GOVERNMENT COLLEGE OF ENGINEERING

SALEM - 636 011

(An Autonomous Institution Affiliated to

Anna University, Chennai)

REGULATIONS 2022

CURRICULAM AND SYLLABUS

(For Candidates admitted from 2022 - 2023 onwards)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

(FULL TIME PROGRAMME)

Rough Draft

VISION

Strive continuously to develop Excellence in Technical Education and Research by producing technically competent Electronics and Communication Engineers to meet the growing demands of technology and socioeconomic needs.

MISSION

- To foster and achieve unmatched excellence in Electronics and Communication Engineering Domain.
- To pursue continuous improvement in infrastructure and state-of-the art laboratories.
- To establish and set best teaching and learning standards among top grade Engineering Departments across the nation.
- To encourage learning, research, creativity, innovation and professional activity by offering ambience and support.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO'S)

- **PEO 1:**The graduates will utilize their expertise in Engineering to solve industry's technological problems.
- **PEO 2**:Analyze real life problems, design appropriate system to provide solutions that are technically sound, economically feasible and socially acceptable.
- **PEO 3**:Exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning.

PROGRAM OUTCOMES(PO'S)

- **PO 1**:An ability to apply knowledge of Mathematics, Science, and Engineering in the Electronic and Communication Engineering.
- **PO 2**:An ability to design and conduct experiments, as well as to analyze and interpret data.
- **PO 3**:An ability to design a System, or Process to meet desired needs within realistic constraints such as Economic, Environmental, Social, Ethical, Health care and Safety, Manufacturability, and Sustainability.
- **PO 4**:An ability to identify, formulate and solve complex problems in the area of Electronics and Communication Engineering.
- **PO 5**:An ability to use the techniques, skills, and modern Engineering tools necessary for Engineering practice.
- **PO 6**:Knowledge of contemporary issues relevant to professional Engineering practice.

- **PO 7**:The broad education necessary to understand the impact of Engineering solutions in Global, Economic, Environmental and Social context.
- **PO 8**:An understanding of Professional and Ethical responsibility.
- **PO 9**:An ability to function on multidisciplinary teams.
- **PO 10**:An ability to communicate effectively.
- **PO 11**:Recognition of the need for, and an ability to engage in research and to involve in life-long learning.
- **PO 12**:An ability to work as a leader in a team, to manage projects in Multidisciplinary Environments.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To analyse, design and develop solutions for the real time problems and to apply the technical Knowledge for developing quality products for Electronics and Communication based Industry.

PSO2: To adapt to emerging Information and Communication technologies and to develop innovative ideas and solutions in RF & Communication, Networking, Embedded Systems, and VLSI.

PSO3: An ability to make use of acquired technical knowledge to get employed in the field of Electronics and Communication and also to become successful Entrepreneur.

GOVERNMENT COLLEGE OF ENGINEERING, SALEM – 636 011.
B.E – ELECTRONICS AND COMMUNICATION ENGINEERING (FULL TIME)

SEMESTER I											
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**				**Max. Marks**			
				L	**T**	**P**	**C**	**CA**	**FE**	**Total**	
1	22MC101	Induction Program	MC	-	-	-	0	-	-	-	
THEORY											
2	22EN101	Communicative English (Theory cum Practical)	HS	2	0	2	3	50	50	100	
3	22MA101	Matrices, Calculus and Ordinary Differential Equations	BS	3	1	0	4	40	60	100	
4	22PH102	Material Science for Engineering	BS	2	1	0	3	40	60	100	
5	22CY101	Engineering Chemistry	BS	3	1	0	4	40	60	100	
6	22CS101	Problem Solving and C Programming	ES	3	0	0	3	40	60	100	
7	22MC102	Heritage of Tamil/ தமிழர் மரபு	HS MC	1	0	0	1	100	-	100	
PRACTICAL											
8	22CS102	Computer Practice and C Programming Laboratory	ES	0	0	3	1.5	60	40	100	
9	22ME102	Workshop Manufacturing Practices	ES	0	0	4	2	60	40	100	
TOTAL				14	3	9	**21.5**	430	370	800	

