave propagation for mm wave, Channel performance at 60 GHz – Gigabit wireless communication – Development of millimeter wave standards-coexistence, mm wave link budget.

PRACTICALS:

1. Generation and modulation of millimeter waves.
2. mm wave communication system performance
   (i) Link budget calculation
   (ii) Noise figure measurements

UNIT – II mm WAVE TRANSCEIVERS AND ANTENNAS 9L, 6P

Millimeter wave design considerations, Transceiver architecture, Transceiver without mixer, Receiver without oscillator, mmwave antennas – beam steering antennas, Spatial diversity of MIMO arrays in mmwave communication.

PRACTICALS:

1. Performance analysis of mm wave transceiver.
2. Simulation of Antennas for mm wave applications.

UNIT – III OPTICAL FIBER CHARACTERISTICS 9L, 6P

Introduction to Optical Communication, optical fiber structure and parameters, ray and mode theory of light propagation in optical fibers, Optical signal distortion – Attenuation, Dispersion - Standard Single mode and multimode Fibers.

PRACTICALS:

1. Analog and digital transmission of optical waves.
2. Attenuation characteristics and Numerical aperture measurement of an optical fiber.

UNIT – IV OPTICAL TRANSMITTERS AND RECEIVERS 9L, 6P

Materials for optical sources, light-emitting diodes, semiconductor laser diodes, power-current characteristics, noise, direct and external modulation – Principles of optical detection, spectral responsivity, PIN Detectors and APD, preamplifier types, receiver noises

PRACTICALS:

1. Characteristics of LED and PIN Diode
2. Characteristics of Laser and Avalanche photo diode (APD).

UNIT – V OPTICAL WIRELESS COMMUNICATIONS 9L, 6P

Overview of FSO Optical Transmitters – Receivers – Subsystems – Pointing, Acquisition and Tracking – Line of sight analysis- factors affecting FSO–selecting transmission wave integration of FSO in Optical networks – installation of FSO systems.

PRACTICALS:

1. Analysis of light fidelity (Li-Fi) network for indoor wireless optical communication

system
2. Performance analysis of free space optical network under external limiting factors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Demonstrate understanding of propagation issues at Millimeter wave frequencies and characterize the channel
2. Understand millimeter wave communication systems architectures and beamforming
3. Understand and analyze fiber transmission characteristics
4. Understand and compare optical transmitters and receivers
5. Understand and analyze free space optical communication systems

REFERENCES:

1. Kao-Cheng Huang, Zhaocheng Wang, “Millimeter Wave Communication Systems” Wiley 2011.
2. Gerd Kaiser “Optical Fiber Communications”, Tata McGraw Hill, New Delhi, 5th Edition, 2013.
3. Hemani Kaushal, V.K. Jain, Subrat Kar, “Free Space Optical Communication”, Springer India, New Delhi, 2017.
4. Govind P. Agrawal, “Fiber-Optic Communication Systems”, John Wiley & Sons, reprint, 3rd Edition, 2012.
5. Sergey M. Smolskiy Author, Leonid A. Belov and Victor N. Kochemasov, “Handbook of RF, Microwave, and Millimeter-Wave Components”, Artech House Microwave Library, 2012.
6. I. Robertson, N. Somjit and M. Chongcheawchamnan, “Microwave and Millimetre-Wave Design for Wireless Communications”, 2016.
7. T.S. Rappaport, R.W. Heath Jr., R.C. Daniels and J.N. Murdock, “Millimeter Wave Wireless Communications: Systems and Circuits”, 2015.
8. K.C. Huang, Z. Wang, “Millimeter Wave Communication Systems”, Wiley-IEEE Press, 2011.
9. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, “Millimeter Wave Wireless Communication”, Prentice Hall, 2014.

ARTICULATION MATRIX:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	2	1	1	2			1		1		
CO2	3	3	2	1	2			1		1		
CO3	3	3	2	2	2			1		1		
CO4	3	3	2	2	2			1		1		
CO5	3	2	2	2	2			1		1		
Average	3	2.4	1.8	1.6	2			1		1		

EC23703	SUMMER INTERNSHIP	L	T	P	C
		0	0	0	1

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations

No of weeks: 2

COURSE OUTCOMES:

At the end of the course, students will have

1. System-level design processes, verification and validation techniques, manufacturing and production processes in the firm or research facilities in the laboratory/research institute
2. Analysis of industrial / research problems and their solutions
3. Development of solutions to the problems
4. Documentation of system specifications, design methodologies, process parameters, testing parameters and results
5. Preparing of technical report and presentation

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	1	1	1	1	1	1	1	1
CO2	2	3	3	2	1	1	1	1	1	1	1	1
CO3	2	3	3	2	1	1	1	1	1	1	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1
Average	1.8	2.4	2.4	1.8	1	1	1	1	1	1.4	1	1

EC23801	PROJECT WORK / INTERNSHIP CUM PROJECT WORK	L	T	P	C
		0	0	16	8

COURSE OBJECTIVES:

To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

TOTAL : 240 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

1. Formulate and analyze problem / create a new product/ process.
2. Design and conduct experiments to verify
3. Develop working/simulation model
4. Analyze the results and provide solution for the identified problem
5. Prepare project report and make presentation.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	1	1	1	1	1	1
CO2	3	3	3	2	1	1	1	1	1	1	1	1
CO3	3	3	3	2	1	1	1	1	1	1	1	1
CO4	3	2	2	2	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1
Average	2.6	2.4	2.4	1.8	1	1	1	1	1	1.4	1	1

EC23001	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

UNIT I DISRETE-TIME RANDOM SIGNALS 9

Discrete random process – Ensemble averages, Stationary and ergodic processes, Autocorrelation and Autocovariance properties and matrices, White noise, Power Spectral Density, Spectral Factorization, Innovations Representation and Process, Filtering random processes, ARMA, AR and MA processes.

UNIT II SPECTRUM ESTIMATION 9

Bias and Consistency, Periodogram, Modified periodogram, Blackman-Tukey method, Welch method, Parametric methods of spectral estimation, Levinson-Durbin recursion.

UNIT III LINEAR ESTIMATION AND PREDICTION 9

Forward and Backward linear prediction, Filtering - FIR Wiener filter- Filtering and linear prediction, non-causal and causal IIR Wiener filters.

UNIT IV ADAPTIVE FILTERS 9

Principles of adaptive filter – FIR adaptive filter – Newton‘s Steepest descent algorithm – LMS algorithm – Adaptive noise cancellation, Adaptive equalizer, Adaptive echo cancellers.

UNIT V MULTIRATE SIGNAL PROCESSING 9

Introduction to Multirate signal processing- Decimation-Interpolation-Polyphase Decomposition ofFIR filter-Multistage implementation of sampling rate conversion - Applications of Multirate signal processing.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

CO1: To analyze statistical characteristics of random signals

CO2: To identify appropriate spectrum estimation method based on type of random signal

CO3: To design optimum filters for processing random signal

CO4: To design filters for quasi stationary signals

CO5: To analyze and design systems with varying sample rate

TEXT BOOKS:.

1. Monson H, Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and SonsInc., New York, Indian Reprint, 2008.
2. John G.Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson, 4th Edition,2007.

REFERENCE BOOKS:

1. Sophocles J. Orfanidis, "Optimum Signal Processing, An Introduction", McGraw Hill,2nd Edition 2007
2. Dwight F. Mix, "Random Signal Processing", Prentice Hall, 1995.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2		1		1		1
CO2	3	3	3	2	2	2		1		1		1
CO3	3	3	3	2	2	1		1		1		1
CO4	3	3	3	2	1	1		1		1		1
CO5	3	3	3	2	1	1		1		1		1
Average	3	3	3	2	1.6	1.4		1		1		1

EC23002	DIGITAL SPEECH PROCESSING	L	T	P	C
		3	0	0	3

UNIT I SPEECH FUNDAMENTALS **10**

Articulatory Phonetics–Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

UNIT II SPEECH ANALYSIS **10**

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures mathematical and perceptual–Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization –Dynamic Time Warping, Multiple Time–Alignment Paths.

UNIT III SPEECH MODELING **8**

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT IV SPEECH RECOGNITION **8**

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent subword units; Applications and present status.

UNIT V SPEECH SYNTHESIS **9**

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness–role of prosody, Applications and present status.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to use speech related parameters

CO2: Ability to extract significant features from speech to reduce redundancy in speech by using several distortion measures

CO3: Ability to develop models for speech signals

CO4: Ability to develop speech recognition algorithms

CO5: Ability to develop artificial speech generation of human speech

TEXT BOOKS:

1. Lawrence Rabiner and Biing-Hwang Juang,"Fundamentals of Speech Recognition", Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing–An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 3rd Edition,2018.

REFERENCE BOOKS:

1. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, Reprint2001
2. Steven W.Smith, "The Scientist and Engineer‘s Guide to Digital Signal Processing", California Technical Publishing,1997.
3. Thomas FQuatieri,"Discrete-Time Speech Signal Processing Principles and Practice", Pearson Education,2004
4. Claudio Becchetti and Lucio Prina Ricotti,"Speech Recognition", John Wiley and Sons,1999.
5. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing and Perception of Speech and Music", Wiley

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				1				1		1		
CO2	2	2	2	1				1		1		2
CO3	2	2	2	1				1		1		2
CO4	3	3	3	1				1		1		3
CO5	3	3	3	1				1		1		3
Average	2.5	2.5	2.5	1				1		1		2.5

EC23003	PRINCIPLES OF DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Elements of digital image processing systems, Image sensing and Acquisition, - Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, Color image fundamentals - RGB, HSI models, Image sampling, Quantization, dither, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD

UNIT II IMAGE ENHANCEMENT 9

Point processing, Histograms, Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement.

UNIT III IMAGE RESTORATION 9

Image Restoration - degradation model, Unconstrained and Constrained restoration, Inverse filtering, Wiener filtering, Geometric transformations-spatial transformations.

UNIT IV IMAGE SEGMENTATIONAND MORPHOLOGY 9

Edge detection, Canny edge detection, Harris corner detection, Edge linking via Hough transform, Thresholding - Region based segmentation– Region growing – Region splitting and Merging, Contour based methods, Morphological Operations – Dilation, Erosion, Opening , Closing- Segmentation by morphological watersheds

UNIT V IMAGE COMPRESSION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, LZW compression, Transform coding, JPEG standard, MPEG

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to analyze the sampling and quantization effects in images and choose appropriate transforms for image processing applications

CO2: Ability to utilize appropriate preprocessing techniques for manipulation of images

CO3: Ability to apply restoration techniques to recover degraded images

CO4: Ability to employ image processing algorithms for extraction of region of interest

CO5: Ability to utilize and develop image compression techniques

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing"', Pearson, Education,Inc., 4th Edition, 2018.
2. Anil K. Jain, "Fundamentals of Digital Image Processing"', Pearson Education, Inc., 2002.

REFERENCE BOOKS:

1. Kenneth R. Castleman, "Digital Image Processing", Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing usingMATLAB ", Pearson Education, Inc., 2004.
3. D,E. Dudgeon and RM. Mersereau, "Multidimensional Digital Signal Processing", PrenticeHall Professional Technical Reference, 1990.
4. William K. Pratt, "Digital Image Processing", John Wiley, New York, 2002.
5. Milan SonkaetaI, "Image Processing, Analysis and Machine Vision", Brookes/Cole, VikasPublishing House, 2nd Edition, 1999.
6. Alan C. Bovik, "Handbook of image and Video Processing ", Elsevier Academic press, 2005.
7. S.Sridhar, "Digital Image Processing" Oxford University press, Edition 2011.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1			1		1		
CO2	3	3	1		1			1		1		
CO3	3	2			1			1		1		
CO4	3	3	1		1			1		1		
CO5	3	2	1		1			1		1		
Average	3	2.4	1		1			1		1		

EC23004	DSP ARCHITECTURE AND PROGRAMMING (I)	L	T	P	C
		2	0	2	3

UNIT I ARCHITECTURES FOR PROGRAMMABLE DSP PROCESSORS 6

Basic Architectural features, DSP Computational building blocks, Bus architecture and memory, Data addressing capabilities, Address generation Unit, Programmability and program execution, Speed issues, Features for external interfacing.

UNIT II TMS320C5X PROGRAMMABLE DSP PROCESSOR 6L, 6P

Architecture of TMS320C54xx DSP processors, Addressing modes – Assembly language Instructions - Memory space, interrupts, and pipeline operation of TMS320C54xx DSP Processor, On-Chip peripherals, Block Diagram of TMS320C54xx DSP starter kit.

PRACTICALS:

1.Real time waveform generation
2. Programming examples C and Assembly language

UNIT III TMS320C6X PROGRAMMABLE DSP PROCESSOR 6L, 8P

Commercial TI DSP processors, Architecture of TMS320C6x DSP Processor, Linear and Circular addressing modes, TMS320C6x Instruction Set, Assembler directives, Linear Assembly, Interrupts, Multichannel buffered serial ports, Block diagram of TMS320C67xx DSP Starter Kit and Support Tools.

PRACTICALS:

1.Programming examples using C and Linear Assembly
2. Implementation of moving average filter
3. FIR implementation with a Pseudorandom noise sequence as input to a filter

UNIT IV IMPLEMENTATION OF DSP ALGORITHMS 6, 6P

DSP Development system, On-chip, and On-board peripherals of C54xx and C67xx DSP development boards, Code Composer Studio (CCS) and support files, Implementation of Conventional FIR, IIR, and Adaptive filters in TMS320C54xx/TMS320C67xx DSP processors for real-time DSP applications, Implementation of FFT algorithm for frequency analysis in real-time.

PRACTICALS:

1. Fixed point implementation of IIR filter
2. FFT of Real-Time input signal

UNIT V APPLICATIONS OF DSP PROCESSORS 6L, 10P

Voice scrambling using filtering and modulation, Voice detection and reverse playback, Audio effects, Graphic Equalizer, Adaptive noise cancellation, DTMF signal detection, Speech thesis using LPC, Automatic speaker recognition

PRACTICALS:

Case study – Realization of applications

THEORY : 30 PERIODS

HARDWARE & SOFTWARE SUPPORT TOOLS:

- TMS320C54xx/TMS320C67xx DSP Development board
- Code Composer Studio (CCS)
- Function Generator and Digital Storage Oscilloscope
- Microphone and speaker

PRACTICAL: 30 PERIODS

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1:Understand the architectural features of DSP Processors.
CO2:Comprehend the organization of TMS320C54xx DSP processors
CO3:Build solutions using TMS320C6x DSP Processor
CO4:Implement DSP Algorithms
CO5:Study the applications of DSP Processors.

TEXT BOOKS:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, Cengage Learning India Private Limited, Delhi 2012
2. Rulph Chassaing and Donald Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, Second Edition, Wiley India (P) Ltd, New Delhi, 2008

REFERENCE BOOKS:

1. B.Venkataramani and M.Bhaskar, “Digital Signal Processors – Architecture, Programmingand Applications”, Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2. TMS320C5416/6713 DSK user manual at https://www.ti.com

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2			1		1		2
CO2	3	3	2	2	2			1		1		2
CO3	3	3	2	2	2			1		1		2
CO4	3	3	2	3	2			1		1		2
CO5	3	2	2	2	2			1		1		2
Average	3	2.8	2.2	2.2	2			1		1		2

EC23C19	VLSI SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

UNIT I PIPELINING AND PARALLEL PROCESSING 9

Introduction to DSP Systems, Typical DSP algorithms, Data flow graph representations, Loop bound and Iteration bound, Longest Path Matrix algorithm; Pipelining and Parallel processing of FIR digital filters, Pipelining and Parallel processing for low power.

UNIT II RETIMING AND ALGORITHMIC STRENGTH REDUCTION 9

Retiming - definitions and properties; Unfolding – an algorithm for Unfolding, properties of unfolding, sample period reduction and parallel processing application; Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT algorithm architecture transformation, Odd-Even Merge-Sort architecture, Parallel Rank-Order filters.

UNIT III FAST CONVOLUTION AND COMBINED PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS 9

Fast convolution – Cook-Toom algorithm, Modified Cook-Took algorithm; Look- Ahead pipelining in first- order IIR filters, Look- Ahead pipelining with power-of-two decomposition, parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES 9

Bit-Level Arithmetic Architectures- parallel multipliers with sign extension, 4x 4 bit Baugh-Wooley carry-save multiplication tabular form and implementation, CSD representation, CSD multiplication using Horner‘s rule for precision improvement, Distributed Arithmetic.

UNIT V NUMERICAL STRENGTH REDUCTION AND WAVE PIPELINING 9

Numerical Strength Reduction – subexpression elimination, Multiple Constant Multiplications, Synchronous pipelining and Clocking styles, Clock skew in edge-triggered single-phase clocking, Wave pipelining.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to determine the parameters influencing the efficiency of DSP architectures and apply pipelining and parallel processing techniques to alter FIR structures for efficiency.

CO2: Ability to analyze and modify the design equations leading to efficient DSP architectures

CO3: Ability to speed up convolution process and develop fast and area efficient IIR structures.

CO4: Ability to develop fast and area efficient multiplier architectures.

CO5:Ability to reduce multiplications and build fast hardware for synchronous digital systems.

TEXT BOOKS:

1. Keshab K. Parhi, “VLSI Digital Signal Processing Systems”, Design and implementation Wiley, Inter Science, Reprint 2008.

REFERENCE BOOKS:

1. Roger Woods, John MCAllister, Gaye Light body and Ying Yi, “FPGA-based implementation of Signal Processing systems”, Wiley 2nd edition, 2011.
2. Shoab Ahmed Khan, “Digital design of signal processing systems- A Practical Approach”, A John Wiley and Sons, Ltd., publication, 2011.
3. Mohammed Ismail and Terri Fiez, “Analog VLSI Signal and Information Processing” ,McGraw-Hill, 1994
4. S.Y. Kung, H.J. White House, T. Kailath, “VLSI and Modern Signal Processing”, Prentice Hall, 1985
5. Jose E. France, YannisT sividis, “Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing”, Prentice Hall, 1994

ARTICULATION MATRIX:

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

EC23005	DIGITAL CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I CONTINUOUS TIME SYSTEMS 6

Review of frequency and time response analysis and specifications of control systems, need for controllers, continuous time compensations, continuous time PI, PD, PID controllers.

UNIT II SIGNAL PROCESSING IN DIGITAL CONTROL 12

Sampling, time and frequency domain descriptions, aliasing, hold operations, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sample rate, reconstruction, Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems.

UNIT III DESIGN OF DIGITAL CONTROL ALGORITHMS 9

Review of principle of compensator design, Z-plane specifications, digital compensator design using frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in Z-plane.

UNIT IV STATE VARIABLE TECHNIQUES 9

Discrete State Variable concepts, Characteristic equation, Eigen values and Eigenvectors, Jordan canonical models, Phase Variable companion forms.

UNIT V CONTROLLABILITY, OBSERVABILITY AND STABILITY 9

Definitions and Theorems of Controllability and Observability, Relationships between Controllability, Observability and Transfer Functions, Jury, Routh, Lyapunov stability analysis, Principles of state and output feedback.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to analyze the characteristics of continuous time systems and determine their impacts on the design of digital control systems.

CO2: Ability to comprehend the basics of digital signal processing techniques in the applications of digital control systems.

CO3: Ability to illustrate the design of various digital control algorithms and its implementation issues in digital control systems.

CO4: Ability to analyze the discrete state variable concepts and its control system specifications

CO5: Ability to merge the concepts of controllability, observability and stability in a design of modern digital control systems.

TEXT BOOKS:

1. Benjamin C.Kuo, Digital Control Systems, OXFORD University Press, 2nd Edition, 2007.

REFERENCE BOOKS:

1. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 2nd Edition, 2007.
2. K.Ogata,"Discrete-Time Control Systems", PHI, 2nd Edition,2007.
3. Gene. F.Franklin, J.D.Powell, M.Workman, "Digital Control of Dynamic Systems", AddisonWesley, 3rd Edition, 2000.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1			1		1		
CO2	3	3	3		1			1		1		
CO3	3	3	3		1			1		1		
CO4	3	2			1			1		1		
CO5	3	2			1			1		1		
Average	3	2.4	3		1			1		1		

EC23006 MULTIMEDIA COMPRESSION AND NETWORKS L T P C

3 0 0 3

UNIT I MULTIMEDIA COMPONENTS 9

Introduction- Multimedia skills- Multimedia components and their characteristics- Text, sound, images, graphics, animation, video, hardware.

UNIT II AUDIO AND VIDEO COMPRESSION 9

Audio compression–DPCM-Adaptive DPCM –adaptive predictive coding-linear Predictive coding code excited LPC-perpetual coding – Video compression principles-H.261, H.263, MPEG1, 2, 4.

UNIT III TEXT AND IMAGE COMPRESSION 9

Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding –source encoding- text compression –static Huffman coding dynamic Huffman coding –arithmetic coding –Lempel Ziv-Welsh Compression-image compression

UNIT IV VoIP TECHNOLOGY 9

Basics of IP transport, VoIP challenges, H.323/ SIP –Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service – CODEC Methods-VOIP applicability.

UNIT V MULTIMEDIA NETWORKING 9

Multimedia networking- Applications-streamed stored and audio-making – Best Effort service protocols for real time interactive Applications-distributing multimedia-beyond best effort service secluding and policing Mechanisms-integrated services-differentiated Services-RSVP.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to characterize the features of multimedia components

CO2: Ability to develop audio and video processing systems

CO3: Ability to develop compression algorithms for processing text and images

CO4: Ability to tackle network issues in the transmission of text, audio and video signals

CO5: Understand the different multimedia networking and their applications.

TEXT BOOKS:

1. Fred Halshall, "Multimedia Communication - Applications, Networks, Protocols and Standards", Pearson education, 2007
2. Tay Vaughan, "Multideai: Making It Work", TMH, 8th Edition, 2007.

REFERENCE BOOKS:

1. Kurose and W. Ross, "Computer Networking A Top Down Approach", Pearson education,3rd Edition, 2005.
2. Marcus Goncalves —Voice over IP Networks, McGraw Hill,
3. KR. Rao,Z S Bojkovic, D A Milovanovic, "Multimedia Communication Systems: Techniques,Standards, and Networks", Pearson Education, 2007
4. R. Steimnetz, K. Nahrstedt, "Multimedia Computing, Communications and Applications",Pearson Education, 1st Edition, 1995.
5. Ranjan Parekh, "Principles of Multimedia", TMH, 2006.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1					1		1		1
CO2	3	2	2					1		1		2
CO3	3	3	3	2				1		1		1
CO4	3	3	3	2				1		1		2
CO5	3	3	3	2				1		1		2
Average	3	2.4	2.2	2				1		1		1.6

EC23007	CMOS ANALOG IC DESIGN	L	T	P	C
		3	0	0	3

UNIT I BASIC BUILDING BLOCKS 9

NMOS and PMOS device operation in saturation and sub-threshold regions, device transconductance, output impedance and equivalent circuit. Introduction to Device models for simulation. CS, CG, and source follower circuits. gm/Id design methodology.

UNIT II MULTIPLE TRANSISTOR STAGES 9

Cascode circuits, folded cascode circuits, Differential amplifier circuits, quantitative analysis of differential pair, CMRR, Differential pair with MOS loads, Gilbert Cell, Current Mirrors.

UNIT III FREQUENCY RESPONSE AND NOISE CHARACTERISTICS 9

Miller effect and association of poles with nodes, Frequency response of CS stage, Zero value time constant method, short circuit time constant method to analyze dominant and non dominant poles, Characteristics of noise – thermal and flicker noise. Noise in CS, CG, Cascode and source follower stages.

UNIT IV OPERATIONAL AMPLIFIERS 9

Two stage op-amps, gain boosting, common mode feedback, input range limitation, slew rate, power supply rejection, noise in op-amps.

UNIT V FEEDBACK AND STABILITY 9

Properties of feedback circuits, topologies, effect of loading and noise in feedback circuits. Stability in multipole systems, phase margin, frequency compensation in two stage op-amps, other compensation techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Design DC biasing circuit of various MOSFET amplifier configurations

CO2: Analyze small signal modeling of various MOS circuits

CO3: Analyze noise modeling associated with various MOS circuits

CO4: Analyze op-amp circuits and its stability conditions

CO5: Design negative feedback amplifier circuits

TEXT BOOKS:

1. B.Razavi, “Design of CMOS Analog Integrated Circuits", Tata McGraw Hill, 2nd Edition, 2017.
2. P.R.Gray, Hurst and Meyer "Analysis and Design of Analog Integrated Circuits", John Wiley, 5th Edition, 2009.

REFERENCE BOOKS:

1. Willy Sansen , “Analog Design Essentials:", Springer, 2006
2. NPTEL Course: http://nptel.ac.in/courses/117106030/#
3. Phillip E. Allen, Douglas R.Holberg, “CMOS Analog Circuit Design”, Third edition, Oxford University Press, 2013
4. Kenneth William Martin, David Johns, “Analog Integrated Circuit Design”, Wiley India, 2nd Edition 2013.
5. Jacob Baker “CMOS: Circuit Design, Layout, and Simulation”, Wiley IEEE Press, 4th Edition, 2019.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2			1		1		2
CO2	3	3	3	2	2			1		1		2
CO3	3	3	2	2	2			1		1		2
CO4	3	3	3	3	2			1		1		2
CO5	3	2	3	3	2			1		1		2
Average	3	2.8	2.6	2.4	2			1		1		2

EC23008	VLSI TESTING AND DESIGN FOR TESTABILITY	L	T	P	C
		3	0	0	3

UNIT I TEST REQUIREMENTS AND METRICS 9

Validation platforms- SOC design methodology, IP components, Integration, Clocking, I/Os and interfaces, Device modes, Logic, memories, analog, I/Os, power management; Test requirements- Test handoffs, Testers where DUT and DFT fit into design / framework; Test- ATPG, DFT, BIST, COF, TTR; Test cost metrics and test economics; Logic fault models- SAF, TDF, PDF, Iddq, St-BDG, Dy-BDG, SDD; Basics of test generation and fault simulation- Combinational circuits, Sequential; Specific algorithmic approaches, CAD framework, Optimizations.

UNIT II SCAN DESIGN AND BIST 9

Scan Design- Scan design requirements, Types of scan and control mechanisms, Test pattern construction for scan, Managing scan in IPs and SOCs, Scan design optimizations, Partitioning, Clocking requirements for scan and delay fault testing, Speed of operation; BIST – Framework, Controller configurations, FSMs, LFSRs, STUMPS architecture, Scan compression and bounds, Test per cycle, Test per scan, Self-testing and self-checking circuits, Online test.

UNIT III MEMORY TEST AND TEST INTERFACES 9

Memory Test -Memory fault models, Functional architecture as applicable to test, Test of memories, Test of logic around memories, BIST controller configuration, Test of logic around memories, DFT and architecture enhancements, Algorithmic optimizations; Test Interfaces-Test control requirements, Test interfaces - 1500, JTAG, Hierarchical, serial control, Module / IP test, SOC test, Board test, System test, Boundary scan.

UNIT IV DESIGN CONSIDERATIONS AND POWER MANAGEMENT DURING TEST 9

Design Considerations- Design considerations, Physical design congestion, Partitioning, Clocks, Test modes, Pins, Test scheduling, Embedded test, Architecture improvements, Test in the presence of security; Power management during test- Methods for low power test, ATPG methods, DFT methods, Scan methods, Low power compression, Test of power management, Implications of power excursions, Optimizations.

UNIT V ANALOG TEST 9

Test requirements. DFT methods. BIST methods. Test versus measurement. Defect tests versus performance tests. Tests for specific modules - PLL, I/Os, ADC, DAC, SerDes, etc. RF test requirements.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand logic and fault simulation requirements and testability measures.

CO2: Understand the Design for Testability.

CO3: Develop interfacing and memory testing.

CO4: Perform testing with power management techniques.

CO5: Carry-out fault Detection in analog circuits

TEXT BOOKS:

1. Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Vishwani Agrawal and Michael Bushnell, Springer, 2002.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2			1		1		2
CO2	3	3	2	1	2			1		1		2
CO3	3	3	2	2	2			1		1		2
CO4	3	3	3	2	1			1		1		2
CO5	3	3	3	2	2			1		1		2
Average	3	3	2.6	1.8	1.8			1		1		2

EC23C12	DATA CONVERTERS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

Quantization noise, anti aliasing filters, gain and offset errors, definitions of INL and DNL, SNR, SFDR, ENOB of ADC/DACs, finite duration pulse aperture effects, transistor matching, Bandgapreference design.

UNIT II D/A CONVERTER DESIGN, SAMPLE AND HOLD CIRCUITS 9

Current Steering DACs, current cell design issues. Properties of MOS Switches, charge injection, bootstrapping, sampling jitter, thermal noise, Quantization noise and nonlinearity effects.

UNIT III COMPARATOR DESIGN 9

Comparator architectures, metastibility and yield, Clock feed through effects, switched capacitoramplifiers and offset cancellation.

UNIT IV ADC/DAC ARCHITECTURES 9

SAR, Flash, Pipeline and time interleaved ADC topologies and their CMOS realizations issues. Error correction procedures for ADCs.

UNIT V OVER SAMPLING CONVERTERS 9

Delta sigma modulators, alternative modulator architectures, quantization and noise shaping, decimation filtering, implementation of Delta sigma modulators, delta sigma DACs.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: To carry out the design of the various building blocks used in mixed signal (A/D and D/A converters) CMOS IC Design. These include sample and hold circuits, comparators and switched capacitor amplifiers,

CO2: To carry out simple designs of flash ADCs, pipeline ADCs, Current Steering DACs and sigma delta converters.

CO3: To carry out the paper design based on hand calculations for the above important functional blocks and enable the student to carry out circuit simulations and layout design.

CO4: To characterize the performance parameters of any industry standard flash ADCs, pipeline ADCs, Current Steering DACs and sigma delta converters.

CO5: To pursue design and/or research carriers in the broad field of electronics and communication.

TEXT BOOKS:

1. Marcel Pelgrom, "Analog to Digital Conversion", Springer Verlag, 2nd Edition, 2013.
2. Shanthi Pavan, Richard Schreier, Gabor C. Temes , “Understanding Delta-Sigma DataConverters”, Willey –IEEE Press, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Franco Malobreti "Data Converters", Springer Verlag, 2007
2. VLSI DataConversion Circuits EE658 recorded lectures available at http://www.ee.iitm.ac.in/~nagendra/videolecture

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2			1		1		2
CO2	3	3	3	2	2			1		1		2
CO3	3	3	2	2	2			1		1		2
CO4	3	3	3	3	2			1		1		2
CO5	3	2	3	3	2			1		1		2
Average	3	2.8	2.6	2.6	2			1		1		2

EC23009	RF MICROELECTRONICS	L	T	P	C
		3	0	0	3

UNIT I RF BASICS 9

Discrete and CMOS realization passive components for RF, Impedance Matching, Distortion, IIP3, Dynamic range, Noise sources, Noise Figure, Friis Formula for cascaded blocks. Heterodyne and Homodyne architectures.

UNIT II CMOS LNAs AND MIXERS 9

Noise Figure of and impedance matching issues CS, CG and differential LNAs, Design examples, Passive mixers andconversion loss, Active mixers, Gilbert cells, linearity and Noise Figure of mixers

UNIT III OSCILLATORS 9

Feedback, one port view of oscillators, cross coupled oscillators, ring oscillator, Voltage controlled oscillator (VCO) LC VCO, Phase noise. Design of VCO, Quadrature oscillators

UNIT IV PLLs AND SYNTHESIZERS 9

Phase Detectors, charge pumps and their transfer functions, Non idealities, Synthesizers based on first, second and third order PLLs and stability issues, Introduction to integer and fractional N synthesizers.

UNIT V POWER AMPLIFIERS 9

Class A, B, C, D, E, F and AB power amplifiers, Linearization and impedance matching issues of power amplifiers.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Develop and analyze RF transceivers

CO2: Design and analyze LNAs and mixers for Transceivers

CO3: Design and develop RF oscillators

CO4: Design and develop PLLs and synthesizers

CO5: Design power amplifiers.

TEXT BOOKS:

1. B. Razavi, "RF Microelectronics", Pearson Education, 2nd Edition, 2012.
2. Hooman Darabi," Radio Frequency Integrated Circuits and Systems", Cambridge University Press, Cambridge, 2020

ARTICULATION MATRIX:

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

EC23010	VLSI PHYSICAL DESIGN AUTOMATION	L	T	P	C
		3	0	0	3

UNIT I VLSI DESIGN CYCLE **9**

VLSI Design problem – design domains, methods and technologies - VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable problems - general purpose methods for combinatorial optimization

UNIT II DESIGN ALGORITHMS **9**

Design rules – symbolic layout- layout compaction- problem formulation - algorithms for constraint graphcompaction - placement and partitioning - Circuit representation - Placement algorithms –partitioning algorithms.

UNIT III FLOOR PLANNING AND ROUTING **9**

Floor planning concepts - shape functions and floor plan sizing – Routing -Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing.

UNIT IV VLSI SIMULATION **9**

Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis.

UNIT V SYNTHESIS AND SCHEDULING **9**

Hardware models for high level synthesis - High level Synthesis - Internal representation - Allocation assignment and scheduling - Simple scheduling algorithms - Assignment problem - High level transformations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world.

CO2: Apply VLSI design methodologies and design rules for digital circuits.

CO3: Use floor planning and rooting concepts for digital circuits.

CO4: Apply Gate level and Switch level modelling and Simulation

CO5: Apply high level logic synthesis and scheduling.

TEXT BOOKS:

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons,2002.

REFERENCE BOOKS:

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer AcademicPublishers, 2002.
2. Giovanni De Micheli, “Synthesis and optimization of digital circuits”, McGraw Hill, 1994.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1			1		1		
CO2		3	2	2				1		1		
CO3		3	3	3	3			1		1	3	3
CO4		3	3	3	3			1		1		
CO5		3	3	3				1		1	3	3
Average	3	2.8	2.6	2.6	2.33			1		1	3	3

EC23011	CLOCK AND POWER MANAGEMENT CIRCUITS	L	T	P	C
		3	0	0	3

UNIT I REFERENCE CIRCUITS 9

Performance Metrics, Current Mirrors, Self Biased Current Reference, startup circuits, VBE based Current Reference, VT Based Current Reference, Band Gap Reference, Supply Independent Biasing, Temperature Independent Biasing, PTAT and CTAT Current Generation, Constant Gm Biasing

UNIT II LOW DROP OUT REGULATORS 9

Performance Metrics, Shunt regulator, Error amplifier, AC Design, Stability, Internal and External Compensation, PSRR – Internal and External compensation circuits, NMOS vs. PMOS regulators.

UNIT III DC-DC CONVERTERS 9

Switching DC-DC converters, CCM and DCM modes of operation, design flow and specifications, building blocks, loss components, small signal model of DC-DC converters, loop gain analysis, frequency compensation of uncompensated DC-DC converters.

UNIT IV FREQUENCY SYNTHESIZERS 9

Integer-N Phase Lock Loop(PLL), Fractional-N Phase Lock Loop, Delay-Lock Loop (DLL), multiplying-DLL, Injection-locked PLLs, and Sub-sampled PLLs.

UNIT V CLOCK AND DATA RECOVERY CIRCUITS 9

Channel characteristics-intersymbol interference, eye diagrams, Linear equalization at the transmitter and receiver; CDR Architectures, Trans Impedance Amplifiers, Linear Half Rate CDR Circuits, Wide capture Range CDR Circuits.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Design reference circuits for a given specification.

CO2: Design LDO and analyze its stability aspects.

CO3: Analyze DC-Dc converters performance.

CO4: Design Frequency synthesizers meeting a given specification.

CO5: Design clock generation circuits in the context of high speed I/Os, High speed Broad BandCommunication circuits and Data Conversion Circuits.

TEXT BOOKS:

1. Gabriel. A. Rincon-Mora, "Voltage references from diode to precision higher order bandgap circuits", John wiley& Sons, Inc 2002.
2. Gabriel. A. Rincon-Mora, "Analog IC Design With Low-Dropout Regulators", McGraw-Hill Professional Pub, 2nd Edition, 2014
3. Floyd M. Gardner, "Phase Lock Techniques" John wiley & Sons, Inc 2005.

REFERENCE BOOKS:

1. R. Best, "Phase-Locked Loops :Design, Simulation, and Applications", McGraw Hill, 2003.
2. Williams and Taylor, "Electronic Filter Design Handbook", McGraw-Hill, 3rd Edition, 1995
3. Deliyannis, Sun, and Fidler, "Continuous-Time Active Filter Design", CRC Press 1998
4. BehzadRazavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2001.
5. Courses:ee5325_2017_2: start [Integrated Circuits and Systems group, IIT Madras]

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2			1		1		2
CO2	3	3	3	2	2			1		1		2
CO3	3	3	2	2	2			1		1		2
CO4	3	3	3	3	2			1		1		2
CO5	3	2	3	3	2			1		1		2
Average	3	2.8	2.6	2.6	2			1		1		2

EC23012	OPTOELECTRONICS	L	T	P	C
		3	0	0	3

UNIT I SEMICONDUCTOR THEORY 9

Basic quantum mechanics, semiconductor statistics, carrier transport, optical processes, and junction theory, Properties of simple and compound semiconductors, Optical absorption, Opticalrecombination, Recombination and carrier lifetime.

UNIT II LIGHT EMITTING DIODES 9

Energy Bands. Direct and Indirect Bandgap Semiconductors: *E-k* Diagrams. *pn* Junction Principles. The *pn* Junction Band Diagram. Light Emitting Diodes. LED Materials. Heterojunction High Intensity LEDs. LED Characteristics. LEDs for Optical Fiber Communications, White LED for display and lighting applications.

UNIT III STIMULATED EMISSION DEVICES 9

Stimulated Emission and Photon Amplification. Stimulated Emission Rate and Einstein Coefficients. Optical Fiber Amplifiers. LASER Oscillation Conditions. Principle of the Laser Diode.Heterostructure Laser Diodes. Rate Equation- Characteristics. Light Emitters for Optical Fiber Communications. Quantum Well and Quantum dot Devices. Vertical Cavity Surface Emitting Lasers (VCSELs). Optical Laser Amplifiers.

UNIT IV PHOTOVOLTAICS AND DISPLAY DEVICES 9

Photovoltaic Device Principles. *pn* Junction Photovoltaic I-V Characteristics. Solar Cells Materials, Devices and Efficiencies. Liquid crystal displays, Reflective and Trans reflective types,TFT displays, Plasma displays, LED TV.

UNIT V POLARIZATION AND MODULATION OF LIGHT 9

Polarization. Light Propagation in an Anisotropic Medium: Birefringence. Electro-Optic Effects.. Acousto-Optic Modulator. Magneto-Optic Effects. Integrated Optical Modulators Electro-absorption modulators. Non-Linear Optics and Second Harmonic Generation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand various kinds of semiconductor materials used in optoelectronics

CO2: Understand the mechanisms of light absorption and emission in p-n junctions

CO3: Use photodiodes, LEDs, and laser diodes for various applications.

CO4: Understand the mechanism of Photovoltaic devices and display devices.

CO5: Understand the various polarization and modulation of light signals.

TEXT BOOKS:

1. S. O. Kasap, "Optoelectronics and Photonics: Principles and Practices", Pearson, 2013.
2. Michael Parker, "Physics of optoelectronics", CRC press, 2018.

REFERENCE BOOKS:

1. P. N. Prasad, "Nano photonics", John Wiley & Sons, 2004.
2. Deng-Ke Yang , Shin Tson Wu, "Fundamentals of Liquid Crystal Devices", Revisededition, John Wiley and sons, 2015
3. Saleh and Teich, "Fundamentals of Photonics", Wiley Interscience, 2nd Edition, 2013.
4. J. Singh, “Electronic and Optoelectronic Properties of Semiconductor Structures“, Cambridge University press, 2007.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2					1		1		2
CO2	3	3	3					1		1		2
CO3	3	3	2					1		1		2
CO4	3	3	3					1		1		2
CO5	3	2	3					1		1		2
Average	3	2.8	2.6					1		1		2

EC23013	SIGNAL INTEGRITY (I)	L	T	P	C
		2	0	2	3

UNIT I COUPLED LINE FUNDAMENTALS 6

Maxwell's Equations, Common Vector Operators - Wave Propagations- Reflections of Electromagnetic Waves - Coupled Wave Equations - Coupled Line Analysis – Modal Analysis – Crosstalk Minimization

UNIT II DIFFERENTIAL SIGNALLING 6

Removal of Common Mode Noise - Differential Crosstalk - Virtual Reference Plane – Propagation of Modal Voltages - Common Terminology - Drawbacks of Differential Signaling.

UNIT III CHANNEL MODELLING 6

Frequency domain effects in time domain analysis – Requirements for a physical channel - Creating a Physical Transmission Line Model – Non-ideal return paths

UNIT IV I/O CIRCUIT MODELLING 6

I/O Design Considerations - Push-Pull Transmitters - CMOS Receivers - ESD Protection Circuits – On-Chip Termination – Bergeron diagrams

UNIT V MODELLING AND BUDGETTING OF TIMING JITTER AND NOISE 6

Eye diagram – Bit error rate – Jitter sources and Budgets – Noise sources and Budgets – Peak distortion analysis methods – Mixed signal design considerations

THEORY : 30 PERIODS

PRACTICAL EXERCISES:

1. Generation of the high-frequency differential signal using an arbitrary waveform generator
2. Measurement of near-end and far-end crosstalk (NEXT & FEXT) using vector network analyzer
3. Generate an Eye diagram and conduct measurements on the timing parameters.
4. Perform the Time Domain Reflectometry test.
5. Perform the jitter analysis using the spectral and Q-scale methods for detailed decomposition of jitter components, including the extraction of industry-standard dual-Dirac model parameters
6. Generate LVDS signal and conduct signal integrity measurements.

LIST OF EQUIPMENTS:

1. 2 channel 1 GHz Arbitary waveform generator
2. Two-port vector network analyzer and accessories
3. 2GHz 4 flex channel scope with automated jitter and eye diagram measurement
4. LVDS measurement suite 121 C

PRATICAL: 30 PERIODS

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the fundamental concepts of signal integrity in high-speed PCBs and mitigate reflection and crosstalk.

CO2: Interpret the frequency dependence of dielectrics and apply concepts of differential signaling.

CO3: Describe various aspects of high-speed channel modelling.

CO4: Explain the design considerations high speed I/O circuits.

CO5: Interpret jitter and noise and perform budgeting.

TEXT BOOKS:

1. Hall Stephen H. and Howard L. Heck, Advanced Signal Integrity for High-Speed Digital Designs, Wiley Publications, 2009

REFERENCE BOOKS:

1. Mike Peng Li, Jitter, Noise, and Signal Integrity at High-Speed, Prentice Hall, 2007
2. Paul G. Huray, The Foundations of Signal Integrity, Wiley Publications, 2010
3. Stephen C. Thierauf, Understanding Signal Integrity, Artech House, 2011
4. Samuel H Russ, Signal Integrity: Applied Electromagnetics and Professional Practice, Springer International publishing, 2016

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2			1		2		
CO2	3	3	3	3	2			1		2		
CO3	3	3	3	3	1			1		2		
CO4	3	3	3	3	1			1		2		
CO5	3	3	3	3	2			1		2		
Average	3	3	3	3	1.6			1		2		

EC23014	ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY IN ELECTRONIC SYSTEMS	L T P C 3 0 0 3

UNIT I INTRODUCTION 9

Classification of electromagnetic interference sources - Natural sources - Man-made sources - Surveys of the electromagnetic environment.

UNIT II COUPLING MECHANISMS 9

Propagation and Cross talk – Basic Principles – Representation of EM Coupling from External Fields – Determination of EM field generated by Transmission Lines – Electromagnetic Coupling between Systems – Penetration and Coupling – Propagation and Cross Talk

UNIT III INTERFERENCE CONTROL TECHNIQUES 9

Shielding Theory – Shielding Effectiveness - Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 9

Need for standards - The international framework - FCC – Military Standard MIL-STD-461D-EMC measurement techniques – Measurement tools – Test environments – Transient EMI test wave simulators

UNIT V EMC IN WIRELESS TECHNOLOGIES AND ELECTRIC VEHICLES 9

Efficient use of the frequency spectrum – EMC, Interoperability, and Coexistence – Transmission of high frequency signals over telephone and power networks - EMC Problems of Electric Vehicles - EMC Problems of Wireless Charging System, EMC Problems of Battery Management System, Vehicle EMC Requirements.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1:Understand the various parameters in electromagnetic interference and compatibility

CO2:Summarize electromagnetic field coupling mechanisms

CO3:Analyze various interference control techniques

CO4:Appreciate the need for various standards and measurement procedures

CO5:Understand the impact of EMI on wireless technologies and Electric vehicles

TEXT BOOKS:

1. Christos Christopoulos, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Third Edition, 2023.
2. Li Zhai, Electromagnetic Compatibility of Electric Vehicle, 1st Edition, Springer 2021.

ARTICULATION MATRIX:

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

EC23017	IoT ENABLED SYSTEMS DESIGN	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – IoT Enabling Technologies – IoT Architecture -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates – A panaromic view of IoT applications

UNIT II MIDDLEWARE AND PROTOCOLS OF IOT 9

Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture approach for IoT Systems – SOA based IoT Middleware) Middleware architecture of RFID, WSN, SCADA, M2M –Interoperability challenges of IoT-Protocols for RFID, WSN, SCADA, M2M- Zigbee, KNX, BACNet, MODBUS - Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems - Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) – Resource management in IoT.

UNIT III COMMUNICATION AND NETWORKING 9

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition –Application Layer Protocols: CoAP and MQTT-Data aggregation & dissemination.

UNIT IV IOT IMPLEMENTATION TOOLS 9

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python, Implementation of IoT with Raspberry Pi.

UNIT V APPLICATIONS AND CASE STUDIES 9

Home automations - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style – Case study

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Articulate the main concepts, key technologies, strength and limitations of IoT.

CO2: Identify the architecture, infrastructure models of IoT.

CO3: Analyze the networking and how the sensors are communicated in IoT.

CO4: Analyze and design different models for IoT implementation

CO5: Identify and design the new models for market strategic interaction.

TEXT BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, 2017.
2. Honbo Zhou, “Internet of Things in the cloud:A middleware perspective”, CRC press, 2012.
3. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on Approach)”, VPT, 1st Edition, 2014.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012 .

REFERENCE BOOKS:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.
2. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, “Internet of Things (IoT) in 5G Mobile Technologies” Springer International Publishing Switzerland 2016.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things” Springer-Verlag Berlin Heidelberg, 2011.

ARTICULATION MATRIX:

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

EC23018	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	C
		3	0	0	3

UNIT I NUMBER THEORETIC AND ALGEBRAIC ALGORITHMS 9

Introduction to Network Security-Cryptography Attacks, Services and Mechanisms-Mathematics of Cryptography: Modular Arithmetic, Modular Inverse: Extended Euclidean Algorithm, GF(2^n) fields: Polynomials- Classical Ciphers: Substitution, Transposition cipher - Steganography

UNIT II SYMMETRIC KEY CIPHERS 9

Block ciphers: Overview of DES ,AES: Encryption and Decryption for AES, Key Expansion Algorithm for AES –Modes of Block Ciphers-Stream Cipher:RC4, Application Example: WLAN Security

UNIT III ASYMMETRIC KEY CIPHERS 9

Primes, Primality testing, Factorization-Chinese Remainder Theorem-Quadratic Congruences-Exponentiation and Logarithm- -RSA-Rabin – ElGammal

UNIT IV AUTHENTICATION AND KEY MANAGEMENT 9

Message integrity – Message authentication – SHA-512 – WHIRL POOL-Digital signature Standard :DSA- Entity authentication– password – challenge response – Biometrics – Kerberos. Key Management: Symmetric Key Management - Public Key Distribution-Diffie Hellman technique

UNIT V NETWORK SECURITY PROTOCOLS 9

E-mail Security: PGP , S/MIME – Web Security: SSL and TLS - SET Protocol – Network layer Security:IPsec - Internet Key Exchange – ISAKMP, Application Examples.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to apply and analyze modular arithmetic and various Classical Ciphers

CO2: Ability to develop and analyze symmetric key cryptosystems

CO3: Ability to develop and analyze Asymmetric key cryptosystems

CO4: Ability to develop and analyze authentication Schemes and key management techniques.

CO5: Ability to apply and analyze different Network Security Protocol

TEXT BOOKS:

1. Behrouz A.Forouzan, Debdeep Mukhopadhyay, “Cryptography & Network Security”, Tata McGraw hill, 2018.
2. William Stallings “Cryptography & Network Security: Principles & Practices”, Eighth Edition, Pearson Education Limited,2022.

REFERENCE BOOKS:

1. Douglas R.Stlinson “Cryptography Theory and Practice”, CRC Press-Taylor and Francis Group, 2018.
2. Charlie Kaufman, Radia Perlman, Mike Speciner “Network Security Private Communication in a Public World”, Pearson India, 2016.
3. Eric Maiwald “Network Security A Beginner’s Guide”, Tata McGraw-Hill Publishing Company limited, 2013

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1					1		1		
CO2	3	2						1		1		
CO3	3	3	2					1		1		
CO4	3	3	2	1				1		1		
CO5	3	1	1					1		1		
Average	3	2.4	1.5	1				1		1		

EC23019	COGNITIVE RADIO NETWORKS	L	T	P	C
		3	0	0	3

UNIT I SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE 9

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Essential functions of the software radio, SDR, hardware architecture, software architecture, top level component interfaces, interface topologies among plug and play modules.