SEMESTER II										
S. No.	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**				**Max. Marks**		
				L	**T**	**P**	**C**	**CA**	**FE**	**Total**
THEORY										
1	22MA203	Linear Algebra, Partial Differential Equation Vector Calculus	BS	3	1	0	4	40	60	100
2	22PH201	Physics- Electromagnetism	BS	2	1	0	3	40	60	100
3	22HS201	Universal Human Values	HS	2	1	0	3	40	60	100
4	22EE201	Principles of Electrical Engineering	ES	3	0	0	4	40	60	100
5	22ME101	Engineering Graphics & Design	ES	1	0	4	3	40	60	100
6	22MCIN01	Engineering Sprints	EE	0	0	2	1	100	-	100
7	22MC201	Tamizhars and Technology/ தமிழரும்தொழில் நுட்பமும்	HS MC	1	0	0	1	100	-	100
8	22NC201	NCC COURSE – I (only for NCC Students)	NC	3	0	0	3	40	60	100
PRACTICAL										
9	22EN102	Professional Skills Laboratory	HS	0	0	2	1	60	40	100
10	22PH103	Physics Laboratory	BS	0	0	3	1.5	60	40	100
11	22CY102	Chemistry Laboratory	BS	0	0	3	1.5	60	40	100
12	22EE202	Principles of Electrical Engineering Laboratory	ES	0	0	3	1.5	60	40	100
TOTAL				15	3	17	**24.5**	680	520	1100

***NCC credit course level I is offered for NCC students only. The grades earned by the students will be recorded in the Mark sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER III											
S. No.	Course Code	Course Title	Cat.	Hours / Week				Max. Marks		
				L	T	P	C	CA	FE	Total
THEORY											
1	22MA304	Fourier Series, Complex Variables and Transforms	BS	3	1	0	4	40	60	100
2	22EC301	Semiconductor Devices and Circuits	PC	3	0	0	3	40	60	100
3	22EC302	Digital System Design	PC	3	0	0	3	40	60	100
4	22EC303	Network Theory and Synthesis	PC	3	0	0	3	40	60	100
5	22EC304	Transmission Lines and Waveguides	PC	3	0		3	40	60	100
6	22EC305	Analog Communication	PC	3	0	0	3	40	60	100
7	22MC301	Indian Constitution	MC	2	0	0	0	100	-	100
8	22MCIN02	Innovation Sprint	EE	0	0	2	1	100	-	100
9	22NC301	NCC Course – II(Only for NCC Students)	NC	3	0	0	3*	40	60	100
PRACTICAL										
10	22EC306	Semiconductor Devices and Circuits Laboratory	PC	0	0	4	2	60	40	100
11	22EC307	Digital System Design Laboratory	PC	0	0	4	2	60	40	100
TOTAL				20	1	10	**24**	560	440	1100

SEMESTER IV										
S. No.	Course Code	Course Title	Cat.	Hours / Week				Max. Marks		
				L	T	P	C	CA	FE	Total
THEORY										
1	22MA402	Probability and Stochastic Process	BS	3	1	0	4	40	60	100
2	22EC401	Analog Circuits	PC	3	0	0	3	40	60	100
3	22EC402	Microprocessors and Microcontrollers	PC	3	0	0	3	40	60	100
4	22EC403	Signals and Systems	PC	3	0	0	3	40	60	100
5	22EC404	Control Systems	PC	3	0	0	3	40	60	100
6	22EC405	Antenna and Wave Propagation	PC	3	0	0	3	40	60	100
7	22MCIN03	Design Sprint	EE	0	0	2	1	100	-	100
8	22CYMC01	Environmental Science	MC	2	-	1	0	100	-	100
PRACTICAL										
9	22EN401	Placement and Soft skills Laboratory	HS	0	0	4	2	60	40	100
10	22EC406	Analog Circuits Laboratory	PC	0	0	4	2	60	40	100
11	22EC407	Microprocessors and Microcontrollers Laboratory	PC	0	0	4	2	60	40	100
TOTAL				20	1	15	**26**	620	480	1100

*NCC credit course level II is offered for NCC students only. The grades earned by the students will be recorded in the Mark sheet, however the same shall not be considered for the computation of CGPA

SEMESTER V										
S. No.	Course Code	Course Title	Cat.	Hours / Week				Max. Marks		
				L	T	P	C	CA	FE	Total
THEORY										
1	22EC501	Digital Communication	PC	3	0	0	3	40	60	100
2	22EC502	Digital Signal Processing	PC	3	0	0	3	40	60	100
3	22EC503	Embedded Systems	PC	3	0	0	3	40	60	100
4	22EC504	Principles of Management	PC	3	0	0	3	40	60	100
5	22__OExx	Open Elective -1	OE	3	0	0	3	40	60	100
6	22MCIN04	Ideation Sprint	EE	0	0	2	1	100	-	100
PRACTICAL										
7	22EC505	Communication Systems Laboratory	PC	0	0	4	2	60	40	100
8	22EC506	Digital Signal Processing Laboratory	PC	0	0	4	2	60	40	100
TOTAL				15		10	**20**	420	380	800