UNIT II COGNITIVE RADIOS AND ITS ARCHITECTURE 9

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture

UNIT III SPECTRUM SENSING AND IDENTIFICATION 9

Primary Signal Detection: Energy Detector, Cyclostationary Feature Detector, Matched Filter ,Cooperative Sensing , Definition and Implications of Spectrum Opportunity, Spectrum Opportunity Detection , Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.

UNIT IV INFORMATION THEORETICAL LIMITS ON CR NETWORKS 9

Types of Cognitive Behavior, Interference-Avoiding Behavior: Spectrum Interweave, Interference-Controlled Behavior: Spectrum Underlay, Underlay in Small Networks: Achievable Rates, Underlay in Large Networks: Scaling Laws, Interference-Mitigating Behavior: Spectrum Overlay, Opportunistic Interference Cancellation

UNIT V USER COOPERATIVE COMMUNICATIONS 9

User Cooperation and Cognitive Systems , Relay Channels: General Three-Node Relay Channel, Wireless Relay Channel , User Cooperation in Wireless Networks: Two-User Cooperative Network, Cooperative Wireless Network , Multihop Relay Channel

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1:Ability to understand the basics of SDR and cognitive radio
CO2:Ability understand the architecture of cognitive radio and SDR
CO3:Ability to identify the role of spectrum sensing and dynamic spectrum access
CO4: Ability to apply the concept of cognitive radio in wireless networks for capacity enhancements.
CO5: Ability to apply the cooperative communication in CR system.

TEXT BOOKS:

1. Alexander M. Wyglinski, MaziarNekovee, And Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles And Practice”, Elsevier Inc. , 2010.
2. Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons, Ltd, 2009.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, “Cognitive Radio Networks - From Theory to Practice”, Springer Series, Analog Circuits and Signal Processing, 2009.
4. J. Mitola, “Cognitive Radio: An Integrated Agent Architecture for software defined radio”, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
5. Simon Haykin, “Cognitive Radio: Brain –empowered wireless communications”, IEEE Journal on selected areas in communications, Feb 2005.
6. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, “Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks”, May 2006

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1					1		1		
CO2	2	2	1					1		1		
CO3	3	2	1					1		1		
CO4	3	2	1					1		1		
CO5	3	2	1					1		1		
Average	1.6	2	1					1		1		

EC23020	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

UNIT I SATELLITE ORBITS AND TRAJECTORIES 8

Orbital Mechanics—Orbit Equations, Kepler‘s Laws, Orbital Period, Orbits and their types, look angle calculation; Satellite Launch.

UNIT II SATELLITE SUBSYSTEM 8

Satellite Subsystems—AOCS, TTC&M, Power, Transponders, Antennas; earth control-Effects of earth-Perturbation, suntransit, moontransit, satellite power design, MTBF.

UNIT III SATELLITE LINK DESIGN 10

Basic Equations; System Noise and G/T ratio; Uplink, Downlink and Design for a specified C/N ratio, with GEO and LEO examples; Atmospheric and Rain effects on link performance. Single link design-double link design aspects, Review of modulation techniques for satellite communication; Error control requirements for satellite link—ARQ, Concatenated Codes, Interleaving, Turbo codes.

UNIT IV MULTIPLE ACCESS FOR SATELLITE COMMUNICATIONS 9

FDM-FM-FDMA - TDMA-structure, standards and system design; Onboard Processing systems; DAMA and PAMA; CDMA-system design and capacity.

UNIT V SATELLITE APPLICATIONS 10

Communication Satellite - Frequency bands, Orbits, Payload, Satellite Telephony, Satellite Radio, Satellite television, Regional satellite systems, National satellite systems.

Remote sensing satellite - Orbits, payload, Types of image: image classification, Interpretation. Weather forecasting satellites – Orbits, payloads, applications.

Navigation Satellites – development of satellite navigation systems, GPS system, Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1:Ability to understand about satellite orbits, trajectories and their associated parameters.

CO2:Knowledge on electronic subsystem associated with the satellite and earth station.

CO3:Ability to compute the satellite link parameters under various propagation conditions.

CO4: Ability to understand about multiple access technique and standards used for satellite communication systems.

CO5: Ability to understand about satellite applications in communication, remote sensing, weather forecasting and navigation

TEXT BOOKS:

1. Dennis Roddy, “Satellite Communication”, 4th Edition, Mc Graw Hill International, 2017.
2. Timothy Pratt, Charles, W.Bostain, Jeremy E.Allnutt, "Satellite Communication”, 3rd Edition, Wiley Publications,2021.
3. Anil K. Maina, Varsha Agrawal, “Satellite Communications”, Wiley India Pvt Ltd, 2015, ISBN: 978-81-265-2071-8.

REFERENCE BOOKS:

1. W.L.Pritchard, H G Suyderhoud and R A Nelson, "Satellite Communication System Engineering", Prentice Hall, 2nd Edition, 1993.
2. Tri. T. Ha, "Digital Satellite Communications', McGraw Hill, 2nd Edition, 1990.
3. B.N.Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.
4. M. Richharia, "Satellite Systems for Personal Applications", John Wiley, 2010

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1				1		1		
CO2	3	3	1	1				1		1		
CO3	3	3	1	1				1		1		
CO4	3	3	1	1				1		1		
CO5	2	2	1	1				1		1		
Average	2.6	2.6	1	1				1		1		

EC23021	OPTICAL WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

UNIT I OPTICAL WIRELESS COMMUNICATION SYSTEMS **9**

Introduction – Indoor Optical Wireless Communication Channel : LOS & Non-LOS Propagation Model Ceiling Bounce Model - Artificial Light Interference - Outdoor Channel : Atmospheric Channel Loss, Fog and Visibility, Beam Divergence, Optical and Window Loss, Pointing Loss , Atmospheric Turbulence effects

UNIT II MODULATION TECHNIQUES **9**

Analogue Intensity Modulation - Digital Baseband Modulation Techniques - Pulse Position Modulation and Variants - Pulse Interval Modulation - Dual-Header PIM (DH-PIM) - Comparisons of Baseband Modulation Schemes - Subcarrier Intensity Modulation - Orthogonal Frequency Division Multiplexing - Optical Polarization Shift Keying.

UNIT III FSO LINK PERFORMANCE UNDER TURBULENCE **9**

On–Off Keying Performance in Poisson and Gaussian Atmospheric Optical Channel, Pulse Position Modulation, Subcarrier Intensity Modulation : Generation and Detection, SIM-FSO Performance in Log-Normal Atmospheric Channel, BER of SIM-FSO and Outage Probability in Log-Normal Atmospheric Channels - Atmospheric Turbulence-Induced Penalty.

UNIT IV OUTDOOR OWC LINKS WITH DIVERSITY TECHNIQUES **9**

Atmospheric Turbulence Mitigation Techniques - Receiver Diversity in Log-Normal Atmospheric Channels : Maximum Ratio Combining, Equal Gain Combining, Selection Combining, Effect of Received Signal Correlation on Error Performance & Outage Probability – Transmit Diversity & Transmit – Receive Diversity - Terrestrial Free Space Optical Links with Subcarrier Time Diversity – Aperture Averaging.

UNIT V VISIBLE LIGHT COMMUNICATIONS **9**

Introduction - System Description: VLC System Model, SNR Analysis, Channel Delay Spread - System Implementations: Bit Angle Modulation, Pulse Modulation Schemes, PWM with Discrete Multitone Modulation, Multilevel PWM-PPM, PWM with NRZ-OOK - Multiple-Input–Multiple-Output VLC - Home Access Network.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to understand the characteristics of optical wireless communication systems

CO2: Ability to describe the different modulation techniques involved with OWC systems

CO3: Ability to understand and analyze the free space optical link performance

CO4: Ability to understand the characteristics of various diversity techniques for outdoor OWC systems

CO5: Ability to understand the VLC systems and its modulation techniques.

TEXT BOOKS:

1. Z. Ghassenlooy, W.Popoola and S. Rajbhandari, “Optical Wireless Communications – System and Channel Modelling with MATLAB”, CRC Press, Taylor & Francis Group, 2013.

REFERENCE BOOKS:

1. Ivan B. Djordjevic, “Advanced Optical and Wireless Communication Systems”, Springer, 2018.
2. Murat Uysal Carlo Capsoni Zabih Ghassemlooy Anthony Boucouvalas Eszter Udvary Editors, “Optical Wireless Communications - An Emerging Technology”, Springer, 2018.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2					1		1	1	
CO2	2	2	2					1		1	1	
CO3	3	3	2					1		1	1	1
CO4	2	2	2					1		1	1	
CO5	2	2	2					1		1	1	
Average	2.2	2.2	2					1		1	1	1

EC23022	DIGITAL SWITCHING AND NETWORKING	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Overview of existing Voice, Data and Multimedia Networks and Services; Review of Basic Communication principles; Synchronous and Asynchronous transmission, Line Codes

UNIT II TRUNK TRANSMISSION **9**

Multiplexing & Framing - types and standards; Trunk signaling; Optical Transmission-line codes and Muxing: SONET/SDH; ATM; Microwave and Satellite Systems.

UNIT III LOCAL LOOP TRANSMISSION **9**

The Analog Local Loop; ISDN local loop; DSL and ADSL; Wireless Local Loop; Fiber in the loop; Mobile and Satellite Phone local loop.

UNIT IV SWITCHING **9**

Evolution; Space switching, Time switching and Combination Switching; Blocking and Delay characteristics; Message ,Packet and ATM switching; Advances in switching techniques – shared memory fast packet switches, shared medium fast packet switches and space division fast packet switches, Photonic switching - Optical TDM, WDM.

UNIT V TELETRAFFIC ENGINEERING **9**

Telecom Network Modeling; Arrival Process; Network Blocking performance; Delay Networks-Queuing system analysis and delay performance.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to comprehend existing voice and data communication networking techniques

CO2: Ability to understand the different type of signaling, optical and satellite networks

CO3: Ability to analyze the different local loop data transmission schemes**.**

CO4: Ability to analyze the different switching schemes**.**

CO5: Ablity to understand tele traffic models and performances

TEXT BOOKS:

1. J. Bellamy, "Digital Telephony", John Wiley, 3rd Edition, 2003.
2. JE Flood, "Telecommunications Switching, Traffic and Networks", Pearson, 2005.

REFERENCE BOOKS:

1. R.A.Thompson, "Telephone switching Systems", Artech House Publishers, 2000.
2. W. Stalling, "Data and Computer Communications", Prentice Hall, 1993.
3. T. N. Saadawi, M.H. Ammar,A.E.Hakeem, "Fundamentals of Telecommunication Networks", Wiley Interscience, 1994.
4. W.D. Reeve, "Subscriber Loop Signalling and Transmission Hand book", IEEE Press Telecomm Handbook Series, 1995.
5. Tarmo Anttalaien, "Introduction to Telecommunication Network Engineering", Artech House,2nd Edition, 2003.
6. T. Viswanathan, "Telecommunication Switching Systems", Prentice-Hall, 1992.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1					1		1		
CO2	2	2	1					1		1		
CO3	2	2	1					1		1		
CO4	3	2	1					1		1		
CO5	3	2	1					1		1		
Average	2.4	2	1					1		1		

EC23023	ADHOC AND WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION AND APPLICATIONS 9

Introduction to Ad hoc Networks, Characteristic features, Need for Ubiquitous Computing network, Applications of Ad hoc, Mobility Models: - Brownian Model, Column model, Random Walk Model, Random Waypoint model, Random Gauss Markov Model, Reference point Group Mobility Model.

UNIT II ROUTING PROTOCOLS 9

Need for Different routing Protocols, Proactive Vs Reactive Routing. Unicasting: Dynamic Source Routing, Ad Hoc On-Demand Distance Vector Routing, Temporally Ordered Routing Algorithm, Signal Stability Based Routing, Location Aided Routing, Associativity Based Routing, Zone Routing Protocol. Multicasting: Tree Based Algorithm: CAMP, Mesh based Algorithm: On-Demand Multicast Routing Protocol.

UNIT III OVERVIEW OF WIRELES SENSOR NETWORKS 9

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks-Single- Node Architecture, Layered architecture- Hardware Components, Energy Consumption of Sensor Nodes, Physical Layer and Transceiver Design Considerations.

UNIT IV MAC AND ROUTING PROTOCOLS OF WSN 9

MAC Protocols for Wireless Sensor Networks: Low Duty Cycle Protocols, Wakeup Concepts-S-MAC, PRMA Overview of Address and Name Management, Routing Protocols: Energy-Efficient Routing.

UNIT V INTRODUCTION AND APPLICATION OF LOWPAN 9

Introduction - Architecture, Protocol stack - Link layers – Addressing - Header format – Bootstrapping - Mesh topologies - Internet integration, Functions of an Adaptation Layer,Routing - Mesh-Under -Route-Over –ROLL, Common Protocols –WSP, MQTTS, CAP, Operating system – Contiki - µIPv6, case study - Industrial automation - Health care.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to identify the necessity of Adhoc networks and models need for Adhoc networks

CO2: Ability to analyses different routing protocols & algorithms of Adhoc networks

CO3: Ability to describe the basic requirements of wireless sensor networks

CO4: Ability to analyze various types of MAC and routing algorithms of WSN

CO5: Ability to apply Internet protocol version 6 to WSN and software

TEXT BOOKS:

1. Charles E. Perkins, "Ad hoc Networking", Addison-Wesley,2008.
2. Tracy Camp, Jeff Boleng, Vanessa Davies, "A survey on Mobility Models for Ad hoc Network Research Wireless Communications and Mobile Computing", Special Issue on Mobile Ad hoc Networking: Research, Trends and Applications, Vol.2. No. 5. pp.483- 502,2002.
3. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley,2007.

REFERENCE BOOKS:

1. Hongmei Deng, Wei Li and Dharma P. Agrawal, "Routing security in Wireless Adhoc Networks", IEEE Communication Magazine, Oct.2002.
2. Feng Zhao & Leoni das J. Guibas, ""Wireless Sensor Networks, An Information Processing Approach", Elsevier,2016.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, And Applications”, John Wiley,2015.
4. Zach Shelby, Carsten Bormann,“—6LoWPAN:The Wireless Embedded Internet”, John Wiley& Sons, 2009.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							1		1		
CO2	3	2						1		1		
CO3	2							1		1		
CO4	3	2						1		1		
CO5	3	2			2			1		1		
Average	2.6	2			2			1		1		

EC23024	RADAR TECHNOLOGIES	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO RADAR 9

The Origins of Radar, Radar principles, Basic Block Diagram, Radar classifications based on Frequencies, Radar Fundamentals: Detection, Range, velocity, The simple form of the Radar Equation, Pulsed Radar equation, Detection of Signals in Noise- Receiver Noise, Signal-to-Noise Ratio, Probabilities of Detection and False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets, Transmitter Power, Pulse Repetition Frequency, Antenna Parameters, System losses.

UNIT II CW, MTI AND PULSE DOPPLER RADAR 9

CW and Frequency Modulated Radar, Doppler and MTI Radar- Delay Line Cancellers, Staggered Pulse Repetition Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance, MTI from a Moving Platform (AMIT), Pulse Doppler Radar.

UNIT III TRACKING RADAR 9

Tracking with Radar, Mono pulse Tracking, Conical Scan, Sequential Lobing, Limitations to Tracking Accuracy, Low-Angle Tracking - Comparison of Trackers, Track while Scan (TWS) Radar- Target prediction , state estimation, Measurement models, Kalman Filtering, Extended Kalman filtering.

UNIT IV RADAR SIGNAL PROCESSING 9

Radar Signal Processing Fundamentals, Detection strategies, Optimal detection, Threshold detection, Constant False alarm rate detectors, Adaptive CFAR, pulse compression waveforms, compression gain, LFM waveforms matched filtering, Binary phase coded pulse compression; Barker codes; Quadriphase code; Polyphase codes; Castas codes; radar ambiguity functions, radar resolution, Detection of radar signals in Noise and clutter, detection of non fluctuating target in noise, Doppler spectrum of fluctuating targets, Range Doppler spectrum of stationary and moving radar.

UNIT V RADAR TRANSMITTERS AND RECEIVERS 9

Radar Transmitter, Linear Beam Power Tubes, Solid State RF Power Sources, Magnetron, CrossedField Amplifiers, Other RF Power Sources. Radar Receiver, Receiver noise power, Super heterodyne Receiver, Duplexers and Receiver Protectors- Radar Displays. Radar Antenna - Reflector Antennas - Electronically Steered Phased Array Antennas – Phase Shifters.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Identify the Radar parameters

CO2: Differentiate various radar types

CO3: Evaluate different tracking and filtering schemes

CO4: Apply signal processing in target detection

CO5: Design Radar transmitter and receiver blocks

TEXT BOOKS:

1. Habibur Rahman, Fundamental Principles of Radar, CRC press, Taylor and Francis, 2019.
2. M.I.Skolnik , “Introduction to Radar Systems”, Tata McGraw Hill 2006.
3. M. R. Richards, J. A. Scheer, W. A. Holm, Editors “Principles of Modern Radar, Basic Principles”, SciTech Publishing, 2012

REFERENCE BOOKS:

1. Nathansan, “Radar design principles-Signal processing and environment”, PHI, 2nd Edition,2007.
2. Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw-Hill, 2005.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2			1		1	2	2
CO2	3	3	3	3	2			1		1	2	2
CO3	3	3	3	3	2			1		1	2	2
CO4	3	3	3	2	3			1		1	1	2
CO5	3	2	2	2	3			1		1	1	2
Average	3	2.2	2.2	2.6	2.4			1		1	1.6	2

EC23025	MICROWAVE ELECTRONICS	L	T	P	C
		3	0	0	3

UNIT I MICROWAVE THEORY AND TWO PORT NETWORKS **10**

Introduction to microwave theory and component basics, wire, resistor, capacitor and inductor – properties - Low frequency parameters-impedance, admittance, hybrid and ABCD. High frequency parameters - Formulation of S parameters, properties of S parameters - Reciprocal and lossless networks, transmission matrix.

UNIT II MICROWAVE FILTER DESIGN AND MATCHING NETWORKS **10**

Tuned Circuits, Filter design- Low Pass Butterworth filter, Low Pass Chebyshev filter, Microstrip Realization – Impedance matching networks, frequency response, T and Π matching networks, microstrip-line matching networks.

UNIT III MICROWAVE SOURCES AND COMPONENTS **9**

Microwave Diodes - PN Junction, Varactor, Schottky, PIN, Tunnel, and GUNN Diode, Microwave Attenuators, Microwave RF Switches, power divider, directional coupler, phase shifter, circulator, isolator. Microwave Tubes.

UNIT IV MICROWAVE AMPLIFIERS AND OSCILLATORS DESIGN **8**

Amplifier /oscillator with two terminal device - Amplifier /oscillator configurations with IMPATT/Gunn diodes – Amplifier / oscillator with three terminal microwave transistor- Two cavity klystron amplifier, Reflex klystron oscillator, TWT amplifier, Magnetron oscillator – Theory and applications.

UNIT V MICROWAVE MEASUREMENTS **8**

Measuring Instruments – VSWR meter, Power meter, Spectrum Analyser, Network Analyser – principles; Measurement of Impedance, frequency, power, VSWR, Q factor, dielectric constant, S-Parameter. Hazards of microwaves, permitted power levels for practical applications - effect of microwaves on human body.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of microwave theory and techniques.

CO2: Apply techniques to design filters and matching networks for high frequency applications.

CO3: Remember microwave devices & components used in Microwave communication systems.

CO4: Design and analyze the amplifiers and oscillators.

CO5: Evaluate the microwave systems by Measuring Microwave signal parameters.

TEXT BOOKS

1. Subal Kar, “Microwave Engineering - Fundamentals , Design and Applications”, University Press , first edition, 2016
2. Annapurna Das and Sisir K Das, —Microwave Engineering, Tata McGraw Hill Inc., 2nd edition, 2014.
3. David.M.Pozar, "Microwave Engineering", John Wiley and Sons, 4 th Edition, 2021.

ARTICULATION MATRIX:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	1	1	1	1	1	2	2
CO2	2	3	3	2	2	2	1	1	1	1	2	2
CO3	3	2	1	2	1	1	1	1	1	1	2	2
CO4	2	3	3	3	1	2	1	1	1	1	2	2
CO5	3	2	2	3	1	1	1	1	1	1	2	2
Average	2.4	2.4	2.2	2.4	1.2	1.4	1	1	1	1	2	2

EC23026	PASSIVE RFAND MICROWAVE INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO MICROWAVE INTEGRATED CIRCUITS **9**

Definitions – Applications – Multi-chip module technology – Passive components: Inductors, Capacitors, Resistors, Via-holes and grounding, Microstrip components and Coplanar circuits – Micromachined passive components.

UNIT II FILTERS AND PHASE SHIFTERS **9**

Classification – filter synthesis- low pass filters – band pass filters – Kuroda's identities – diode phase shifters- ferrite phase shifters – differential phase shifters.

UNIT III AMPLIFIERS **9**

Introduction – Classical stability and gain analysis – Matching techniques – Lossy matching - FET feedback amplifier – Power amplifiers – Low noise amplifiers.

UNIT IV OSCILLATORS **9**

Introduction – Design principles – Active device – CAD techniques for large-signal oscillator design – Phase noise in oscillators – MMIC Voltage controlled oscillator design – MMIC Injection locked oscillator design.

UNIT V MEASUREMENT TECHNIQUES **9**

Test fixture measurement – Probe station measurement – Thermal and cryogenic measurements – Experimental field probing techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the various passive microwave components and its fabrication procedures

CO2: Design microwave integrated amplifiers, oscillators, phase shifters and filters

CO3: Analyze the stability of amplifiers and oscillators.

CO4: Interpret the types of filters and phase shifters.

CO5: Summarize the various measurement techniques for MIC technology

TEXT BOOKS

1. Robertson ID, Lucyszyn S, RFIC and MMIC Design and Technology, Institution of Engineering and Technology; 2nd Edition, 2001.
2. Leo G Maloratsky, "Passive RF and microwave integrated circuits",Elsevier, 2004.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2				1		1		1
CO2	3	1	3	2	3			1		1		
CO3	3	1	1	3	3			1		1		
CO4	3	1	1	1				1		1		
CO5	3	1	1	1				1		1		1
Average	3	1	1.4	1.8	3			1		1		1

EC23027	ELECTRONIC WARFARE	L	T	P	C
		3	0	0	3

UNIT I ELECTRONIC WARFARE (EW) PRINCIPLES AND OVERWIEW **10**

Electronic Warfare Taxonomy mission and scenarios; ESM; Introduction to Signals intelligence (SIGINT), Electronic Counter Measures (ECM), Electronic Counter Countermeasures (ECCM); Electronic Support Measure (ESM) Receivers; Radar Warning Receivers (RWR), current ESM receivers; Passive direction finding and emitter location.

UNIT II ELECTRONIC COUNTER MEASURES (ECM) **10**

Noise jamming; Deception Electronic Counter Measures (DECM); Rangr gate deception; Angle deception; ECM against Conical scanning Tracking radars, Monopulse Tracking radars and Pulse compression; Velocity Deception; Modern ECM systems; Expandable Electronic Counter Measures.

UNIT III RADAR ELECTRONIC COUNTER - COUNTER MEASURES (ECCM) **9**

Radar applications in Weapon systems; Surveillance Radars and its detection Range – clear and jamming Environments; Surveillance Radars Frequency tradeoffs and ECCM considerations. ECM jamming Equations; Repeater jammer equations; EW receiver sensitivity.

UNIT IV EW SIGNAL PROCESSING **8**

Signal environment - EM sensor subsystem; The receiver subsystem; The pre-processor; data servo loop; Mile parameter tracking; Advanced pulley power; Managed Jamming; EW technology and Future trends.

UNIT V NAVIGATION AND LANDING AIDS **8**

Principles of Automatic Direction Finders; DME;VOR; TACAN, Instrument Landing System, Microwave landing System; GPS operation; 3D position Determination; GPS based Landing system.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Know the principles of electronic warfare, electronic support measure and electronic counter measures

CO2: Performance analysis of Radar Warning Receivers and modern ECM

CO3: Explain system assessment, counter measures (ECCM)

CO4: Work in EM signal Processing

CO5: Work using radio Navigational techniques and GPS

TEXT BOOKS:

1. Curtis Schleher. D. — 'Introduction to Electronic Warfare', Artech House Inc., U.S.A., 1986
2. Skolnik, M.I. "Introduction to Radar System", Third Edition, McGrawHill, 2017.
3. Myron Kayton, Walter R. Fried, " Avionics Navigation Systems" John Wiley & Sons, 1997.
4. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 2004.

ARTICULATION MATRIX:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	1	2	1	1		1		1	1	1
CO2	3	3	2	3	1	2		1		1	1	2
CO3	3	3	2	3	1	2		1		1	1	2
CO4	3	3	2	3	1	2		1		1	2	2
CO5	2	3	2	3	1	3		1		1	2	2
Average	2.4	2.8	1.8	2.8	1	2		1		1	1.4	1.8

EC23028	ADVANCED ANTENNAS	L	T	P	C
		3	0	0	3

UNIT I ANTENNA PARAMETERS AND ARRAYS 10

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell's equations - Antenna fundamental parameters

One Dimensional Arrays, Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Two dimensional uniform arrays; smart antennas, switched beam and adaptive arrays, phased arrays.

UNIT II MICROSTRIP ANTENNA 10

Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch, Rectangular patch, Circular patch, and Ring antenna – radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Reconfiguration Mechanisms; Computer Aided Design of Microstrip Antennas, Microstrip Reflectarray Antennas, Microstrip antenna for 5G mobile networks.

UNIT III ANTENNAS FOR 5G NETWORKS 9

Advanced antenna for 5G networks, digital and analog beam forming, Multi- antenna features, Multi user MIMO,cell- specific beam forming, UE-specific beam forming, advanced antenna system for network deployments, multi antenna performance in macro network deployments, deployment scenarios and considerations.

UNIT IV ANTENNAS FOR OTHER APPLICATIONS 8

Mobile phone antenna, base station, hand set antenna PIFA – Vivaldi Antennas - UWB Antennas - Antennas in Medicine – Leaky Wave Antennas – Plasma Antennas – Wearable Antennas – RFID Antennas - Automotive antennas, Reconfigurable antennas - Meta materials.

UNIT V TERAHERTZ ANTENNAS 8

Material for Tera Hertz antennas. Tera Hertz sources, Tera Hertz antennas, Planar antenna and arrays, Reflect arrays, Lens antennas, Horn antennas, CNT antennas, Graphene antennas, applications of Tera Hertz antennas.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basic antenna parameters and arrays

CO2: Design microstrip antennas

CO3: Identify the concepts of antenna for 5G network applications

CO4: Develop antennas for various applications

CO5: Understand the theory of Tera Hertz antennas

TEXT BOOKS

1. Krauss.J.D, Ronald J Marhefka and Ahmed S khan, “Antennas and Wave Propagation”, Fifth edition, Tata Mc Graw Hill, New Delhi, 2017.
2. Peter von Butovitsch, Henrik Asplund, David Astely, Thomas Chapman, Mattias Frenne, Farshid Ghasemzadeh, Måns Hagström, Billy Hogan, George Jöngren, Jonas Karlsson, Fredric Kronestedt and Erik Larsson, “Advanced Antenna Systems for 5G Network Deployments” Academic Press, 1st edition, 2020.
3. Saim Ghafoor, Mubashir Husain Rehmani, Alan Davy, ” Next Generation Wireless Terahertz Communication Networks” 1st edition, Taylor and Francis group ,2021.

ARTICULATION MATRIX:

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

EC23029	PIC MICROCONTROLLERS	L	T	P	C
		3	0	0	3

UNIT I 8-BIT PIC MICROCONTROLLER AND BASIC PERIPHERALS **9**

Microprocessors and microcontrollers, introducing PIC 16F877- architecture, memory technologies, timing circuits, power-up and reset, parallel ports, ADC, interrupt, serial peripheral buses (UART, I2C, SPI), PWM, counters and timers, instruction set and assembly language programming.

UNIT II 16-BIT PIC MICROCONTROLLER **9**

DsPIC30F microcontroller- architecture, DSP engine, memory, parallel ports, system and power management, ADC, interrupt, PWM.

UNIT III PIC DEVELOPMENT TOOLS AND PROGRAMMING **9**

Software development tools- editor, assembler, compiler, cross-compiler and simulator, Hardware development tools- development board, device programmer, in-circuit emulator and debuggers. Embedded C Programming, data types and variables, data type modifiers, storage Class modifiers, C statements, structures and operations, pointers, libraries, in-line assembly programming, optimizing and testing embedded C programs.

UNIT IV MULTITASKING AND THE REAL-TIME OPERATING SYSTEM **9**

The challenge of multitasking and real time, multitasking with sequential programming, State machines, Real time operating system, RTOS services, synchronization and messaging tools, CCS PIC C Compiler RTOS. Design example: Voltmeter with RS232 serial output.

UNIT V PERIPHERAL INTERFACING WITH PIC MICROCONTROLLER **9**

Human and physical interfaces- switches to keyboard, LED display, liquid crystal display, Actuators and sensors, PWM, serial communication protocols (UART, I2C, SPI), programming interrupt, timers and counter.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to design and develop PIC microcontroller based systems.

CO2: Ability to comprehend and appreciate DSP in PIC microcontrollers.

CO3: Ability to analyze, demonstrate and apply proper development tools for PIC microcontrollers.

CO4: Ability to apply the concept of multitasking and RTOS in embedded system design.

CO5: Ability to implement various communication protocols and interfacing concepts in embedded system.

TEXT BOOKS:

1. David. E. Simon, "An Embedded Software Primer", Addison-Wesley, Reprint 2015.
2. Kirk Zurell, "C programming for Embedded Systems", CRC Press, 2016.
3. Dogan Ibrahim, "Advanced PIC microcontroller projects in C", Newnes publication, 2012.
4. Tim Wilmshurst, "Designing Embedded Systems with PIC microcontrollers-Principles and Applications", Newnes Publications, 2007.

REFERENCE BOOKS:

1. Douglas V.Hall, "Microprocessor and Interfacing, Programming and Hardware", Tata Mc Graw Hill Revised, 2nd Edition 2016, 11th Reprint 2011.
2. Muhammad Ali Mazidi, RolinMcKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Prentice Hall publications, 2007
3. Julio Sanchez Maria P.Canton, “Microcontroller Programming: The microchip PIC”, CRC Press, Taylor & Francis Group,2007
4. Martin Bates, "Interfacing PIC microcontrollers-Embedded Design by Interactive Simulation",Newnes Publication, 2006

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	1	1		1		1		
CO2	1	2	2	1	1	1		1		1		
CO3	1	2	2	2	1	1		1		1		
CO4	1	2	2	2	1	1		1		1		
CO5	1	2	2	2	1	1		1		1		
Average	1	2	1.8	1.6	1	1		1		1		

EC23030	ADVANCED MICROCONTROLLERS	L	T	P	C
		3	0	0	3

UNIT I RISC PROCESSORS 9

RISC Vs CISC, RISC properties and evolution, Advanced RISC microcontrollers, PIC18xx microcontroller family, Architecture, Instruction set, ROM, RAM, Timer programming, Serial port programming, Interrupt programming, ADC and DAC interfacing, CCP module and programming.

UNIT II CISC PROCESSORS 9

RL78 16 BIT Microcontroller architecture, addressing modes, on-Chip memory, ADC, interrupts, MAC unit, Barrel shifter, internal and external clock generation, memory CRC, on chip debug function and self programming.

UNIT III MSP430 16 - BIT MICROCONTROLLER 9

The MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x. Low power aspects of MSP430 : low power modes, active Vs standby current consumption, FRAM Vs Flash for low power and reliability.

UNIT IV PROGRAMMING AND PERIPHERAL INTERFACE USING MSP430 FAMILIES 9

Memory mapped peripherals, I/O pin multiplexing, Timers, RTC, watchdog timer, PWM control, Analog interfacing and data acquisition, DMA, programming with above internal peripherals using optimal power consumption. Case study: Remote control of air conditioner and home appliances.

UNIT V COMMUNICATION INTERFACE USING MSP 430 MICROCONTROLLER 9

Serial and parallel communication, synchronous and asynchronous interfaces, Implementing and programming of : UART, I2C and SPI protocol. wireless connectivity : NFC, Zigbee, bluetooth and WiFi. MSP430 development tools. Case study: Implementing WiFi connectivity in smart electric meter.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1:Ability to discriminate RISC and CISC processors, and work with PIC microcontrollers.

CO2:Ability to work with the 16 bit microcontroller RL78 and design microcontroller based systems for a Real world application.

CO3:Gaining design knowledge and concepts on MSP430 family of Microcontroller.

CO4:Ability to design real time systems by deploying Interfacing peripherals with MSP430.

CO5:Ability to design and develop microcontroller based smart electronic system communication protocols.

TEXT BOOKS:

1. Alaxander G, James M. Conard, " Creating fast, Responsive and energy efficient Embedded systems using the Renesas RL78 microcontroller", Micrium press, USA, Reprinted by S.P Printers, 2011

REFERENCE BOOKS:

1. Muhammad Ali Mazidi, Rolind D. Mckinlay and Danny Causey. "PIC Microcontroller and Embedded Systems", Pearson Education, 2008.
2. John H. Davies, "MSP 430 Micro controller basics", Elsevier, 2008

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	1	1		1		1		
CO2	1	2	2	1	1	1		1		1		
CO3	1	2	2	2	1	1		1		1		
CO4	1	2	2	2	1	1		1		1		
CO5	1	2	2	2	1	1		1		1		
Average	1	2	1.8	1.6	1	1		1		1		

EC23031	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I EMBEDDED DESIGN PROCESS AND HARDWARE COMPONENTS **9**

Complex Systems and RISC processors - Embedded System Design Process - Formalism for System Design - CPU – CPU Bus–CPU performance-CPU Power Consumption – Memory System Mechanism– Configuring and Programming Input and Output Peripherals - Supervisor Mode, Exceptions and Traps -Coprocessors.

UNIT II SOFTWARE TOOLS AND EMBEDDED C PROGRAMMING **9**

Compilation process - Native vs Cross-Compilers - Run-time libraries - Writing a library - Using Standard and alternative libraries - Porting Kernels – Techniques for Emulation and Debugging – Embedded C Program Structure – Data types - Operators, expressions and control statements – Functions and Procedures - Structures and union- Linux Programming

UNIT III REAL TIME OPERATING SYSTEM **9**

Concurrent Software – Foreground/Background systems, Multi-threaded Programming, shared resources and Critical sections – Scheduling – Cyclic, Round-Robin, Priority based, Deadline driven and Rate Monotonic schedules – Memory Management – Shared Memory -Commercial operating systems. Evaluating operating system performance – Power optimization strategies for processes

UNIT IV HARDWARE ACCELERATORS & NETWORKS **9**

Multiprocessors- CPUs and Accelerators – Performance Analysis- Distributed Embedded Architecture – Networks for Embedded Systems: - I^2C, CAN Bus, Ethernet, Myrinet – Network based design – Internet enabled systems

UNIT V EMBEDDED SYSTEM APPLICATIONS- CASE STUDY **9**

Design Methodology- Elevator controller, Water level controller, Traffic Light Control System, Temperature monitoring and control system, ink jet printer, ATM machine- - Design of Real time embedded systems

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain about different hardware components and software development tools.

CO2: Utilize the Embedded C program methodology for building real time systems.

CO3: Detail the concept and usage of RTOS in Embedded applications.

CO4: Apply the communication protocol in Embedded System development.

CO5: Design a real time embedded system.

TEXT BOOKS:

1. Wayne Wolf, "Computers as Components –Principles of Embedded Computing System Design", Morgan Kaufmann Publishers, 2nd Edition, June2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide-Designing and Optimizing System Software", Morgan Kaufmann Publishers,2004.
3. SteveHeath, "Embedded Systems Design", Newnes Publications, 2nd Edition,2003.
4. Kirk Zurell, “C Programming for Embedded Systems”, R & D Books, 2000
5. K.V.K.K.Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dream tech press, 2005.
6. Tammy Noergaard, “Embedded Systems Architecture”, Elsevier, 2006.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	3	1		1		1		
CO2	1	1	1	1	1	1		1		1		
CO3	1	1	1	1	2	1		1		1		
CO4	3	3	3	3	3	2	1	1		1	3	3
CO5	3	3	3	3	3	2	1	1		1	3	3
Average	1.8	1.8	1.8	1.8	2.4	1.4	1	1		1	3	3

EC23032	OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I OPERATING SYSTEMS OVERVIEW 9

Introduction to operating systems – Computer system organization, architecture – Operating system structure, operations – Process, memory, storage management – Protection and security – Distributed systems – Computing Environments – Open-source operating systems – OS services – User operating-system interface – System calls – Types – System programs – OS structure – OS generation – System Boot – Process concept, scheduling – Operations on processes – Cooperating processes – Inter-process communication – Examples – Multithreading models – Thread Libraries – Threading issues – OS examples

UNIT II PROCESS MANAGEMENT 9

Basic concepts – Scheduling criteria – Scheduling algorithms – Thread scheduling – Multiple processor scheduling – Operating system examples – Algorithm Evaluation – The critical-section 129 problem – Peterson‘s solution – Synchronization hardware – Semaphores – Classic problems of synchronization – Critical regions – Monitors – Synchronization examples – Deadlocks – System model – Deadlock characterization – Methods for handling deadlocks – Deadlock Prevention – Deadlock Avoidance – Deadlock detection – Recovery from deadlock

UNIT III STORAGE MANAGEMENT 9

Memory Management – Swapping – Contiguous memory allocation – Paging –Segmentation – Example: The Intel Pentium - Virtual Memory: Background – Demand paging – Copy on write – Page replacement – Allocation of frames – Thrashing.

UNIT IV FILE AND DISK MANGEMENT 9

File concept – Access methods – Directory structure – File-system mounting –Protection – Directory implementation – Allocation methods – Free-space management – Disk scheduling – Disk management – Swap-space management – Protection

UNIT V INTERPROCESS COMMUNICATION 9

The Linux System – History – Design Principles – Kernel Modules – Process Management – Scheduling – Memory management – File systems – Input and Output – Inter-process Communication – Network Structure – Security – Windows 7 – History – Design Principles – System Components – Terminal Services and Fast User – File system – Networking.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to articulate the main concepts, key ideas, strengths and limitations of operating systems

CO2: Ability to understand the process management of operating systems

CO3: Ability to interpret various storage management in operating systems.

CO4: Ability to understand file concepts and various technical management in OS.

CO5: Ability to know about the scheduling concepts and inter-process communications.

TEXT BOOKS:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts Essentials", John Wiley & Sons Inc., 10th Edition, 2019.

REFERENCE BOOKS:

1. Andrew S. Tanenbaum, "Modern Operating Systems", Addison Wesley, 4th Edition, 2016.
2. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education, 2012.
3. M Dhamdhere, "Operating Systems: A Concept-based Approach", Tata Mc Graw-Hill Education,2nd Edition, 2007
4. William Stallings, "Operating Systems: Internals and Design Principles", Prentice Hall, 7th Edition, 2011.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1		1		1		
CO2	1	1	1	2	1	1		1		1		
CO3	1	1	2	1	1	1		1		1		
CO4	1	1	1	1	1	1		1		1		
CO5	1	1	2	2	1	1		1		1		
Average	1	1	1.4	1.4	1	1		1		1		

EC23033	PARALLEL AND DISTRIBUTED PROCESSING	L	T	P	C
		3	0	0	3

UNIT I THEORY OF PARALLELISM 9

Parallel Computer Models- The State of Computing, Multiprocessors and Multicomputer and Multivectors and SIMD computers, PRAM models

UNIT II PARALLEL PROCESSING APPLICATIONS 9

Conditions of parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architectures. Principles of Scalable Performance, Performance Metrics and Measures.

UNIT III HARDWARE TECHNOLOGIES 9

Processor and Memory Hierarchy- Advanced Processor Technology, Superscalar and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.

UNIT IV PARALLEL PROGRAMMING 9

Parallel Programming Models- Shared Memory Multiprocessors- Constructs for specifying Parallelism- Sharing data- Parallel Programming Languages and Constructs- Open MP– Introduction.

UNIT V DISTRIBUTED SYSTEMS 9

Models, Hardware concepts, communication, synchronization mechanism, case study: MPI and PVM, Distributed file systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the Problem Solving Techniques in Parallel Computing

CO2: Solve Problems Related to Memory Management

CO3: Design Efficient Memory Hierarchical Scheme

CO4: Translate the Information from Virtual Memory to Main Memory

CO5: Design Distributed Systems

TEXT BOOKS:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts Essentials", John Wiley & Sons Inc., 10th Edition, 2019.

REFERENCE BOOKS:

1. Kai Hwang &NareshJotwani, “Advanced Computer Architecture”, Tata McGraw Hill Education Private Limited, Second Edition, 2011.
2. V.Rajaraman, C.Siva Ram Murthy,”Parallel Computers” Architecture and Programming, Prentice Hall of India Private Limited, 2016.
3. Barry Wilkinson, Michael Allen, “Parallel Programming” Techniques and Applications using Networked Workstations and Parallel Computers, Pearson, 2012.
4. Hwang.K.Briggs F.A., “Computer Architecture and Parallel Processing”, Tata McGraw Hall, 2014.
5. Quinn M.J, “Designing Efficient Algorithm for Parallel Computers”, Mc Graw Hill, 2003.

ARTICULATION MATRIX:

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

EC23034	ROBOTICS	L	T	P	C
		3	0	0	3

UNIT I SCOPE OF ROBOTS 9

The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots – Economic and Social Issues- applications.

UNIT II ROBOT COMPONENTS 9

Fundamentals of Robot Technology- Automation and Robotics- Robot anatomy-Work volume-Precision of movement- End effectors- Sensors.

UNIT III ROBOT PROGRAMMING 9

Robot Programming - Methods - interlocks textual languages. Characteristics of Robot level languages, characteristic of task level languages.

UNIT IV ROBOT WORK CELL 9

Robot Cell Design and Control- Remote Center compliance-Safety in Robotics.

UNIT V FUTURE TRENDS 14 9

Telepresence robot, Autonomous mobile robots, Walker Robots, Solar-ball Robot, Underwater bots, Aerobots, Advanced robotics in Space –Specific features of space robotics systems-long-term technical developments, Next generation robots.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to comprehend and appreciate the significance and role of robotics in the present contemporary world

CO2: Ability to know about robotic components.

CO3: Ability to develop robot programming

CO4: Ability to design robot cell with safety measures.

CO5: Ability to understand future trends in robot technology.

TEXT BOOKS:

1. Barry Leatham-Jones, "Elements of industrial Robotics", Pitman Publishing,1987.
2. J.M.Selig,"IntroductoryRobotics",Prentice Hall,1992.

3. John Iovine,"Robots, Android and Animatronics", 2nd Edition, McGraw-Hill,2012.
4. JohnM.Holland, "Designing Autonomous Mobile Robots-Inside the mind of an Intelligent Machine", Newnes Publication,2004.
5. Robert J.Schilling, "Fundamentals of Robotics-Analysis and Control", Pearson Education,2006

REFERENCE BOOKS:

1. Mikell P. Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill Book Company, 1986.
2. FuK.S.Gonzaleaz R.C. and LeeC.S.G., "Robotics Control Sensing, Vision and Intelligence", McGraw Hill, International Editions,1987.
3. Bernard Hodges and Paul Hallam, "Industrial Robotics", British Library Cataloging in Publication,1990.
4. Deb, S.R., "Robotics Technology and Flexible Automation", Tata McGraw Hill, 1994.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	1	1		1	1	1		1
CO2	2	2	2	2	1	1		1	1	1		1
CO3	2	2	2	2	1	1		1	1	1		1
CO4	2	2	2	2	1	1		1	1	1		1
CO5	2	1	1	1	1	1		1	1	1		1
Average	2	1.6	1.6	1.6	1	1		1	1	1		1

EC23C22	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical TrendsEconomical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering – traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design -Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation.

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal.

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Define, formulate and analyze a problem

CO2: Solve specific problems independently or as part of a team

CO3: Gain knowledge of the Innovation & Product Development process in the Business Context

CO4: Work independently as well as in teams.

CO5: Manage a project from start to finish.

TEXT BOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, 5th Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, 11thEdition, 2005.

REFERENCE BOOKS:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Prentice Hall, 2nd Edition, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, 7th Edition, 2013

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2			1	1	1	1	1	2	2	1
CO2	2	2	2		1	1	1	1	1	2	2	1
CO3	2	2	2	2	1	1	1	1	1	2	2	1
CO4	2	2	2	2	1	1	1	1	1	2	2	1
CO5	2	2	2	2	1	1	1	1	1	2	2	1
Average	2	2	2	2	1	1	1	1	1	2	2	1

EC23035	ELECTRONIC SYSTEM PROTOTYPING (I)	L	T	P	C
		1	0	4	3

UNIT I INTRODUCTION TO ELECTRONIC SYSTEM DESIGN 3L

Fundamentals of Electronic Components, Overview of PCB's, Classes and types of PCB's, Choosing of PCB Materials, TH Components, SMD Components and its form factors, Layout planning, Placement rules, Routing techniques for PCB's, PCB Dimensions and Tolerances, Copper Trace and Etching Tolerances, Standard Hole Dimensions, Soldermask Tolerance, Thermal issues.

UNIT II INTRODUCTION TO EDA TOOLS 3L,16P

Various EDA Tools, Schematic Design, Schematic Capture, Component Selection, Annotation, Foot print assignment, Wiring, Design Rule Check, Netlist generation, Convert to PCB, Component Placement, Manual Routing, Auto Routing, Gerber file generation, Fabrication of PCB using different Methods.

PRACTICAL:

- Design a simple circuit (TH) using EDA tool and convert schematic into layout design.
- Fabrication of PCB using traditional method.

UNIT III PCB DESIGN FLOW USING EDA TOOL 3L,16P

Board Manual routing, Cleanup Locking traces, Post processing the board design for manufacturing. Setting up a user account, Submitting Gerber files and requesting a quote, Annotating the layer types and stack-up, Receipt inspection and testing, Nonstandard Gerber files.

PRACTICAL:

- Design a simple circuit (SMD) using EDA tool and convert schematic into layout design.
- Fabrication of PCB using LASER technology.

UNIT IV COMPONENT PLACEMENT AND ITS ASSEMBLY TECHNIQUE 3L,16P

PCB Assembly and Soldering Processes- Component Placement and Orientation Guide, Component Spacing for Through-hole Devices. Component Spacing for Surface Mounted Devices SMDs, Mixed THD and SMD Spacing Requirements. Solder Footprint and Pad stack Design for PCB Manufacturability, PTH land dimension (annular ring width), Clearance between plane layers and PTHs Soldermask and solder paste dimensions.

PRACTICAL:

- Drilling of PCB, component placement and its assembly processes using TH component.

- Component placement and its assembly processes using SMD components (PICK and PLACE).

UNIT V PCB DESIGN FOR SIGNAL INTEGRITY 3L, 12P

Circuit Design Issues Not Related to PCB Layout, Issues Related to PCB Layout, Ground Planes and Ground Bounce, PCB Electrical Characteristics, PCB Routing Topics, Making and Editing Capture Parts, The Capture Part Libraries, Types of Packaging, Pins, Part Editing Tools, Constructing Capture Parts, making and editing layout footprints.

PRACTICAL:

- Microscopic inspection of PCB's and its troubleshooting techniques.
- Design an Enclosure for the fabricated PCBs.

THEORY : 15 PERIODS

LIST OF EXPERIMENTS:

1. Design a simple circuit (TH) using EDA tool and convert schematic into layout design.
2. Design a simple circuit (SMD) using EDA tool and convert schematic into layout design.
3. Fabrication of PCB using traditional method.
4. Fabrication of PCB using LASER technology.
5. Drilling of PCB, component placement and its assembly processes using TH component.
6. Component placement and its assembly processes using SMD components (PICK and PLACE).
7. Microscopic inspection of PCB's and its troubleshooting techniques.
8. Design an Enclosure for the fabricated PCBs.

PRACTICAL: 60 PERIODS

TOTAL : 75 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

CO1: To understand the basics and industry standards related to the design and fabrication of PCBs.

CO2: Leads new users of the software through a very simple design.

CO3: To know and guide in designing plated through-holes, surface-mount lands, and Layout footprints in general.

CO4: To know to construct capture parts using the Capture Library Manager and Part Editor.

CO5: To understand and to fabricate PCBs

TEXT BOOKS:

1. Kraig Mitzner, “Complete PCB Design Using OrCad Capture and Layout”, Newness, 1st Edition, 2007.
2. Simon Monk, “Make Your Own PCBs with EAGLE: From Schematic Designs to FinishedBoards”, McGraw-Hill Education TAB; 2nd Edition, 2017.
3. Douglas Brooks, “Signal Integrity Issues and Printed Circuit Board Design”, PrenticeHall, 2012.
4. Lee W. Ritchey , John Zasio, Kella J. Knack, “Right the First Time: a Practical Handbookon High Speed PCB and System Design”, Speeding Edge , 2003

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		3	3	2	1	2	1	3	3
CO2	3	2	1		3	3	2	1	2	1	3	3
CO3	3	2	1		3	3	2	1	2	1	3	3
CO4	3	3	2	1	3	3	2	1	2	1	3	3
CO5	3	3	3	2	3	3	2	1	2	1	3	3
Average	2.8	2.4	1.6	1.5	3	3	2	1	2	1	3	3

EC23036	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

UNIT I SCIENCE OF MEASUREMENT 9

Measurement System – Instrumentation – Characteristics of measurement systems – Static and Dynamic – Errors in Measurements – Calibration and Standards

UNIT II TRANSDUCERS 9

Classification of Transducers – Variable Resistive transducers – Strain gauges , Thermistor, RTD-Variable Inductive transducers- LVDT, RVDT,- Variable Capacitive Transducers – Capacitor microphone- Photo electric transducers – Piezo electric transducers – Thermocouple-IC sensors - Fibre optic sensors – Smart/intelligent sensors.

UNIT III SIGNAL CONDITIONING AND SIGNAL ANALYZERS 9

DC and AC bridges – Wheatstone, Kelvin, Maxwell, Hay and Schering. Pre- amplifier – Isolation amplifier – Filters – Data acquisition systems. Spectrum Analyzers – Wave analyzers – Logic analyzers

UNIT IV DIGITAL INSTRUMENTS 9

Digital Voltmeters – Millimeters – automation in Voltmeter – Accuracy and Resolution in DVM -Guarding techniques – Frequency counter- Data Loggers – Introduction to IEEE 488/GPIB Buses

UNIT V DATA DISPLAY RECORDING AND SYSTEMS 9

Dual trace CRO – Digital storage and Analog storage oscilloscope. Analog and Digital Recordersand printers. Virtual Instrumentation - Block diagram and architecture – Applications in various fields. Measurement systems applied to Micro and Nanotechnology

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Discuss about the principles of various measurement techniques.

CO2: Analyze the transducers and its impact.

CO3: Explain about the signal conditioning system and signal analyzers.

CO4: Illustrate the digital measurement equipments.

CO5: Emphasize the need for data acquisition, recording and display systems.

TEXT BOOKS:

1. Albert D.Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2008.
2. Ernest o Doebelin and Dhanesh N Manik, "Measurement Systems", McGraw-Hill, 5th Edition ,2007.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	1	3		2	2	2	2	2	2	2
CO2	1	3	3		3	2	2	2	2	2	2	2
CO3				3		2	2	2	2	3	2	2
CO4		2	2							3		
CO5	1	2	2	3								
Average	1	1.6	2.6	3	3	2	2	2	2	2.5	2	2

EC23037	SOFT COMPUTING	L	T	P	C
		3	0	0	3

UNIT I FUZZY SET THEORY 9

Introduction to Neuro- Fuzzy and Soft Computing – Fuzzy Sets – Basic Definition and Terminology - Set-theoretic Operations - Member Function Formulation and Parameterization -Fuzzy Rules and Fuzzy Reasoning - Extension Principle and Fuzzy Relations - Fuzzy If –Then Rules - Fuzzy Reasoning - Fuzzy Inference Systems - Mamdani Fuzzy Models - Sugeno Fuzzy Models –Tsukamoto Fuzzy Models –Input Space Partitioning and Fuzzy Modeling.

UNIT II OPTIMIZATION 9

Derivative based Optimization - Descent Methods - The Method of Steepest Descent – Classical Newton‘s Method – Step Size Determination - Derivative-free Optimization –Genetic Algorithms –Simulated Annealing –Random Search – Downhill Simplex Search.

UNIT III NEURAL NETWORKS 9

Supervised Learning Neural Networks – Perceptrons – Adaline – Back propagation Mutilayer Perceptrons – Radial Basis Function Networks – Unsupervised Learning Neural Networks - Competitive Learning Networks - Kohonen Self-Organizing Networks – Learning Vector Quantization -Hebbian Learning.

UNIT IV NEURO FUZZY MODELING 9

Adaptive Neuro-Fuzzy Inference Systems - Architecture - Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN - Coactive Neuro Fuzzy Modeling –Neuro Fuzzy Spectrum

UNIT V APPLICATIONS OF COMPUTATIONAL INTELLIGENCE 9

Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing or Color Recipe Prediction**.**

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Use fuzzy logic rules and models

CO2: Apply various optimization schemes

CO3: Design and implement various neural networks

CO4: Discuss hybrid soft computing

CO5: Develop different soft computing frame works for Engineering applications

TEXT BOOKS:

1. J.S.R.Jang, C.T. Sunand E.Mizutani, "Neuro Fuzzy and Soft Computing", Pearson Education,2015
2. N.P.Padhy,"Artificial Intelligence and Intelligent Systems", Oxford University Press,2005

REFERENCE BOOKS:

1. TimothyJ.Ross, "Fuzzy Logic with Engineering Applications",McGraw-Hill,3ed., 2011.
2. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley,N.Y.,1989.
3. S.Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI,2013.
4. R.Eberhart,P.Simpson and R.Dobbins, "Computational Intelligence-PCTools",Academic Press Professional,Boston,1996.
5. Dr.S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing",Wiley India, 3rd Edition, 2018.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3					1		1		
CO2	3	3		3				1		1		
CO3		3	3					1		1		
CO4	3	3	3	3				1		1		
CO5	3		3	3	1			1		1		1
Average	3	3	3	3	1			1		1		1

EC23C20	BIO-INSPIRED COMPUTING	L	T	P	C
		3	0	0	3

UNIT I EVOLUTIONARY COMPUTATION & GENETIC ALGORITHM **9**

Evolutionary Computation (EC), Features of EC, Genetic Algorithms, Crossover and Mutation Operators, Selection Mechanism – Fitness Proportionate- Ranking and Tournament selection- Building Block – Hypothesis and Schema Theorem- Applications.

UNIT II ANT COLONY OPTIMIZATION **9**

Ant Colony Optimization - From real to artificial ants, ACO Algorithm, ACO and model based search, ACO Pheromone Updation and Evaporation, Applications.

UNIT III PARTICLE SWARM OPTIMIZATION **9**

Particle Swarm Optimization-Anatomy of a Particle, Velocity and Position Updation, PSO topologies, Control Parameters, Applications

UNIT IV MULTI-OBJECTIVE OPTIMIZATION **9**

Multi-Objective Optimization- Ranking and Diversity, Classical Multi-Objective Optimization Methods, Non-Dominated Genetic Algorithm, Strength Pareto Evolutionary algorithm, Performance assessment of Multi-Objective EC Techniques

UNIT V RECENT ADVANCES IN SWARM INTELLIGENCE TECHNIQUES **9**

Grey-Wolf Optimization- Crow Search Optimization, Salp Swarm Algorithm, Case Studies on Hybrid Optimization Methods for Neural Networks Evolution for real-world application.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to implement and apply genetic algorithms

CO2: Ability to build and apply ANT colony optimization technique

CO3: Ability to implement and apply particle swarm optimization algorithm

CO4: Ability to implement and apply multi-objective optimization methods

CO5: Ability to apply hybrid optimization in the Neural Network Models for real-world applications

TEXT BOOKS:

1. David E.Goldberg, “Genetic Algorithms in search, Optimization & Machine Learning”, Pearson Education,2006
2. Kenneth A De Jong, “Evolutionary Computation A Unified Approach”, Prentice Hall of India, New Delhi,2006.
3. Xin Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.

REFERENCE BOOKS:

1. Marco Dorigo and Thomas Stutzle, “Ant Colony optimization”, Prentice Hall of India, New Delhi, 2004
2. . N P Padhy, “Artificial Intelligence and Intelligent Systems”,Oxford University Press, 2005.
3. Engel brecht, A.P., “Fundamentals of Computational Swarm Intelligence” ,Wiley,2005.

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ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1			1		1		
CO2	3	3	2	3	1			1		1		
CO3	3	3	2	3	1			1		1		
CO4	3	3	2	3	1			1		1		
CO5	3	3	3	3	1			1		1		
Average	3	2.8	2.2	3	1			1		1		

EC23038	PATTERN RECOGNITION	L	T	P	C
		3	0	0	3

UNIT I FEATURE EXTRACTION AND TRANSFORMATION **9**

Introduction - Features, Feature vectors - Feature selection and ranking - Singular value decomposition – Karhunen Loeve Transformation - Feature Selection through Functions Approximation - Binary Feature Selection -Case studies on features obtained from speech and audio signals..

UNIT II DIMENSIONALITY REDUCTION **9**

Discriminant functions - Fisher's Discriminant analysis - Principal Component Analysis - Kernel PCA - Independent component analysis.

UNIT III LEARNING MODELS **9**

Linear models for Classification - Classifiers based on Bayes Decision theory – Naïve Bayes - Nearest neighbor rules - Mixture models - Mixture of Gaussian - Hidden Markov Models - Maximum Likelihood for the Hidden Markov Model.

UNIT IV CLUSTERING **9**

Clustering Concept - Hierarchical Clustering Procedures - Partitional Clustering - Clustering of Large Data Sets - EM Algorithm - Grid Based Clustering - Density Based Clustering.

UNIT V RECENT ADVANCES IN PATTERN RECOGNITION **9**

Fuzzy Logic - Fuzzy inference systems - fuzzy decision making - Neuro - fuzzy techniques, Deep Learning techniques - CNN and transfer learning models - Case studies on character recognition - Face recognition - Fingerprint identification using intelligent techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Extract features and select relevant information

CO2: Apply appropriate dimensionality reduction methods

CO3: Design and implement learning models

CO4: Analyze and Work on different clustering algorithms

CO5: Apply pattern recognition techniques for different kinds of applications

TEXT BOOKS:

1. R.O. Duda, P.E. Hart and D.G. Stork, "Pattern Classification" John Wiley, 2021.
2. Christopher M. Bishop, " Pattern Recognition and Machine Learning", Springer 2011.

REFERENCE BOOKS:

1. TimothyJ.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill,3ed., 2011.
2. Dr.S.N. Sivanandam and S.N. Deepa,"Principles of Soft Computing", Wiley,3rd Edition, 2018.
3. M. Narasimha Murthy, V. Susheela Devi, "Pattern Recognition", Universities Press, 2011.
4. Menahem Friedman, Abraham Kandel, "Introduction to Pattern Recognition Statistical, Structural, Neural and Fuzzy Logic Approaches", World Scientific publishing Co. Ltd, 2020.
5. S. Theodoridis, K. Koutroumbas, "Pattern Recognition", Fourth Edition, Academic Press, 2009.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			2	2			1		1		
CO2	3	2	2	2	3			1		1		
CO3	3	3	2	3	3			1		1		
CO4	3	3	2	3	3			1		1		
CO5	3	3	2	3	3			1		1		
Average	3	2.75	2	2.6	2.8			1		1		

EC23C16	INTRODUCTION TO MEMS AND NEMS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO MEMS AND NEMS 9

MEMS, Microsystem and microelectronics, Applications of MEMS, Materials for MEMS: Silicon, silicon compounds, polymers, metals. Introduction to NEMS, Nano scaling, classification of nano structured materials, Applications of nanomaterials.

UNIT II FABRICATION OF MEMS AND NEMS 9

Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching; Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.

UNIT III MICRO AND NANO SENSORS 9

Acoustic sensor – Quartz crystal microbalance, Surface acoustic wave, Flexural plate wave, shear horizontal; Vibratory gyroscope, Pressure sensors, Quantum well infrared photodetectors

UNIT IV MICRO AND NANO ACTUATORS 9

Electrostatic actuators, piezoelectric actuators, Thermal actuators, Actuators using shape memory alloys, Microgrippers, Micromotors, Microvalves, Micropumps

UNIT V PACKAGING AND CHARACTERIZATION OF MEMS AND NEMS 9

Micro / nano systems packaging, Essential packaging technologies, Selection of packaging materials; Nano material characterization - SEM, TEM, AFM, STM.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Familiarize the basics of micro/nano electromechanical structures, devices and systems including their theoretical foundations, applications and advantages

CO2: Recognize the use of materials in micro/nano fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA

CO3: Analyze the key performance aspects of micro/nano electromechanical transducers including sensors

CO4: Analyze the key performance aspects of micro/nano electromechanical transducers including actuators

CO5: Explore the techniques for characterization and packaging requirements of MEMS/NEMS

TEXT BOOKS:

1. Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata Mcgraw Hill, 2002.
2. Murty B.S, Shankar P, Raj B, Rath, B.B, Murday J, Textbook of Nanoscience and Nanotechnology, Springer publishing, 2013.

REFERENCE BOOKS:

1. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures”, CRC Press, 2002
2. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006
3. Vinod Kumar Khanna, “Nanosensors: Physical, Chemical, and Biological”, CRC press, 2012.
4. Mahalik N P, MEMS, Tata McGraw Hill, 2007.
5. Manouchehr E Motamedi, “MOEMS: Micro-Opto-Electro-Mechanical Systems”, SPIE press, First Edition, 2005.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1				1	1	1		
CO2	3	3	2	1				1	1	1		
CO3	3	3	2	1				1	1	1		
CO4	3	3	2	2				1	1	1		
CO5	3	3	2	2				1	1	1		
Average	3	3	2	1.4				1	1	1		

EC23039	SENSORS, ACTUATORS AND INTERFACE ELECTRONICS	L	T	P	C
		3	0	0	3

UNIT I STRAIN, PRESSURE AND TEMPERATURE SENSORS 9

Introduction, Stress & Pressure sensors: Resistance strain gauge, piezoelectric strain gauge. Fiber-optic sensor, Pressure gauges. Temperature Sensors: Bimetallic strip, thermocouples, Resistance thermometers, thermistors, bolometer, Pyroelectric detector.

UNIT II MOTION SENSORS 9

Capacitor plate sensor, Inductive sensors, LVDT Accelerometer systems, rotation sensors drag cup devices, piezoelectric devices, Rotary encoders.

UNIT III OPTICAL SENSORS 9

Color temperature, light flux, photo sensors, photomultiplier, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber optic sensors, electro optic sensors & fiber-optic applications, light transducer, solid-state transducers and liquid crystal devices.

UNIT IV ACTUATORS 9

Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Hydraulic actuators – Variable transformers: synchros, resolvers, Inductosyn

UNIT V INTERFACING ELECTRONIC SENSORS 9

Proximity detectors – Inductive and capacitive, ultrasonic, photo beam detectors Reed switch, smoke sensors. Direct Sensor-Microcontroller Interfacing, intelligent sensors.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Select sensors for the measurement of physical variables for real time applications

CO2: Use sensors for motion sensing applications

CO3: Use sensors for optoelectronic applications

CO4: Understand and apply actuators for engineering applications

CO5: Interface different sensors for engineering applications

TEXT BOOKS:

1. Doebelin E O, “Measurement Systems, Application and Design”, McGraw Hill, Fifth Edition, 2004.
2. Ian R Sinclair, “Sensors and Transducers”, Newnes publishers, Third Edition, 2001.

REFERENCE BOOKS:

1. Ramon Pallás Areny, John G. Webster, “Sensors and Signal conditioning”, John Wiley and Sons, Second Edition, 2000.
2. Jack P Holman, “Experimental Methods for Engineers”, McGraw Hill, USA, Seventh Edition, 2001.
3. Patranabis D, “Sensors and Transducers”, Tata McGraw Hill, Seventh Edition, 2003.
4. Jon Wilson, “Sensor Technology Handbook”, Newnes, First Edition, 2004.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1		1	1	1		1		
CO2	3	3	3	1		1	1	1		1		
CO3	3	3	3	1		1	1	1		1		
CO4	3	3	3	2		1	1	1		1		
CO5	3	3	3	2		1	1	1		1		
Average	3	3	2.8	1.4		1	1	1		1		

EC23040	INDUSTRIAL IOT AND INDUSTRY 4.0 (I)	L	T	P	C
		2	0	2	3

UNIT I UNDERSTANDING IOT CONCEPT AND DEVELOPMENT PLATFORM **6**

IOT Definition, Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics

UNIT II ANALYZING & DECODING OF COMMUNICATION PROTOCOL USED IN IOT DEVELOPMENT PLATFORM **6**

UART Communication Protocol, I2C Protocol device interfacing and decoding of signal, SPI Protocol device interfacing and decoding of signal, WIFI and Router interfacing, Ethernet Configuration, Bluetooth study and analysis of data flow, Zigbee Interfacing and study of signal flow

UNIT III IOT PHYSICAL DEVICES AND ENDPOINTS AND CONTROLLING HARDWARE AND SENSORS **6**

IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins. Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors; Sensors- Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor.

UNIT IV CLOUD SERVICES USED IN IOT DEVELOPMENT PLATFORM **6**

Configuration of the cloud platform, Sending data from the IOT nodes to the gateways using different communication options; Transferring data from gateway to the cloud; Exploring the web services like mail, Messaging (SMS) and Twitter etc.; Tracking of cloud data as per the requirement; Google Cloud service architect; AWS clod Services architect; Microsoft Azure cloud services Architect; OEN source Cloud Services; Initial State IoT Dashboard & Cloud Services

UNIT V CHALLENGES IN IOT SYSTEM DESIGN – HARDWARE & SOFTWARE **6**

Antenna design and placement, Chip-package system development, Power electronics, electromagnetic interference/compatibility (EMI/EMC), Electronics reliability; Battery simulation.

THEORY : 30 PERIODS

PRACTICAL EXERCISES:

Study and Program different Sensors for IoT applications

- LDR sensor, IR sensor, Temperature Sensor, Ultrasound Sensor, Gas sensor
- Write a program using IR sensor for working morning alarm and night lamp
- Write a program using Temperature sensor for detecting heat / fire
- Write a program using Gas sensor for detecting LPG gas leak
- Write a program using Ultrasound sensor for range detection
- Write a program using sensors for carparking assist
- Write a program using sensors for water level indicator and overflow detection

Designing and debugging complex mixed signal devices (analog, digital, and RF)

- Write a program to interface Bluetooth and implement DC Motor.
- Write a program to control LEDs using Alexa Echo Dot.
- Write a program to control Buzzer using Alexa Echo Dot.
- Write a program to control DC motor using Google Assistance.
- Write a program to control Stepper motor using Google Assistance
- Studying and decoding Computer Bus (RS-232, UART).
- Studying Bluetooth analysis and measurement of Signals
- studying WLAN analysis of 802.11a/b/g/j/p, 802.11n, 802.11ac Signals

Understanding battery requirements

- Determining ultra-low deep sleep current of Node
- Measuring Transmit and Receive current signals of Node
- Capturing short transients and fast transients signals of node
- Recording Device(node) operations over extended states.
- Create stable low noise voltage supply for every state of your IOT devices, from sleep to transmit .
- Record and Generate Battery sources with the battery simulation options

Understanding Modulation techniques –

- Understanding of ASK, FSK Modulation and measurements
- Capturing the live ASK Signal and decoding it.
- Understanding the BPSK, QPSK & QAM Modulation Techniques and analysis.
- Understanding the APSK & APCO modulation & analysis.

List of equipment for a batch of 30 students (3 in a bench):

- Real time Spectrum Analyser upto atleast 6.2GHz and 40MHz bandwidth – Qty #1
- DC Power supply - 120W with Battery simulation – Qty #1
- Graphical Digital Multimeter with built-in digitizer and datalogging for 20 channels – Qty #1
- 200MHz 6 channel scope with Serial trigger & decode capability for I2C, SPI, RS- 232/422/485/UART buses, and built-in 50MHz AFG and 8 digital

channel analysis – Qty #1

- AI Node with pre-configured SSD, USB Camera, USB Hub, USB Mouse, and USBKeyboard. – Qty 1no
- Sensor IOT Application Board with built-in 7 sensors (LDR #2, IR #2, Temperature #1,Ultrasound #1 and LPG Gas sensors #1); Embedded uC mother board, LCD display, Buzzer, Power supply (12V,1A) with adaptor and PCB Base plate; - Qty 5 nos
- All in One General Purpose Board
- IOT Gateway – Qty 1no
- Bluetooth Module– Qty 1no
- Router – Qty 1no
- Portable Sensor Kit – Qty 1no
- IOT sensor kit – Qty 1no
- RFID Module – Qty 1no
- Finger Print Module – Qty 1no
- Stepper Motor – Qty 1no
- DC Motor – Qty 1no

  Amazon Echo device – Qty 2nos

PRACTICAL: 30 PERIODS

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the building blocks of IoT technology and explore the vast spectrum of IoTapplications

CO2: Use processors & peripherals to design & build IoT hardware

CO3: Assess, select and customize technologies for IoT applications

CO4: Connect numerous IOT applications with the physical world of humans and real life problem solving.

CO5: Design and implement IOT applications that manage big data

TEXT BOOKS:

1. “Internet of Things - A Hands-on Approach”, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. “Getting Started with Raspberry Pi”, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

REFERENCE BOOKS:

1. Raspberry Pi Cookbook, “Software and Hardware Problems and Solutions”, Simon Monk,O'Reilly (SPD), 2016, ISBN 7989352133895
2. N. Ida, “Sensors, Actuators and Their Interfaces”, SciTech Publishers, 2014.

3. Peter Waher, “Learning Internet of Things”, Packt Publishing, 2015 3. Editors OvidiuVermesan

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	2		1	1	1		2
CO2	3	2	2	2	1	2		1	1	1		2
CO3	3	2	2	2	2	2		1	1	1		2
CO4	3	2	3	2	3	2		1	1	1		2
CO5	3	3	3	3	3	3		1	1	1		1
Average	3	2.25	2.4	2.2	2	2.2		1	1	1		1.8

EC23C01	WIRELESS SENSOR NETWORK DESIGN	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

Principle of Wireless Sensor Network -Introduction to wireless sensor networks- Challenges, Comparison with ad hoc network, Node architecture and Network architecture, design principles, Service interfaces, Gateway, Short range radio communication standards-IEEE 802.15.4, Zigbee andBluetooth. Physical layer and transceiver design considerations.

UNIT II MAC AND ROUTING PROTOCOLS 9

MAC protocols – fundamentals, low duty cycle protocols and wakeup concepts, contention and Schedule-based protocols - SMAC, BMAC,TRAMA, Routing protocols – Requirements, Classification-SPIN, Directed Diffusion, COUGAR, ACQUIRE, LEACH, PEGASIS.

UNIT III 6LOWPAN 9

6LoWPAN Architecture - protocol stack, Adaptation Layer, Link layers – Addressing, Routing - Mesh- Under - Route-Over, Header Compression - Stateless header compression - Context-based header compression, Fragmentation and Reassembly , Mobility – types, Mobile IPv6, Proxy Home Agent, Proxy MIPv6, NEMO –Routing – MANET, ROLL, Border routing.

UNIT IV APPLICATION 9

Design Issues, Protocol Paradigms – End-to-end, Real-time streaming and sessions, Publish/subscribe, Web service paradigms, Common Protocols -Web service protocols, MQ telemetry transport for sensor networks (MQTT-S), ZigBee compact application protocol (CAP),Service discovery, Simple network management protocol (SNMP), Real-time transport and sessions, Industry- Specific protocols.

UNIT V TOOLS 9

TinyOS – Introduction, NesC, Interfaces, modules, configuration, Programming in TinyOS using NesC, TOSSIM, Contiki – Structure, Communication Stack, Simulation environment – Cooja simulator, Programming

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Design solutions for WSNs applications

CO2: Develop efficient MAC and Routing Protocols

CO3: Develop solutions for 6LOWPAN applications

CO4: Develop efficient layered protocols in 6LOWPAN

CO5: Use Tiny OS and Contiki OS in WSNs and 6LOWPAN applications

REFERENCE BOOKS:

1. Holger Karl , Andreas willig, “Protocol and Architecture for Wireless Sensor Networks”, JohnWiley Publication, 2006.
2. Anna Forster, “Introduction to Wireless Sensor Networks”, Wiley, 2017.
3. Zach Shelby Sensinode and Carsten Bormann, “ 6LoWPAN: The Wireless Embedded Internet” John Wiley and Sons, Ltd, Publication, 2009.
4. Philip Levis, “TinyOS Programming”, 2006 –www.tinyos.net.
5. The Contiki Operating System.http://www.sics.se/contiki.

ARTICULATION MATRIX:

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

EC23041	FIBER OPTIC SENSORS	L	T	P	C
		3	0	0	3

UNIT I OPTICAL MODULATORS, FABRY-PEROT INTERFEROMETER AND MAGNETIC SENSORS **10**

Introduction - Electro optic effect - Bulk modulators - Integrated optical modulators - All-fiber optical modulators - Intensity based and Fabry perot interferometer sensors: Intensity sensors - Band edge temperature sensors - Encoder-based position sensors - Multimode fabry-perot sensors - Single-mode fabry-perot sensors - Magnetic Sensors: Faraday effect sensors – Magnetostrictive sensors - Lorentz force sensors.

UNIT II GRATING SENSORS **10**

Introduction - Theoretical background - Sensors based on relative movement of opposed gratings - Sensors based on grating period modulation - Development status of sensors - Fiber optic grating- Introduction - Fabrication of fiber grating sensors - Single-parameter fiber bragg gratings - Multiparameter fiber grating strain sensors - Applications of multiparameter fiber bragg gratings - Multiparameter pressure and Temperature sensing - Very high speed position and velocity sensing.

UNIT III POLARIZATION, MACH-ZEHNDER AND MICHELSON INTERFEROMETER SENSORS **9**

Introduction - Theoretical background of polarization sensors - Sensors based on the photoelastic effect - Sensors based on retardation plates - principle of operation of Mach-Zehnder interferometer - Fiber interferometer configurations - Applications of interferometer sensors.

UNIT IV DISTRIBUTED FIBER OPTIC SENSORS, ROTATIONAL SENSORS AND FIBER OPTIC SMART STRUCTURES **8**

Introduction - Distributed sensing - Basic principles of sensor multiplexing – Interferometric sensor multiplexing - Fiber Optic Sensors Based on the Sagnac Interferometer and Passive Ring Resonator - Fiber optic sensor systems.

UNIT V INDUSTRIAL APPLICATIONS AND FIBER OPTIC BIOSENSORS **8**

Introduction - Background - Temperature measurement - Pressure measurement - Fluid-level measurement - Flow measurement - Position measurement - Vibration measurement - Chemical analysis - Current-voltage measurement - Important issues for industrial application - Bio sensors.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to understand optical principles underlying various optical sensing methods

CO2: Ability to comprehend the various modes of modulation of optical signals for sensing

CO3: Ability to understand the different optical sensing technique.

CO4: Ability to understand the sensor multiplexing techniques.

CO5: Ability to understand the application of optical biosensors in different domains.

REFERENCE BOOKS:

1. David A. Krohn, Trevor W. MacDougall and Alexis Mendez, "Fiber optic Sensors: Fundamental and Applications", SPIE, Fourth Edition, 2015
2. Eric Uddand William B. Spillman, Jr., "Fiber optics sensors: An introduction for Engineers and scientists", John Wiley & Sons, Second Edition, 2011
3. Gerd Keiser, "Optical Fiber Communications", Tata McGraw Hill, Fifth Edition, 2013.
4. José Miguel López-Higuera, "Handbook of Optical Fibre Sensing Technology", John Wiley & Sons Ltd., 2002
5. Zujie Fang, Ken Chin, Ronghui Qu, Haiwen Cai, Kai Chang, "Fundamentals of Optical Fiber Sensors", John Wiley &Sons Inc, 2012

ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1				1		1		
CO2	2	2	1	1				1		1		
CO3	3	3	2	1				1		1		
CO4	3	2	2	1				1		1		
CO5	2	3	3	1				1		1		
Average	2.5	2.5	1.8	1				1		1		

EC23C09 BIOMEDICAL INSTRUMENTATION

UNIT I BIOPOTENTIAL ELECTRODES

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalentcircuits.

UNIT II BIOPOTENTIAL MEASUREMENT

Bio signal characteristics– frequency and amplitude ranges. ECG – Einthoven‘s triangle, standard 12 lead syste– 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram.

UNIT III BIOPOTENTIAL AMPLIFIER

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Ba isolation - isolated DC amplifier and AC carrier amplifier. Artifacts and removal.

UNIT IV NON ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMEN

Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure: detector circuit, indirect methods - auscultatory method, oscillometric method, ultrasonic method. Blood flow Cardiac output measurement-Indicator dilution, dye dilution and thermo dilution method.

UNIT V BIOCHEMICAL MEASUREMENT

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), immunologically sensitiv colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the electrode behavior and circuit models.
- **CO2** Analyze the bio signal recordings.
- **CO3** Design various bio amplifiers.
- **CO4** Acquire research knowledge to work with bio signals
- **CO5** Understand the concept of biosensors.

TEXT BOOKS:

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”,Pearson E
2. John G.Webster, “Medical Instrumentation Application and Design”, John Wiley and Sons,New York,

REFERENCES :

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi,3rd Edition, 2
2. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, John Wileyand Sons, 3r

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1						2		1
CO2	3	3	3	1				1		1		1
CO3	3	3	3	2				1	1	1		1
CO4	3	3	3	1					1	1		1
CO5	3	3	3	1				1	1	1		1
Avg	3	3	3	1				1	1	1		1

EC23C07	BIOMEDICAL ASSIST DEVICES	L	T	P	C
		3	0	0	3

UNIT I CARDIAC AND NEUROLOGICAL EQUIPMENT 10

Electrocardiograph, Cardiac Pacemaker- Internal and External Pacemaker, types, Batteries. AC and DCDefibrillator- Internal and External, types, Precautions. Patient monitoring systems, Radio Telemetry (single, multi). Clinical significance of EEG, Multi-channel EEG recording system and applications, Evoked

Potential–Visual, Auditory and Somatosensory.

UNIT II DIATHERMY 9

IR and UV lamp - application. Need for different diathermy units, Short wave diathermy, ultrasonic diathermy, Microwave diathermy. Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures

UNIT III ASSIST DEVICES 9

Heart Lung Machine-Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps,Pulsatile and Continuous Types, Monitoring Process. Hemodialyser — Indication and principle of hemodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT IV RESPIRATORY MEASUREMENT 8

Lung Volume and vital capacity, Spirometer, measurements of residual volume. Pneumo tachometer – Airway resistance measurement, Whole body plethysmography. Intra- Alveolar and Thoracic pressure measurements, Apnea Monitor.

UNIT V PATIENT SAFETY 9

Physiological effects of electricity — important susceptibility parameters — Macro shock, Micro shock hazards, Patient's electrical environment, GFI units, Earthing Schemes. Electrical safety codes and standards, Basic Approaches to protection against shock, Protection equipment design, Electrical safety

analyzer – Testing the Electrical safety of medical equipment, Biomedical Laser Safety

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After studying this course students will be able to

CO1: Describe the working and recording setup of cardiac and neurological equipment.
CO2: Explain about measurements of parameters related to the respiratory system.
CO3: Design and demonstrate the therapeutic effects of diathermy
CO4: Demonstrate the function of assist devices.
CO5: Test the electrical safety of medical equipment in the hospital environment.

TEXT BOOKS:

1. John G. Webster, “Medical Instrumentation Application and Design”, Wiley India Pvt.Ltd, New
   Delhi, 4th edition, 2015.
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”,Pearson education, 2012.

REFERENCE BOOKS:

1. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003.
2. L.A Geddes and L. E. Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition,
   2008.
3. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice Hall of India,
   New Delhi, 2nd edition, 2015.
4. Antony Y. K. Chan, “Biomedical Device Technology, Principles and design”, CharlesThomas Publisher Ltd, Illinois, USA, 2008.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	3	1	1		1		
CO2	3	2	2	2	2	3	2	1		1		
CO3	3	2	3	2	1	2	3	2	1	1		
CO4	3	2	2	2	2	3	1	1		1		
CO5	3	2	2	2	2	3	1	1		1		
Average	3	2	2.2	2	1.8	2.8	1.6	1.2	1	1		

BM23C02	RADIOLOGICAL EQUIPMENT	L	T	P	C
		3	0	0	3

UNIT I MEDICAL X-RAY EQUIPMENT 10

Physics of Radiography. Nature of X-rays, X-Ray absorption – Tissue contrast. X- Ray Equipment (BlockDiagram) — X-Ray Tube, collimator, Bucky Grid, power supply. Digital Radiography- Computed radiography, CCD-Based, TFTs based and CMOS based Digital Radiography Systems. Fluoroscopy - X-ray Image Intensifier tubes — Digital Fluoroscopy. Angiography - cine Angiography, Digital subtractionAngiography. Mammography.

UNIT II COMPUTED TOMOGRAPHY 8

Principles of tomography, CT Generations - X- Ray sources, collimation, X- Ray detectors, Viewing systems, CT Numbers, Imaging Artifacts, spiral CT scanning, ultra-fast CT scanners. Image reconstruction techniques- back projection, iterative method and Fourier slice Theorem.

UNIT III MAGNETIC RESONANCE IMAGING 9

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radiofrequencywave, rotation and precession. Induction of magnetic resonance signals — bulk Magnetization, Relaxationprocesses T1 and T2, Spin echo, MR image acquisition, Imaging parameters- TE, TR and image contrast, Slice selection, frequency encoding and phase encoding. Block Diagram approach of MRI system- system Magnet (Permanent, Electromagnet and Super conductors), Gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components. fMRI.

UNIT IV NUCLEAR IMAGING SYSTEM 9

Radioactivity- Radioactivity decay law, Radio Isotopes- alpha, beta, and gamma radiations. Radiopharmaceuticals. Radiation detectors — gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors. Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height Analyzer. Principles of SPECT and PET.

UNIT V RADIATION THERAPY AND RADIATION SAFETY 9

Effects of radiation- direct and indirect. Radiation therapy — linear accelerator, Tele gamma Machine. Recent Techniques in radiation therapy - Stereotaxic Radiosurgery, Stereotaxic Radiotherapy, Proton beam therapy, 3D CRT, IMRT, IGRT and Cyber knife. Radiation measuring Instruments-Dosimeter, film Badges, Thermo Luminescent dosimeters- electronic dosimeter. Radiation protection in medicine-

radiation protection principles, ICRP, AERB.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1: Explain the physics of different diagnostic medical imaging techniques.

CO2: Demonstrate the Instrumentation behind the medical imaging equipment.

CO3: Understand and apply the image reconstruction methods for image formation.

CO4: Discuss the principle and operation of various types of radiation detectors

CO5: Understand the concepts of various radiation therapy equipment.

CO6: Demonstrate the effects of radiation, radiation safety and protection methods.

TEXT BOOKS:

1. Steve Webb, “The Physics of Medical Imaging’’, Adam Hilger,Philadelpia, 1988.
2. Jerry L.Prince and Jonathan M.Links, Medical Imaging Signals and Systems PearsonEducation Inc. 2014.
3. Jerrold T.Bushberg, J.Anthony Seibert, Edwin M.Leidholdt,Jr, John M.Boone. The Essential Physics of Medical Imaging’’, Lippincott Williams and Wilkins, 3rd Edition, 2012.

REFERENCE BOOKS:

1. Gopal B. Saha, “Physics and Radiobiology of Nuclear Medicine’’, Springer, 3 rd Edition2006.
2. B.H.Brown, PV Lawford, RH Smallwood, DR Hose, DC Barber, “Medical physics andBiomedical Engineering’’, - CRC Press,1999.
3. Myer Kutz, “Standard handbook of Biomedical Engineering and design”, McGraw Hill, 2003.
4. P.Ragunathan, “Magnetic Resonance Imaging and Spectroscopy in Medicine concepts andTechniques’’, Orient Longman,2007.
5. R.Hendee and Russell Ritenour, “Medical Imaging Physics”, William,Wiley-Liss, 4 th Edition,2002

ARTICULATION MATRIX:

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

EC23C08	BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO BCI **9**

Brain Computer Interface system, Classification of BCI- Dependent, Independent, Hybrid BCI, Invasive,
Non-invasive and Partially invasive BCI, Synchronous and Asynchronous BCI, Neuronal Activity in braincortex.

UNIT II SOURCES FOR BCI **9**

EEG signal acquisition – Signal Preprocessing – Artifacts removal, MEG, Signals reflecting brain metabolic activity- PET, fNIRS, fMRI. EEG-Event related potential- P300, Mu band, Sensory Motor Rhythm- Event Related Desynchronization, Event related synchronization, Motor Imagery signals, Visual Evoked potential, Steady state Visual Evoked potential, Slow cortical potential.

UNIT III FEATURE EXTRACTION **9**

Power spectral density, Band power, Wavelet features, Spatial filters- Common Average ReferenceFilter, Laplacian filter, Common Spatial Pattern, PCA and ICA.

UNIT IV CLASSIFICATION **9**

Linear Discriminant Analysis, k Nearest Neighbor classifier, Support Vector Machine, Regression, DeepNeural networks- Transfer learning, Convolution Neural Network.

UNIT V APPLICATIONS OF BCI **9**

Speller based on P300, Speller based on SSVEP, SSVEP based wheelchair control, Motor imagery based control of Exoskeleton, Neurorehabilitation, Gaming, Neuromarketing, Case studies onApplications of BCI.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1: Acquire and analyse the brain signal from different regions of brain cortex for specific BCIApplication
CO2: Apply suitable preprocessing technique to the brain signal
CO3: Analyze the event related potentials
CO4: Extract discriminant features from brain signals
CO5: Classify and derive the control signals for BCI applications
CO6: Design a BCI system for various applications

TEXT BOOKS:

1. Jonathan Wolpaw, Elizabeth Winter Wolpaw, “Brain Computer Interfaces: Principles and
Practice”, Oxford University Press,2012.

2. R. Spehlmann, “EEG Primer”, Elsevier Biomedical Press, 1999.
3. Bernhard Graimann, Brendan Allison, GertPfurtscheller, “Brain-Computer Interfaces:
Revolutionizing Human - Computer Interaction”, Springer, 2010.

REFERENCE BOOKS:

1. Arnon Cohen,” Biomedical signal processing Vol 1 Time and Frequency Domain Analysis”,CRC Press, 1986.
2. Arnon Cohen, “Biomedical Signal Processing Vol 2: Compression and automaticrecognition”,CRC Press Inc., 2021.
3. Bishop C.M., “Neural Networks for Pattern Recognition”, Oxford, Clarendon Press, 1995.

ARTICULATION MATRIX:

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

EC23C18 **SOFT COMPUTING AND ITS APPLICATIONS** **L T P C**

3 0 0 3

UNIT I FUZZY SET THEORY **10**

Introduction to Neuro-Fuzzy and Soft Computing - Fuzzy Sets - Basic Definition and Terminology - Set- theoretic Operations - Member Function Formulation and Parameterization - Fuzzy Rules and Fuzzy Reasoning - Extension Principle and Fuzzy Relations - Fuzzy If -Then Rules - Fuzzy Reasoning - Fuzzy Inference Systems - Mamdani Fuzzy Models - Sugeno FuzzyModels - Tsukamoto Fuzzy Models.

UNIT II OPTIMIZATION **8**

Derivative based Optimization - Descent Methods - The Method of Steepest Descent - Classical Newton‘s Method - Step Size Determination - Derivative free Optimization - Genetic Algorithms - Simulated Annealing - Random Search - Downhill Simplex Search.

UNIT III ROUGH SETS **9**

Rough sets - Rough set theory - Set approximation - Rough membership - Attributes- Dependency of attributes - Rough equivalence - Reducts - Rough Reducts based on SVM - Hybrid set systems - Fuzzyrough sets.

UNIT IV HYBRID TECHNIQUES **9**

ANN concepts - Adaptive Neuro - Fuzzy Inference Systems - Architecture - Hybrid Learning Algorithm -Coactive Neuro Fuzzy Modeling - Neuro-Fuzzy Spectrum - Neuro- Fuzzy- GA systems and case studies.

UNIT V APPLICATIONS OF COMPUTATIONAL INTELLIGENCE **9**

Neural networks for facial and emotion recognition - Detection of brain disorders - Study of cardiacconditions - Soft Computing for detection of Chest disorders.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

CO1: Work on fuzzy logic and design inference systems
CO2: Apply various derivative and non-derivative optimization schemes
CO3: Understand concepts related to rough sets
CO4: Discuss hybrid soft computing with case studies
CO5: Develop different soft computing frame works for Engineering applications

TEXT BOOKS:

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro Fuzzy and Soft Computing", PearsonEducation, 2015.
2. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.
3. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 3ed., 2011.
4. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning,AddisonWesley, N.Y., 1989.
5. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms",PHI, 2013.
6. R.Eberhart, P. Simpson and R. Dobbins, "Computational Intelligence - PC Tools", AcademicPress Professional, Boston, 1996.
7. Dr.S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India, 3rd Edition,2018.
8. Vladik Kreinovich and Nguyen Hoang Phuong , “Soft Computing for Biomedical Applicationsand Related Topics”, Springer, 2021

ARTICULATION MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	-	3	3	-	-	1				1	1	
CO2	3	3	-	3	-	1				1	1	
CO3	-	3	3	-	-	1					1	
CO4	3	3	3	3	-	1				1	1	
CO5	3	-	3	3	1	1		1		1	1	1
Averag e	3	3	3	3	1	1		1		1	1	1

EC23042 MEDICAL IMAGE ANALYSIS L T P C

3 0 0 3

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two-dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms–2D-DFTandothertransforms.

UNIT II BIO-MEDICAL IMAGE PREPROCESSING 9

Image Enhancement operations–Image noise and modeling, Image restoration–Image degradation model, Inverse and Wiener filtering, Geometric transformations and correction. Case studies on Denoising in Medical images

UNIT III MEDICAL IMAGE RECONSTRUCTION 9

Mathematical preliminaries and basic reconstruction methods, Image reconstruction in CT scanners, MRI, fMRI, Ultrasound imaging. 3D Ultrasound imaging, Nuclear Medical Imaging modalities–SPECT, PET, Molecular Imaging.

UNIT IV MACHINE LEARNING BASED APPROACHES FOR SEGMENTATION AND CLASSIFICATION 9

Decision Trees for Segmentation and Classification - Random Forests for Segmentation and Classification - Neural Networks for Segmentation and Classification - Deep Learning for Medical Image Analysis

UNIT V CASE STUDIES 9

Recent advances in analysis of Retinal Vessel Segmentation, CT - Vessel Segmentation of Lung Images, Tissue Characterization in Ultrasound

TOTAL PERIODS: 45 HOURS

COURSE OUTCOMES:

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

CO1: Apply and Perform Image Processing technique for Denoising, Enhancement and Restoration of Medical Images

CO2: Apply reconstruction techniques in medical images

CO3: Perform and Validate Segmentation Algorithm, Feature Extraction for Medical Images

CO4: Understand the Classification technique and perform classification in medical images using Machine learning techniques

CO5: Implement and validate Image registration algorithm and Fusion techniques in Medical Images

CO6: Apply 3D Visualization techniques in Medical Images

TEXT BOOKS:

1. Atam P. Dhawan, “Medical Image Analysis”, 2nd Edition, Wiley – IEEE Press, 2011.
2. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, 4th Edition, Pearson Education, 2018.
3. Jerry L. Prince and Jonathan M. Links, “Medical Imaging Signals and Systems”, 2nd Edition, Pearson Education, 2014.

REFERENCES:

1. Anil K Jain, “Fundamentals of Digital Image Processing”,1st Edition, Pearson Education India, 2015.
2. Geoff Dougherty, “Digital Image Processing for Medical Applications”, South Asian Edition, Cambridge University Press, 2010.
3. Ravikanth Malladi, “Geometric Methods in Bio-Medical Image Processing (Mathematics and Visualization)”, 1st Edition, Springer, 2002.
4. Ardeshir Goshtasby, “Image Registration Principles, Tools and Methods (Advances in Computer Vision and Pattern Recognition)”, Springer, 2014.

CO- PO Outcome:

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

EC23043	INTRODUCTION TO BIOMIMICRY	L T P C
		3 0 0 3

UNIT I INTRODUCTION TO BIOMIMICRY 9

Definition and historical context of biomimicry - Importance and potential impact of biomimetic approaches - Case studies of successful biomimetic designs.

UNIT II PRINCIPLES OF BIOMIMICRY 9

Core principles: emulate, adapt, and integrate - Biological systems as models for innovation and problem-solving - Ethics and sustainability considerations in biomimicry.

UNIT III BIOLOGICAL INSPIRATION 9

Structure-function relationships in biological organisms - Evolutionary biology and adaptation - Biomimetic materials and structures - Nature's energy and resource management strategies - Case studies of biomimetic materials and processes

UNIT IV APPLICATIONS OF BIOMIMICRY 9

Biomimetic materials and their properties - Bio-inspired robotics and engineering designs - Biomimicry in architecture, design, and urban planning

UNIT V FUTURE DIRECTIONS AND CHALLENGES 9

Emerging trends and technologies in biomimicry - Challenges and limitations of biomimetic approaches - Biomimicry and emerging technologies - Challenges and opportunities in biomimicry - The future of biomimicry.

TOTAL PERIODS: 45 HOURS

COURSE OUTCOMES:

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

CO1: Explain the Core Principles Of Biomimicry
CO2: Identify Biomimetic Examples
CO3: Apply the Biomimicry Process
CO4: Develop Critical Thinking and Problem-Solving Skills
CO5: Gain a Deeper Appreciation for Nature

TEXT BOOKS:

1. Mark Tercek and Jonathan Adams, “Nature’s Fortune: How Business and Society Thrive by Investing in Nature" ISBN – 13 978-0465031818, Edition 1, 2013.
2. Michael Pawlyn, “Biomimicry in Architecture", ISBN – 13 978-1859466285, Edition 2, 2016.

REFERENCES:

1. Biomimicry and Business: How Companies Are Using Nature's Strategies to Succeed - Margo Farnsworth ISBN – 13 978- 0367552596, Edition 1, 2020.
2. Biomimicry - Innovation Inspired by Nature - Janine M. Benyus, William Morrow, An imprint of Harper Collins Publishers. www.harpercollins.com.

CO- PO OUTCOME:

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

EC23015 INTRODUCTION TO SoC DESIGN L T P C

3 0 0 3

UNIT I APPLICATION SPECIFIC INTEGRATED CIRCUIT 9

Overview of ASIC types, design strategies, CISC, RISC and NISC approaches for SoC , architectural issues and its impact on SoC design methodologies, Application Specific Instruction Processor (ASIP) concepts.

UNIT II NO INSTRUCTION SET COMPUTING 9

NISC Control Words methodology, NISC Applications & Advantages, Architecture Description Languages (ADL) for design and verification of Application Specific Instruction set Processors (ASIP), Use of Generic Netlist Representation - A formal language for specification, compilation and synthesis of embedded processors.

UNIT III SIMULATION 9

Different simulation modes, behavioral, functional, static timing, gate level, switch level, transistor/circuit simulation, design of verification vectors, Low power FPGA, SoC related modeling of data path design and control logic, Minimization of interconnects impact, clock tree design issues.

UNIT IV LOW POWER SOC DESIGN / DIGITAL SYSTEM 9

Low power system perspective- power gating, clock gating, adaptive voltage scaling (AVS), Static voltage scaling, Dynamic clock frequency and voltage scaling (DCFS), building blocks for memory, power down techniques, power consumption verification.

UNIT V SYNTHESIS 9

Technology independent and technology dependent approaches for synthesis, optimization constraints, Synthesis report analysis, Single core and Multi core systems, dark silicon issues, HDL coding techniques for minimization of power consumption, Fault tolerant designs

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Ability to identify & formulate a given problem in framework of SoC

Ability to understand NISC Architecture, ADL and ASIP

Ability to simulate SoC at various levels.

Ability to design low power SoC / Digital System

Ability to map the resources and optimize the system performance

REFERENCES:

1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOSFabrication”, Cambridge University Press, 2008.
2. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006.
3. RochitRajsuman, “System-on- a-chip: Design and test”, Advantest America R & DCenter, 2000.
4. P Mishra and N Dutt, “Processor Description Languages”, Morgan Kaufmann, 2008.
5. Michael J. Flynn and Wayne Luk, “Computer System Design: System-on-Chip”, Wiley,2011.

ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P
CO1	1	1	1		1			1		1		
CO2	1	1	1		1			1		1		
CO3	1	2	2	1	2	1		1		1		
CO4	1	2	2	2	1	1		1		1		
CO5	1	3	2	2	2	1		1		1		
Average	1	1.8	1.6	1.7	1.4	1		1		1		

EC23C15	5 G WIRELESS COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

UNIT I MOBILE COMMUNICATIONS OVERVIEW 9

Evolution from 1G to 5G, Analog voice systems in 1G, digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G (EDGE); IMT2000, 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates, IMT Advanced, 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+), IMT2020, enhancements in comparison to IMT Advanced.

UNIT II 5G COMMUNICATION 9

5G potential and applications, Usage scenarios, enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications, Spectrum for 5G, spectrum access/sharing, millimeter Wave communication, carrier aggregation, small cells, dual connectivity.

UNIT III MULTI-CARRIER WAVEFORMS AND MULTIPLE ACCESS SCHEMES 9

Potential Candidate waveforms OF 5G- Principles, Transceiver block diagram, Frame structure, Resource structure and mapping - Filter-bank based multi-carrier (FBMC), Universal filtered multi carrier (UFMC), Generalized frequency division multicarrier (GFDM), MIMO-GFDM; Principle, Transceiver model and types of NOMA - Power Domain NOMA, Sparse Code NOMA, Power Domain Sparse Code NOMA and Cooperative NOMA

UNIT IV 5G NETWORK PROTOCOLS 9

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

UNIT V CURRENT STATE AND CHALLENGES AHEAD 9

5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements, large cell usage, LMLC, possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul / backhaul solutions: LEOs, HAP/UAV.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Demonstrate understanding of the evolution of mobile communication standards developed over the years

CO2: Demonstrate understanding of the potential of 5G Wireless Communication and the enabling technologies

CO3: Perform computations and solve problems on different multi-carrier options and multiple access techniques.

CO4: Assess and evaluate how software defined network functions helps in scalability and ease of operations.
CO5: Evaluate the use of advanced techniques in cellular communications.

TEXT BOOKS:

1. Evolution of air interface towards 5G, Suvra Shekhar Das and Ramjee Prasad, 2018
2. Afif Osseiran, Jose. F. Monserrat and Patrick Marsch,"5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
3. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications", Springer, 2016

REFERENCE BOOKS:

1. Mobile Communications by Jochen Schiller Pub: Financial Times / Imprint of Pearson
2. Mobile Cellular Telecommunications: Analog and Digital Systems by William Lee, Pub: McGraw Hill Education
3. Mobile Communications Design Fundamentals by William Lee, Pub: Wiley India Pvt. Ltd.
4. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1					1		1		
CO2	2	1	1					1		1		
CO3	3	3	2					1		1		
CO4	3	3	2					1		1		
CO5	3	3	3					1		1		
Average	2.6	2.2	1.8					1		1		

EC23016	SPACE TIME WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

The crowded spectrum, need for high data rate, MIMO systems – Array Gain, Diversity Gain, Data Pipes, Spatial MUX, MIMO System Model. MIMO System Capacity – channel known at the TX, Channel unknown to the TX – capacity of deterministic channels, Random channels and frequency selective channels.

UNIT II RADIO WAVE PROPAGATION 9

Radio wave propagation – Macroscopic fading- free space and out door, small scale fading - Fading measurements – Direct pulse measurements, spread spectrum correlation channel sounding frequency domain channel sounding, Antenna Diversity – Diversity combining methods.

UNIT III SPACE TIME BLOCK CODES 9

Delay Diversity scheme, Alamouti space time code – Maximum likelihood decoding maximum ratio combining. Transmit diversity space time block codes for real signal constellation and complex signal constellation - decoding of STBC.

UNIT IV SPACE TIME TRELLIS CODES 9

Space time coded systems, space time code word design criteria, design of space time T C on slowfading channels, design of STTC on Fast Fading channels, performance analysis in slow and fast fading channels, effect of imperfect channel estimation and Antenna correlation on performance, comparison of STBC & STTC.

UNIT V LAYERED SPACE TIME CODES 9

LST transmitter – Horizontal and Vertical LST receiver – ML Rx, Zero forcing Rx; MMSE Rx, SIC Rx, ZF V-blast Rx- MMSE V-blast Rx, Iterative Rx - capacity of MIMO – OFDM systems – capacityof MIMO multi user systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have ability to

- CO1: Analyze the capacity of MIMO channel
- CO2: Analyze the performance of diversity combining techniques under fading environment
- CO3: Apply STBC in MIMO systems.
- CO4: Apply STTC in MIMO systems
- CO5: Analyze the use of layered space time codes for MIMO system.

TEXT BOOKS:

1. Mohinder Jankiraman, "Space Time Codes and MIMO Systems", Artech House, Boston",London . www.artech house.com, 2004.
2. Arogyaswami Paulraj Rohit Nabar, Dhananjay Gore, "Introduction of Space Time Wireless Communication Systems", Cambridge University Press, 2003.

REFERENCE BOOKS:

1. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communications”, Cambridge University Press, 2005.
2. Sergio Verdu "Multi User Detection", Cambridge University Press, 1998.
3. Andre Viterbi, "Principles of Spread Spectrum Techniques", Addison Wesley 1995.
4. Volker Kuhn, "Wireless communication over MIMO channels", John Wiley and Sons Ltd.,2006.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1					1		1		
CO2	3	3	1					1		1		
CO3	3	2	1					1		1		
CO4	3	2	1					1		1		
CO5	3	2	1					1		1		
Average	3	2.4	1					1		1		

EC23C17	INTRODUCTION TO NANO ELECTRONICS	L	T	P	C
		3	0	0	3

UNIT I BASICS OF NANO ELECTRONICS 9

Scaling to nano-Light as a wave and particle- Electrons as waves and particles- origin of quantum mechanics-General postulates of quantum mechanics-Spin and angular momentum-Wave packets and uncertainty.

UNIT II ELECTRONS CONFINEMENT IN LOW DIMENSIONAL STRUCTURES 9

Statistics of the electrons in solids and nanostructures, Density of states in nanostrutures, Time independent Schrodinger wave equation- Electron confinement-Quantum dots, electron confinement Quantum wires, electron confinement Quantum wells.

UNIT III COULOMB BLOCKADE AND SINGLE ELECTRON TRANSISTOR 9

Coulomb blockade-Coulomb blockade in Nano capacitors - Coulomb blockade in tunnel junctions- Single electron transistors, Semiconductor nanowire SETs, Molecular SETs and molecular electronics.

UNIT IV NANOELECTRONIC DEVICES 9

Field-effect transistors, Quantum Cellular automata, Tunneling effect- Tunneling element - Tunneling diode Resonant Tunneling Devices- Light emitting diodes and lasers

UNIT V SPIN BASED DEVICES 9

Ferro magnetic devices , Giant magnetoresistance devices ,Magnetic tunnel junction devices, Spin transfer torque devices

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to familiarise the fundamental underpinnings of nano electronics.
CO2: Ability to analyse the electron properties of traditional low dimensional structures
CO3: Ability to comprehend the mechanism behind single electronic transistors.
CO4: Ability to analyse the key performance of nano electronic devices.
CO5: Ability to explore the basics of spin based devices.

TEXT BOOKS:

1. Hanson, “Fundamentals of Nanoelectronics”, Pearson education, 2009.
2. V. Mitin, V. Kochelap, and M. Stroscio, Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications, Cambridge University Press, 2008

REFERENCE BOOKS:

1. Jan Dienstuhl, Karl Goser, and Peter Glösekötter, “Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices”, Springer-Verlag, 2004. (Unit II, IV & V)
2. Mircea Dragoman, Daniela Dragoman, Nanoelectronics: Principles and Devices, Artech House, 2009.

3e. Robert Puers, Livio Baldi, Marcel Van de Voorde, Sebastiaan E. van Nooten, Nanoelectronics: Materials, Devices, Applications, Wiley, 2017.

ARTICULATION MATRIX:

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

VERTICAL – MINOR DEGREE

ELECTRONICS SYSTEMS

EC23044 INTRODUCTION TO ELECTRONIC DEVICES AND CIRCUITS L T P C

3 0 0 3

UNIT I SEMICONDUCTOR DIODES 9

Review of Properties of Semiconductor Materials - Theory of PN Junction Diode V-I Characteristics and its Temperature dependence - Break down mechanisms – Applications: Rectifiers - Clipper – Clamper, Zener diode- V-I Characteristics - Break down mechanisms - Tunnel Diode, Application: Voltage regulator and Varactor Diode Characteristics.

UNIT II BJT,FET AND CMOS 9

BJT: Transistor types - transistor action - current components - transistor as a switch and amplifier Field effect transistor : JFET and its characteristics - JFET parameters and configurations - MOSFET – types - VI-characteristics - principle of operation. CMOS: Introduction to NMOS and PMOS transistors and their characteristics.

UNIT III DC CIRCUIT ANALYSIS 9

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

UNIT IV NETWORK THEOREM AND SINUSOIDAL STEADY STATE ANALYSIS 9

Superposition theorem, Thevenin and Norton theorems-equivalent circuits, Maximum Power Transfer theorem, Delta-Wye Conversion-Sinusoidal Stead State analysis: Characteristics of Sinusoids, Complex Forcing Function, Phasor, Phasor relationship for R, L, and C, impedance and Admittance.

UNIT V TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9

The Source- Free RL and RC Circuit, Transient Response of RL, RC, RLC circuits for DC and Sinusoidal Excitation using Laplace transform, Parallel Resonance, Series Resonance, Quality Factor.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to understand the working of a diode and its applications

CO2: Ability to understand the functioning of various types of transistor

CO3: Ability to apply the basic laws for DC circuits Analysis

CO4: Ability to apply Network Theorems in DC and analyze AC circuits for phase relationship

CO5: Ability to analyse RLC circuits

TEXT BOOKS:

1. Millman J, Halkias C. C. "Electronic Devices and Circuits", Tata McGraw Hill, 4th ed, New Delhi, 2015.
2. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.
3. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.

REFERENCE BOOKS:

1. Boylestad, R. L. and Nashelsky, L. "Electronic Devices and Circuit Theory ", Pearson Education, New Delhi, 11th ed, 2013.
2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", Mc Graw- Hill, 2nd Edition, 2003.
3. D.R.Cunningham, J.A. Stuller, "Basic Circuit Analysis", Jaico Publishing House, 2005.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1					1		1		
CO2	3	1	1					1		1		
CO3	3	2	1					1		1		
CO4	3	3	2					1		1		
CO5	3	2	1					1		1		
Average	3	2	1.2					1		1		

EC23045	INTRODUCTION TO DIGITAL ELECTRONICS (I)	L	T	P	C
		2	0	2	3

UNIT I NUMBER SYSTEMS 6

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, 84-2-1, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes.

UNIT II BOOLEAN ALGEBRA 6

Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map and Tabulation methods, Realization of Boolean expression using logic gates.

UNIT III COMBINATIONAL LOGIC DESIGN 6

Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder Magnitude Comparator, Decoder, Encoder, Mux/Demux

UNIT IV SEQUENTIAL CIRCUITS 6

Flip-flops- latches - Synchronous sequential circuits–Design of synchronous and asynchronous counters- Shift registers techniques-sequence detector, applications.

UNIT V PROGRAMMABLE LOGIC DEVICES 6

Classification of memories, Read/write operations- Memory decoding and expansion, Static and Dynamic RAM- PLDs- Architecture, Introduction to FPGA.

THEORY : 30 PERIODS

LIST OF EXPERIMENTS

1. Realization of Boolean Expressions using Logic gates
2. Realization of code convertors
3. Realization of Adders
4. Verification of truth table for D , JK Flip flops
5. Realization of synchronous counters using Flip flops
6. Realization of sequence detector

PRACTICAL: 30 PERIODS

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to Understand different number systems

CO2: Ability to apply Boolean algebra and simplification procedure to digital logic

CO3: Ability to design combinational digital circuits using logic gates

CO4: Ability to understand the design of sequential circuits

CO5: Ability to understand the memory devices and programmable logic devices.

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, 'Digital Design', Pearson, 5th Edition, 2013.
2. Charles H. Roth, Jr, 'Fundamentals of Logic Design', Jaico Books, 4th Edition, 2002.
3. Michael D. Ciletti , "Advanced Digital Design with the Verilog HDL", 2nd Edition, Pearson, 2011.

REFERENCE BOOKS:

1. William I. Fletcher, "An Engineering Approach to Digital Design", Prentice- Hall of India, 1980.
2. Floyd T.L., "Digital Fundamentals", Charles E. Merril publishing company,1982.
3. John. F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 4th Edition,2007.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2					1		1		
CO2	3	2	2					1		1		
CO3	3	2	2					1		1		
CO4	3	2	2					1		1		
CO5	3	2	1					1		1		
Average	3	2	1.8					1		1		

EC23046	FUNDAMENTALS OF ELECTROMAGNETICS	L	T	P	C
		3	0	0	3

UNIT I STATIC ELECTRIC AND MAGNETIC FIELDS **9**

Vectors and co-ordinate systems: Cartesian, cylindrical and spherical co-ordinate systems- scal and vector fields.

Conductors in static electric field- Dielectrics in static electric field- Electric flux density and dielect constant- Boundary conditions, Static Magnetic Field-Lorentz force equation, Ampere's law, Bi Savart law, Magnetic flux density, Magnetic Energy.

UNIT II TIME VARYING FIELDS **9**

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potent functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmor fields.

UNIT III PLANE WAVE PROPAGATION **9**

Uniform plane waves and sinusoidally varying waves in time domain and in free space – polarization – power flow and Poynting vector – wave parameters – plane waves in material media – skin effect – reflection and transmission of uniform plane waves – normal and oblique incidence in conductor and dielectric interfaces.

UNIT IV TRANSMISSION LINE BASICS **9**

Transmission line – general solution, Transmission line equivalent circuit, open and short circuited lines - Input impedance, SWR and Power, Characteristic impedance, Impedance matching, Microstrip transmission lines.

UNIT V ANTENNA BASICS **9**

Scalar and vector potentials, Radiation from a current filament, Overview of half wave dipole, Antenna characteristics, radiation pattern, radiation intensity, directivity and power gain, Overview of Yagi-Uda array, Reflector antennas, Microstrip patch antenna, Introduction to modern antennas.

TOTAL : PERIODS

COURSE OUTCOMES:

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

CO1:Understand static EM field concepts

CO2:Understand time varying EM fields and solve engineering problems using Maxwell's law.

CO3:Understand and analyze plane wave propagation.

CO4:Understand the basics of transmission lines.

CO5:Understand the basics of antenna theory.

TEXT BOOKS:

1. M.N.O.Sadiku and S.V.Kulkarni, Principles of electromagnetics, 6th ed.,Oxford (AsianEdition),2015
2. John D Ryder, "Networks lines and fields", 2nd ed, Prentice Hall of India, New Delhi,2005
3. A. C. Balanis, "Antenna theory: Analysis and design", 3rd edJohn Willey and Son's Inc., New York, 2012.
4. John Kraus, "Electromagnetics", McGraw Hill, 2nd ed, 2017.
5. John D Kraus,"Antennas for all Applications", 5th ed, McGrawHill, 2005.

REFERENCE BOOKS:

1. E. C. Jordan and K. G. Balmain, "Electromagnetic Waves and Radiating Systems" 2nd ed, Prentice Hall, 2015.
2. Fawwaz Ulaby, "Fundamentals of Applied Electromagnetics", Prentice Hall, 2007.
3. D.K. Cheng, "Field and Eave Electromagnetics, 2nd ed, Pearson(India), 2002.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1					1		1		1
CO2	3	2	1					1		1		1
CO3	3	2	1					1		1		1
CO4	3	1	1					1		1		1
CO5	3	1	1					1		1		1
Average	3	1.6	1					1		1		1

EC23047 INTRODUCTION TO COMMUNICATION ENGINEERING

L	T	P	C
3	0	0	3

UNIT I ANALOG MODULATION SYSTEMS **9**

Communication system model – Amplitude Modulation – DSBFC, DSBSC, SSB,VSB - Comparison of AM systems - FDM -FM and PM - Narrow band FM and Wideband FM - Bandwidth requirements- Carson‘s Rule.

UNIT II NOISE IN COMMUNICATION SYSTEMS **9**

Types of Noise – Noise Calculations-Transmitter characteristics & Classification - AM broadcasting transmitters - Pilot carrier technique- FM transmitters. Receiver -characteristics and Classification, Superheterodyne receivers.

UNIT III PULSE MODULATION SCHEMES **9**

Sampling -Pulse Amplitude Modulation – TDM - Pulse Width Modulation – Pulse Position Modulation–Quantization - PCM -DPCM– Delta Modulation – Adaptive Delta Modulation

UNIT IV INFORMATION THEORY AND BASEBAND SIGNALLING **9**

Review of Probability theory and random process - Self information measure - Entropy function -Conditional Entropies - Mutual information - Redundancy - Efficiency and channel capacity- Shannon‘s Hartley Law - Concept of base band signaling - Signaling formats - Line coding – ISI.

UNIT V PASSBAND SIGNALLING AND ERROR CONTROL CODING **9**

Introduction to ASK, FSK, PSK, DPSK - M-ary signaling -Parity check codes - Linear block codes - convolution codes -Viterbi Decoding

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to understand the basics of amplitude and frequency modulation Techniques.

CO2: Ability to classify the noise types and understand the functioning of transmitters and receivers

CO3: Ability to differentiate the various pulse modulation schemes

CO4: Ability to encode and decode source symbols and determine the channel capacity and also to analyze baseband signaling schemes

CO5: Ability to apply error control coding schemes and analyze its performance

TEXT BOOKS:

1. S.Haykin, "Communication Systems ", John Wiley, 4th Edition, 2007.
2. S. Haykin, "Digital Communications", John Wiley, 2015.
3. B.P.Lathi, "Modern Digital and Analog Communication Systems", Oxford University Press, 3rd Edition, 2007.

REFERENCE BOOKS:

1. J.G.Proakis, M.Salehi, "Fundamentals of Communication Systems", Pearson Education 2006.
2. H P Hsu, Schaum Outline Series, "Analog and Digital Communications", TMH 2006
3. B.Sklar, "Digital Communications Fundamentals and Applications", Pearson Education 2nd Edition, 2007.

ARTICULATION MATRIX:

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

EC23048 WIRELESS COMMUNICATION TECHNOLOGIES L T P C

3 0 0 3

UNIT I FUNDAMENTALS OF WIRELESS COMMUNICATION 9

Reflection, Diffraction and Scattering of EM waves-Large scale path loss - Free Space and Two-Ray models– Small scale fading- Parameters of mobile multipath channels, classification of multipath fading channels.

UNIT II CELLULAR MOBILE COMMUNICATION 9

Introduction-Frequency Reuse-Channel Assignment Strategies-Hand off Strategies, Interference and System Capacity-Capacity improvement techniques

UNIT III WIRELESS LAN 9

Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sublayer- MAC Management Sublayer- Wireless ATM - HIPERLAN- HIPERLAN-2

UNIT IV WIRELESS INTERFACES – BLUETOOTH, ZIGBEE, LORA 9

Architecture and Applications - IEEE 802.15.4, Bluetooth, Zigbee, LORA, 6LOWPAN, Wi-Fi, WIMAX.

UNIT V 5G WIRELESS TECHNOLOGIES 9

Evolution from 1G to 5G, 3G UMTS, W-CDMA, 3G services and data rates, IMT Advanced, 4G, LTE, OFDM, MIMO, Introduction to 5G Technologies- IoT- Architecture, M2M, SCADA and RFID.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will have

CO1: Ability to understand the wireless channel characteristics and behavior.

CO2: Ability to understand the cellular communication techniques

CO3: Ability to understand the protocol architecture of WLAN

CO4: Ability to understand the architecture and application of different wireless interfaces used in real time.

CO5: Ability to understand the current trends in wireless communication

TEXT BOOKS:

1. Rappaport,T.S., “Wireless communications”, Pearson Education, Second Edition, 2010.
2. Clint Smith. P.E and Daniel Collins, “3G Wireless Networks”, 2nd Edition, Tata McGraw Hill, 2007.
3. Vijay. K. Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers, http://books.elsevier.com/9780123735805, 2007.

4. Zach Shelby, Carsten Bormann,“6LoWPAN:The Wireless Embedded Internet”, John Wiley Sons, 2009.

REFERENCE BOOKS:

1. Perry Lea, “IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security”, 2nd Edition, 2020.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1					1		1		
CO2	2	2	1					1		1		
CO3	2	2	1					1		1		
CO4	2	2	1					1		1		1
CO5	2	2	1					1		1		1
Average	2	2	1					1		1		1

EC23049	INTRODUCTION TO THE INTERNET OF THINGS AND EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

IoT Definition and Characteristics – Evolution of IoT- IoT Enabling Technologies and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies of IoT.

UNIT II SENSORS NETWORKS 9

Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, node, Connecting nodes, Networking Nodes, WSN and IoT.

UNIT III IOT APPLICATIONS 9

Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

UNIT IV INTRODUCTION TO EMBEDDED SYSTEMS 9

Embedded system processor, hardware unit, software embedded into a system, Example of an embedded system, Embedded Design life cycle, Layers of Embedded Systems

UNIT V SYSTEM DESIGN USING GENERAL PURPOSE PROCESSOR 9

Microcontroller architectures (RISC, CISC), Embedded Memory, Strategic selection of processor and memory, Memory Devices and their Characteristics, Cache Memory and Various mapping techniques, DMA.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Describe the evolution of IoT, IoT networking components, and addressing strategies in IoT.

CO2: Understand the various concepts of sensors and actuators for design of IoT.

CO3: Understand various applications of IoT.

CO4: Comprehend Embedded Processor and its software

CO5: Design an Embedded system using processors, memory I/O devices and communication network within realistic constraints

TEXT BOOKS:

1. Sudip Misra, Anandarup Mukherjee, Arijit Roy, “Introduction to IoT”, Cambridge University Press 2021.
2. Hakima Chaouchi, “The Internet of Things Connecting Objects to the Web” ISBN : 978-1- 84821-140-7, Wiley Publications
3. Olivier Hersent, David Boswarthick, and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, Wiley Publications
4. Wayne Wolf “Computers as components: Principles of Embedded Computing System Design”, The Morgan Kaufmann Series in Computer Architecture

REFERENCE BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”,1st Edition, VPT, 2014.
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.
3. Shibu K V," Introduction to Embedded Systems", McGraw Hill Education(India) Private Limited, 2014.
4. Lyla B. Das," Embedded Systems an Integrated Approach", Pearson Education, 2013.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2	1	1			1		1	1	1
CO2	3		3	1	1			1		1		3
CO3	3	2	3				1	1		1		1
CO4	3	2	3					1		1	1	1
CO5	3	3	3					1		1	1	3
Average	3	2.33	2.8	1	1		1	1		1	1	1.8

EC23050	ELECTRONIC SYSTEM DEVELOPMENT (I)	L	T	P	C
		2	0	2	3

UNIT I INTRODUCTION TO ELECTRONIC SYSTEM DESIGN **6**

History, basic physics of passive components, Evolution and Inventors of Electronic Components, basics of digital electronics-logic gates, Digital system design: Digital to Analog converters, Analog to Digital converters, Application- Alphanumeric display Classification, Motion Sensors, Thermal Sensors and Image Sensors, PIR, IR and Water Level Sensors.

UNIT II FUNDAMENTALS OF PRINTED CIRCUIT BOARD **6**

Fundamentals of Electronic Components, Overview of PCB's, Classes and types of PCB's, Choosing of PCB Materials, TH Components, SMD Components and its form factors, Layout planning, Placement rules, Routing techniques for PCB's, PCB Dimensions and Tolerances, Copper Trace and Etching Tolerances, Standard Hole Dimensions, Solder mask Tolerance, Thermal issues, PCB terminologies, Post processing of PCB design and Fabrication.

UNIT III PCB DESIGN FLOW USING EDA TOOL **6**

Electronic Design Automation Tools (EDA), Schematic capture, Component Selection, Annotation, Foot print assignment, Wiring, Design Rule Check, Netlist generation, Convert to PCB, Component Placement, Manual Routing, Auto Routing, Gerber file generation.

UNIT IV COMPONENT ASSEMBLY ON PCB'S AND ITS SOLDERING TECHNIQUES **6**

Drilling Concepts, Component Placement and Orientation, TH Component Assembly, Hand Soldering Techniques, SMD Component Assembly using PICK and PLACE machine, SMD Component Soldering using Reflow oven machine, PCB inspection.

UNIT V PRODUCT DEVELOPMENT **6**

Study of Astable and Monostable Multivibrator using IC555 timer, Comparator using op-amp IC741, LED Chases using Shift register, Controlling relay suing op-amp, design a automatic light control using op-amp IC741, design a water level controller using IC741.

THEORY : 30 PERIODS

LIST OF EXPERIMENTS:

1. Fabrication of PCB using traditional method.
2. Fabrication of PCB using LASER technology
3. Component Placement and its assembly Processes using TH components.
4. Component Placement and its assembly Processes using SMD components
5. Toggle a LED using IC555 Timer Astable and Monostable Multivibrator.
6. To design a counter using Shift Register.

PRACTICAL: 30 PERIODS

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of **electronic system design** related to the design and fabrication of PCBs.

CO2: Lead new users of the software through a very simple PCB design.

CO3: Know and guide in designing plated through-holes, surface-mount lands, and Layout footprints in general.

CO4: Construct capture parts using the Capture Library Manager and Part Editor.

CO5: Understand fabrication steps and fabricate PCBs

TEXT BOOKS:

1. Grob. B and Schultz. M.E. 'Basic Electronics', Tata Mcgraw Hill, 2003.
2. Thomas L. Floyd, 'Electronics Devices', Pearson Education, 2002.
3. Thomas L. Floyd, 'Digital Fundamentals', Pearson Education, 2003.
4. Kraig Mitzner,"Complete PCB Design Using OrCad Capture and Layout",Newness,1st Edition,2007.

REFERENCE BOOKS:

1. Simon Monk, "Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards", McGraw-Hill Education TAB; 2nd Edition, 2017.
2. Douglas Brooks, "Signal Integrity Issues and Printed Circuit Board Design", Prentice Hall, 2012.
3. Lee W. Ritchey , John Zasio, Kella J. Knack, "Right the First Time: a Practical Handbook on High Speed PCB and System Design",Speeding Edge,2003.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	3	3		1		1	2	3
CO2	3	2	1	1	3	3		1		1	2	3
CO3	3	2	1	1	3	3		1		1	2	3
CO4	3	3	2	1	3	3		1		1	2	3
CO5	3	3	3	2	3	3		1		1	3	3
Average	2.8	2.4	1.6	1.2	3	3		1		1	2.2	3

OPEN ELECTIVES

EC23901	AUTOMOTIVE ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To make the students to understand the concepts of electronics components, and the design of various combinational circuits.
- To introduce the Microcomputer Instrumentation and Electronics engine controlability
- To introduce sensor based electronics applications.
- To introduce the motion control, Instrumentation and Telematics.
- To impart knowledge on future automotive systems.

UNIT I AUTOMOTIVE AND ELECTRONICS FUNDAMENTALS 9

Introduction to Automobile Engineering, Automotive Engines and Control Systems, Electronic Engine Management Systems. Introduction to Basic Electronics- Semiconductor Devices. Diodes, Rectifiers, Transistors. Logic Gates, Combinational Circuits and Microprocessors.

UNIT II MICROCOMPUTER INSTRUMENTATION AND ELECTRONICS ENGINE CONTROL 9

Microcomputer Fundamentals- Digital Vs Analog Computers, Microcomputers Vs Mainframe Computers and basic computer programming. Instrumentation Examples of Microcomputer. Electronic Engine Control Motivation. Engine Performance Terms, Electronic Fuel Control systems, Catalytic Converters, Idle Speed Control, Electronic Ignition Systems

UNIT III SENSORS AND ACTUATORS 9

Basic Measurement System, Sensory-Airflow Sensor, Pressure Sensor, Magnetic and hall Effect Sensors, Optical Positioning Sensors. Exhaust and Knock Sensors. Automotive Engine Control Actuators- Fuel Control Actuators, Exhaust Recirculation Actuators, Electrical Motors — Brushless DC and Stepper Motors Ignition System

UNIT IV MOTION CONTROL, INSTRUMENTATION AND TELEMATICS 9

Digital Engine Control and Features, Control Modes- Fuel Control, Engine Start, Engine Crank and Warm-Up, Speed Control Acceleration / Deceeration, EGR Control and Hybrid Electric Vehicle Power train Control, Electronic Steering Control and Electronic Suspension Systems. Advantages of Computer-Based Instrumentation, Digital Consoles — High-Speed Digital Communications CAN, Display Devices LED, LCD, Flat Panel Display, Trip Information Computer, Telematics, GPS Navigation and Structure.

UNIT V DIAGNOSIS AND FUTURE AUTOMOTIVE SYSTEMS 9

Electronic Control System Diagnostics, Service Bay Diagnostic Tool, Onboard Diagnostics, Model-Based Sensor Failure Detection, Diagnostic Fault Codes, Onboard Diagnosis(OBDII),Model-Based Misfire Detection System, Expert Systems in Automotive Diagnosis, Occupant Protection Systems. Future Automotive Systems- Alternative Engine, Advanced Travel and Safety Control-Collision Avoidance Radar Warning System. Low Tire Pressure Warning System. Sensor Multiplexing and Automatic Driving Control.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1:Recognize electronics components required for automotive electronic based systems.

CO2:Understand microcomputer Instrumentation and Electronics Engine Control.

CO3:Gain knowledge to design sensor based electronic applications.

CO4:Comprehend vehicular communication and motor control concepts in automotiveengineering.

CO5:Have an exposure to future automotive systems.

TEXT BOOKS:

1. William B. Ribbens. "Understanding Automotive Electronics" –An Engineering Perspective, 7thEdition, Butterworth.Heinemann Woburn,2017.
2. Tom Weather Jr and Cland C Hunter "Automotive Computers and Control System" PrenticeHall Inc, New Jersey, July 2016.

REFERENCE BOOKS:

1.Tom Denton, "Automobile Electrical and Electronic System", Fourth edition,routledge,2017

2.Ribbens William, "Understanding Automotive Electronics, Elsevier — Health SciencesDivision, 2020

3.V.A.W Hillier "Fundamentals of Automotive Electronics" Second Edition OUP Oxford publisher,1996.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1				1		1		
CO2	2	2	2	1				1		1		
CO3	2	2	2	1				1		1		
CO4	2	2	1	2				1		1		
CO5	2	1	1	2				1		1	1	1

EC23902	ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To understand the basic concepts of electronics components.
- To learn about construction and working of basic electronic devices.
- To impart knowledge on Boolean algebra and design various combinational and sequentialcircuits.
- To introduce the Integrated circuits design and fabrications and related technology.
  To design sensor based electronics applications.

UNIT I ELECTRONIC COMPONENTS 9

History, Evolution and Inventors of Electronic Components - Resistors, Capacitors and Inductors - Types, Construction and Functions, Cables — Construction, Characteristics, Types- High Impedance, Low Impedance, Ribbon, High Temperature, Flat Twin, RF, Telephone, Optical Fiber, Connectors, Switches, Relays, Displays (construction an working) –LED, LCD, LASER, Application- Alphanumeric display.

UNIT II BASIC ELECTRONIC DEVICES AND ITS WORKING 9

History, Evolution and Inventors of Electronics Devices- PN Junction Diodes, Zener, Bipolar Junction Transistors, Field Effect Transistors- JFET & MOSFET, Uni Junction Transistors, Silicon Controlled Rectifier.

UNIT III DIGITAL ELECTRONICS 9

Boolean algebra, Logic Gates, Half and Full adders, Decoder, Encoder, Multiplexer, Demultiplexer, Flip flops- JK, RS, T, D- construction, Truth table, Characteristic equation, Digital to Analog converters, Analog to Digital converters.

UNIT IV INTEGRATED CIRCUITS 9

Evolution and Inventors of Integrated Circuits — Structure, Scale/Level, Classification, Surface Mount Devices and Surface Mount Technology, Printed Circuit Boards, Semiconductor Manufacturing Case Study.

UNIT V ELECTRONICS SYSTEMS 9

Tsunami Warning System — Detection (Seismometer), Data processing and Management, Alert Signal & Messaging, E Nose - Detection (Chemical Sensors), Data processing and Classification, Agriculture Robots — Detection (Navigation, Soil and Crop Sensors), Processing, and Actuation. Automotive electronics — Engine Control, Braking, Driver Assistance, Navigation, Safety and Communication Systems- Video Illustrations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Identify electronics components required for electronic based systems.

CO2: Comprehend basic electronic devices working.

CO3: Explore to design digital electronic systems.

CO4: Gain knowledge on design and fabrication of

CO5: Analyze sensor based electronics applications.

TEXT BOOKS:

1. Malvino, 'Electronic Principles', McGraw Book Co., 1993.
2. Robert L.Boylestad, Louis Nashelsky, " Electronic devices and circuit theory", Pearson education, Eleventh edition, 2015

REFERENCE BOOKS:

1. Grob. B and Schultz. M.E. 'Basic Electronics', Tata Mcgraw Hill, 2003.
2. Thomas L. Floyd, 'Electronics Devices', Pearson Education, 2002.
3. Thomas L. Floyd, 'Digital Fundamentals', Pearson Education, 2003.
4. Millman, Halkias Jacob, Jit Christos and Satyabrata, 'Electronic devices and Circuits', Tata McGraw Hill, 4th Edition, 2015
5. V. R. Deo, Electronic Components and Applications, Ane Books Pvt. Ltd. 2012
6. www.semiconductors.org/main/resources
7. www. technav.ieee.org/tag/5783/electronic-noses
8. www.tsunami.noaa.gov
9. Make Electronics – Learning by Discovery by Charles Platt, 3rd edition,2021.

ARTICULATION MATRIX:

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

EC23903	WIRELESS TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To provide basic understanding about wired and wireless communication.
- To have an exposure to Internet of Things and applications.
- To know the basic wireless network security.
- To get exposed to antenna systems.
- To understand various satellite communication.

UNIT I FUNDAMENTALS OF COMMUNICATION 9

Basics of Communication, Spectrum - FCC, Transceiver design and its Components, Wired and wireless communication. Modulation techniques, OSI Layers, TCP/IP Protocols 1G to 5G developments; 3G, 4G and 5G cell architecture.

UNIT II INTERNET OF THINGS 9

Introduction, IoT- Architecture, IEEE 802.15.4, M2M and IoT Protocols, SCADA and RFID Protocols, Architecture and Applications - Bluetooth, Zigbee, LORA, 6LOWPAN, Wi-Fi, WIMAX.

UNIT III WIRELESS NETWORK SECURITY 9

Cryptography, Integrity, Authentication and Key management, Wireless Threats – Hacking 802.11, Eavesdropping, Jamming, Cyber-crimes and awareness – countermeasures, Wireless Security.

UNIT IV ANTENNA SYSTEMS 9

Introduction, Types of Antennas, Radiation Mechanisms and Measurements, Dipole, Monopole, Mobile Phone Antenna, Smart Antennas, RFID antennas, Automotive Antenna, Reconfigurable Antennas, SAR measurements.

UNIT V SATELLITE COMMUNICATION 9

Basic principles, Kepler's law, Types of satellites — LEO, MEO and GEO. Launch Vehicles, Satellite Subsystems and Satellite links, Applications — GPS, Mobile communication and TV broadcast, Navigation systems, Modern Navigation systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Analyze the wired and wireless communication and networks.To be able to Internet of Things for various applications.

CO2: Apply security protocols in Wireless Networks.

CO3: Explore the antenna systems for Wireless Technologies.

CO4: Understand Satellite Communication technologies.

CO5: Analyze the wired and wireless communication and networks.To be able to Internet of Things for various applications.

TEXT BOOKS:

1.John G Proakis, Masoud Salehi, “Communication Systems Engineering” Prentice Hall,1994

2.Oliver Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things- Key applicationsand Protocols”, Wiley 2012.

REFERENCE BOOKS:

1.Dennis Roddy, “Satellite Communication”, 4th Edition, Tata McGraw-Hill, 2009.

2.Behrou A. Forouan, “Data Communication and Networking” 5th Edition, Tata McGraw Hill,2013.

3.Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, VPT, 1 stEdition, 2014.

4.AfifOsseiran,Jose. F.Monserrat and PatrickMarsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.

5.Kasun Maduranga Silva Thotahewa, Jean-Michel Redoute, Mehmet Rasit Yuce, “Ultra Wideband Wireless Body Area Networks”, Springer, 2016.

6.Timothy Pratt and Charles W.Bostain, “Satellite Communications”, John Wiley and Sons,2nd Edition, 2012.

7.M. Richharia, "Satellite Systems for Personal Applications", John Wiley, 2010

8.Balanis. A, “Antenna Theory Analysis and Design”, 3rd edition, John Wiley and sons, NewYork, 1982.

9.William Stallings, “Cryptography & Network Security - Principles and Practices” Pearson Education, 4th Edition, 2006.

ARTICULATION MATRIX:

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

EC23904 MICROCONTROLLER PROGRAMMING L T P C

3 0 0 3

COURSE OBJECTIVES :

- To study different microcontroller internal architectures.
- To learn the assembly language and C programming - microcontrollers.
- To learn the interfacing concepts in microcontrollers.
- To design a microcontroller system with different basic hardware.
- To program the microcontroller for real time applications – case study.

UNIT I INTRODUCTION TO 8051 MICRO CONTROLLER 9

Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, Interrupts, Timer/Counter and Serial Communication, Programming in Assembly language.

UNIT II INTRODUCTION TO PIC MICROCONTROLLER 9

PIC microcontroller Architecture - Memory - Parallel ports - Interrupts - Timers/Counters - UART-A/D converter – PW, Programming in Assembly language.

UNIT III PROGRAMMING WITH C 9

Introduction to C - Microchip MPLAB IDE - CCS PCM C compiler - Proteus VSM - Microchip PICDEM Mechatronics board, case study.

UNIT IV APPLICATIONS OF 8051 9

Human interface from switches to keypads - LED displays - LCD - interfacing to the physical world- simple sensors: micro switch, Light-dependent resistors, Optical object sensing, opto-sensor applied as a shaft encoder, Ultrasonic object sensor - Actuators: DC and stepper motors - Interfacing to actuators, case study.

UNIT V APPLICATIONS OF PIC MICROCONTROLLERS 9

LED Chasing circuit - Four digit LED Display interface, Interrupt driven event counter with 4-digit LED display - Simple Buzzer interface, Speaker interface - Electronic Siren - Interfacing Digital temperature sensor - Analog temperature sensor IC with A/D converter, case study.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Know the internal architecture of the 8051 microcontrollers.

CO2: Know the internal architecture of the PIC microcontrollers.

CO3: Program in assembly and C with microcontrollers.

CO4: Understand the basic hardware interfacing with microcontroller system.

CO5: Find effective solutions to a wide range of real-world microcontroller applications.

TEXT BOOKS:

1. Muhammad Ali Mazidi and Janice GilliMazidi, The 8051 Micro Controller and Embedded Systems', Pearson Education, 5th Indian reprint, 2007.
2. Martin P.Bates, Programming 8-bit PIC Microcontrollers in C with interactive hardware simulation, Newnes Press, 2008.

REFERENCE BOOKS:

1. Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers Principles and applications, Newnes, Elsevier, 2007.
2. Milan Verle, PIC Microcontrollers – Programming In C, Mikro Elektronika, 2009.
3. Lambert M. Surhone, Miriam T. Timpledon, Susan F. Marseken, Proteus (DesignSoftware), VDM Publishing, 2010
4. Hubert Henry Ward, C Programming for the PIC Microcontroller: Demystify Coding with Embedded Programming, Apress; 1st ed. Edition, December 2019.
5. Dogan Ibrahim, Microcontroller Projects in C for the 8051, Newnes, 2000.

ARTICULATION MATRIX:

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

EC23905	CONSUMER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field Effect Transistors, Power control devices etc.,
- To know about the working principle of LED, LCD and other Opto-electronic devices.
- To introduce the concept of Sensors and voice controls.
- To provide the knowledge on Smart home devices.
- To gain knowledge on current communication technology.

UNIT I CONSUMER ELECTRONICS FUNDAMENTALS 9

History of Electronic Devices- Vacuum Tubes, Transistors, Integrated Circuits- Moorse Law, Semiconductor Devices, Diodes, Rectifiers, Transistors, Logic Gates, Combinational Circuits, ADC,DAC and Microprocessors, Microprocessor Vs Microcontrollers, Microcontrollers in consumer electronics, Energy management, Intelligent Building Perspective.

UNIT II ENTERTAINMENT ELECTRONICS 9

Audio systems: Construction and working principle of: Microphone, Loud speaker, AM and FM receiver, stereo, Home theatre. Display systems: CRT, LCD, LED and Graphics displays Video Players: DVD and Blue RAY. Recording Systems: Digital Cameras and Camcorders.

UNIT III SMART HOME - SENSORS 9

Technology involved in Smart home, Home Virtual Assistants- Alexa and Google Home. Home Security Systems - Intruder Detection, Automated blinds, Motion Sensors, Thermal Sensors and Image Sensors, PIR, IR and Water Level Sensors.

UNIT IV HOME APPLIANCES 9

Home Enablement Systems: RFID Home, Lighting control, Automatic Cleaning Robots, Washing Machines, Kitchen Electronics- Microwave, Dishwasher, Induction Stoves, Smart Refrigerators, Smart alarms, Smart toilet, Smart floor, Smart locks.

UNIT V INTRODUCTION TO SMART OS AND COMMUNICATION 9

Introduction to Smart OS- Android and iOS. Video Conferencing Systems- Web/IP Camera, Video security, Internet Enabled Systems, Wi-Fi, IoT, Li-Fi, GPS and Tracking Systems. Cordless Telephones, Fax Machines, PDAs- Tablets, Smart Phones and Smart Watches.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Fundamental knowledge of electronic devices.

CO2: Fundamental knowledge of entertainment electronic systems.

CO3: Gained knowledge on sensors and controls.

CO4: Operational knowledge on home applications.

CO5: Introductory knowledge on recent trends in communication systems.

TEXT BOOKS:

1. Thomas L Floyd "Electronic Devices" 10th Edition Pearson Education Asia 2018.
2. Philp Hoff "Consumer Electronics for Engineers" - Cambridge University Press.1998.

REFERENCE BOOKS:

1. Jordan Frith, " Smartphones as Locative Media ", Wiley. 2014.
2. Dennis C Brewer, " Home Automation", Que Publishing 2013.
3. Thomas M. Coughlin, "Digital Storage in Consumer Electronics", Elsevier and Newness 2012.
4. Nick vandome, Smart homes in easy steps, - Master smart technology for your home 2018.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1					1		1		1
CO2	1	2	1					1		1		1
CO3	2	2	1					1		1		1
CO4	2	2	1					1		1		1
CO5	2	2	1					1		1		1

EC23906 PRINCIPLES OF MODERN COMMUNICATION SYSTEM L T P C

3 0 0 3

COURSE OBJECTIVES :

- To introduce the relevance of this course to the existing technology with a futuristic visionalong with socio-economic impact and issues
- To understand the design of a cellular system
- To study the characteristic of wireless channel
- To enable the student to understand the necessity for satellite based communication, the essential elements involved and the transmission methodologies.
- To enable the student to understand the role of radar systems as navigational and landingaid.

UNIT I FUNDAMENTALS OF COMMUNICATION 9

The evolution of electronic communication: From smoke signals to smart phones - History of communications: Theoretical Foundations, Development & Applications - Frequencies for communication - Frequency regulations - Overview of communication transmitter and receiver.

UNIT II CELLULAR COMMUNICATION 9

Mobile Cellular Communications: Evolution to cellular networks – Cellular systems generations and standards: 1G, 2G, 3G, 4G - Cellular network components - Components of a mobile phone — setting up a call process - Making a call process - Receiving a call process - Spectrum allocation: Policies and strategies, Role of TRAI.

UNIT III WIRELESS COMMUNICATION 9

Wireless Communication: Introduction - Bluetooth - Infrared communication - IEEE Wireless LANs (Wi-Fi) - IEEE 802.16 (WiMAX) - Future mobile and wireless networks: Introduction to 5G- device to device communication- IoT.

UNIT IV SATILLITE COMMUNICATION 9

Satellite: History of Satellite communication, Basics of Satellites, Types of Satellites, Capacity Allocation - Launch Vehicles and Orbits: Introduction to launching vehicles, Important Orbits,working of rocket, Three Pioneers of Rocketry - Basics of Global Positioning System (GPS) - Applications of GPS.

UNIT V INTRODUCTION TO RADAR AND NAVIGATION 9

RADAR & NAVIGATION: Introduction, Radar Block diagram and Operation, Radar Frequencies, Applications of Radar. Navigation Systems: Introduction & methods of navigation, Instrument Landing System, Microwave landing system- Modern Navigation systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to comprehend and appreciate the significance and role of this course in the presentcontemporary world.

CO2: The student would be capable of designing a cellular system based on resource availabilityand traffic demands.

CO3: The student would be capable of characterizing a wireless channel and evolve the systemdesign specifications.

CO4: The student would be able to demonstrate an understanding of the basic principles of satellite orbits and the communication system components.

CO5: The student would be able to demonstrate an understanding of the basic principles of radardesign and identify suitable navigation systems.

TEXT BOOKS:

1. S. Haykin, “Communication Systems”, 4ed, John Wiley 2007
2. Rappaport Theodore S- “Wireless Communications: Principles and Practice”, 2ed, Pearson Education India, 2010

REFERENCE BOOKS:

1. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 3ed, Oxford University Press,2007
2. Vijay. K.Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers, 2007.
3. Myron Kyton and W.R.Fried “ Avionics Navigtion Systems”, John Wiley & Sons 1997.

ARTICULATION MATRIX:

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

EC23907	COMPUTER VISION AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To provide the basic knowledge on computer vision.
- To understand simple image processing techniques, and algorithms.
- To give an exposure to selected machine learning models.
- To interrelate machine learning concepts and their application in computer vision problems.
- To impart knowledge on different learning algorithms.

UNIT I INTRODUCTION TO COMPUTER VISION 9

Point operators - Linear filtering – neighborhood operators - Feature detection and matching

UNIT II SEGMENTATION 9

Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods

UNIT III MOTION ESTIMATION 9

Translational alignment - Parametric motion - Optical flow - Object detection - Face recognition-Instance recognition -Category recognition - Context and scene understanding

UNIT IV MACHINE LEARNING MODELS 9

Types - Supervised and Unsupervised - Parametric and non-parametric models - discrete and continuous distributions - Generative models for discrete data - Gaussian models

UNIT V LEARNING ALGORITHMS 9

Decision Trees - Multilayer Perceptrons - Kernel Machines - hidden Markov models - Deeplearning - Applications of deep networks

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Comprehend and appreciate the ‘significance and role’ of this course in the present contemporary world.

CO2: Explore the main challenges behind selected contemporary image processing and computer vision problems.

CO3: Demonstrate the principles and applications of contemporary machine learning techniques.

CO4: Implement machine learning algorithms on image and video-related problems.

CO5: Ability to design and develop systems using learning models and algorithms.

TEXT BOOKS:

1. Richard Szeliski , 'Computer Vision: Algorithms and Applications' Springer, 2011.
2. Kevin P. Murphy 'Machine Learning - A Probabilistic Perspective', The MIT Press Cambridge, Massachusetts, London, England, 2012.

REFERENCE BOOKS:

1. Ethem Alpaydın , 'Introduction to Machine Learning' The MIT Press Cambridge, Massachusetts London, England, II Edition , 2010
2. Simon J.D. Prince, "Computer Vision: Models, Learning, and Inference",Cambridge University Press 2012.
3. Forsyth and Ponce, 'Computer Vision: A Modern Approach' Pearson India, 2015.
4. Amin Ahmadi Tazehkandi, 'Hands-On Algorithms For Computer Vision : Learn How To Use The Best And Most Practical Computer Vision Algorithms' Packt Publishing Limited, 2018.

ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		1			1		1		
CO2	2	2	1		1			1		1		
CO3	2	2	2		1			1		1		
CO4	1	1	1		1			1		1		
CO5	1	2	2		1			1		1		

EC23908	ROBOTICS AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To introduce basic robotic terminologies
- To illustrate kinematics and path planning
- To illustrate various parts of robots
- To impart knowledge on machine vision systems
- To apply robot based concepts for automation.

UNIT I INTRODUCTION TO ROBOTS 9

Introduction – Robotics -Definition and origin of robotics –components and structure of robots- different types of robot — various generations of robots — degrees of freedom — Robot classifications and specifications – Spatial descriptions and transformations

UNIT II KINEMATICS OF ROBOTS 9

Link Description - Link-Connection Description - Convention for Affixing Frames To Links - Manipulator Kinematics- Actuator Space-Joint Space And Cartesian Space, Solvability, Algebraic Vs. Geometric, Jacobians, Singularities, Static Forces In Manipulators- Case Studies: Kinematics Of Two Industrial Robots, Inverse Manipulator Kinematics.

UNIT III SENSORS AND ACTUATION SYSTEMS OF ROBOTS 9

Position sensors — optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors — Contact, non-contact, Range Sensing, touch and Slip Sensors, Force and Torque Sensors. Robot Control through Vision sensors, Robot vision locating position, Robot guidance with vision system, End effector camera Sensor. Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

UNIT IV ARTIFICIAL INTELLIGENCE IN ROBOTICS 9

AI introduction, Intelligent Agent - Types of Agents, Agent environment, Problem solving- search algorithms, Examples of Al - Healthcare, Education, Agriculture, Defense

UNIT V APPLICATIONS OF ROBOTICS 9

Telepresence robot, Autonomous mobile robots, Walker Robots, Solar-ball Robot, Underwater bots, Aerobots, Advanced robotics in Space - Specific features of space robotics systems - Next generation robots.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course student will be able to

CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world.

CO2: Understand kinematics of robotic systems

CO3: Integrate mechanical and electrical hardware for a real prototype of robotic device.

CO4: Develop system for industrial automation.

CO5: Provide automatic solution for replacing humans in life threatening area

TEXT BOOKS:

1. “Introduction to Robotics: Mechanics and control “ J. Craig , Pearson,2008
2. Fu K.S. Gonzaleaz R.C. and Lee C.S.G., "Robotics Control Sensing, Vision and Intelligence",McGraw Hill, International Editions, 1987.

REFERENCE BOOKS:

1. “Robotics Engineering“, R. Klafter, PHI learning, 2009
2. John M. Holland, "Designing Autonomous Mobile Robots-Inside the mind of an Intelligent Machine", Newnes Publication, 2004.
3. “Robot : Dynamics and Control”, Spong&Vidyasagar, McGraw Hill 2008.
4. Matthew T. Mason , “Mechanics of Robotic Manipulation (Intelligent Robotics and Autonomous Agents)” , MIT press 2022.
5. Frank Chongwoo Park and Kevin Lynch, “Modern Robotics: Mechanics, Planning, and Control” Cambridge university press, 2017

ARTICULATION MATRIX:

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CO1	3	2	1					1		1		
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CO3	2	2	1					1		1		
CO4	1	2	2					1		1		
CO5	1	3	2					1		1		