SEMESTER VI (Regular Stream)										
S. No.	Course Code	Course Title	Cat.	Hours / Week				Max. Marks		
				L	T	P	C	CA	FE	Total
THEORY										
1	22ECPE6xx	Professional Elective – 1	PE	3	0	0	3	40	60	100
2	22ECPE6xx	Professional Elective – 2	PE	3	0	0	3	40	60	100
3	22ECPE6xx	Professional Elective – 3	PE	3	0	0	3	40	60	100
4	22ECPE6xx	Professional Elective – 4 (Industry based)	PE	3	0	0	3	40	60	100
5	22__Oexx	Open Elective – 2	OE	3	0	0	3	40	60	100
6	22__Oexx	Open Elective -3	OE	3	0	0	3	40	60	100
PRACTICAL										
7	22EC601	Mini Project	EE	0	0	6	3	60	40	100
TOTAL				18	0	6	**21**	300	400	700

SEMESTER VI (Protosem Stream)										
S. No.	Course Code	Course Title	Cat.	Hours / Week				Max. Marks		
				L	T	P	C	CA	FE	Total
THEORY										
1	22IPPS11	Applied Design Thinking	EE	2	0	2	3	100	-	100
2	22IPPS12	Start- up Fundamentals	EE	2	0	2	3	100	-	100
3	22IPPS13	Computational Hardware	EE	2	0	2	3	100	-	100
4	22IPPS14	Coding for Innovators	EE	2	0	2	3	100	-	100
5	22IPPS15	Industrial Design & Rapid Prototyping Techniques	EE	2	0	2	3	100	-	100
6	22IPPS16	Industrial Automation	EE	2	0	2	3	100	-	100
7	22IPPS17	Robotics	EE	2	0	2	3	100	-	100

TOTAL				14	0	14	**21**	700	-	700
SEMESTER VII										
S. No	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**				**Max. Marks**		
				L	**T**	**P**	**C**	**CA**	**FE**	**Total**
THEORY										
1	22EC701	VLSI Design	PC	3	0	0	3	40	60	100
2	22EC702	Optical and Microwave Engineering	PC	3	0	0	3	40	60	100
3	22EC703	Wireless and Mobile Communication	PC	3	0	0	3	40	60	100
4	22__OExx	Open Elective – 4	OE	3	0	0	3	40	60	100
PRACTICAL										
5	22EC704	Optical and Microwave Engineering Laboratory	PC	0	0	4	2	60	40	100
6	22EC705	VLSI Design and Embedded Systems Laboratory	PC	0	0	4	2	60	40	100
TOTAL				12	0	8	**16**	280	320	600
SEMESTER VIII										
S. No	**Course Code**	**Course Title**	**Cat.**	**Hours / Week**				**Max. Marks**		
				L	**T**	**P**	**C**	**CA**	**FE**	**Total**
THEORY										
1	22ECPE8xx	Professional Elective - 5	PE	3	0	0	3	40	60	100
2	22ECPE8xx	Professional Elective - 6	PE	3	0	0	3	40	60	100
PRACTICAL										
3	22EC801	Project Work	EE	0	0	20	7	120	80	200
TOTAL				6	0	20	**13**	200	200	400

Electronics and Communication Engineering Scheme of Credits:163

SUMMARY

Course component	Credits Per Semester								Total Credits
	I	II	III	IV	V	VI	VII	VIII	
HS	3	4		2					9
ES	6.5	7.5							14
BS	11	10	4	4					29
PC			19	19	16		13		67
PE						12		6	18
OE					3	6	3		12
EE		1	1	1	1	3		7	14
MC/HSMC									
Total	20.5	22.5	24	26	20	21	16	13	163

Course Category	Credits	Credit %
Humanities and Social Science	9	5.52
Basic Science	29	17.8
Engineering Science	14	8.60
Program Core	64	39.26
Professional Electives	18	11.04
Open Electives	12	7.36
EEC	17	10.42
Mandatory Courses (Zero Credit)	-	-
	163	100

HS	Humanities and Social Science
BS	Basic Science
ES	Engineering Science
PC	Program Core
PE	Program Elective
OE	Open Elective
EEC	Project Work

PROFESSIONAL ELECTIVES (PE)

S.No	Course Code	Course Title	Cat.	Hours/Week				Max.Marks		
				L	T	P	C	CA	FE	Total
1.	22ECPE601	Electronic Measurements	PE	3	0	0	3	40	60	100
2.	22ECPE602	Computer Architecture	PE	3	0	0	3	40	60	100
3.	22ECPE603	Digital Image Processing	PE	3	0	0	3	40	60	100
4.	22ECPE604	Machine Learning	PE	3	0	0	3	40	60	100
5.	22ECPE605	Modern Sensors and its Applications	PE	3	0	0	3	40	60	100
6.	22ECPE606	Radar Communication	PE	3	0	0	3	40	60	100
7.	22ECPE607	Internet of Things	PE	3	0	0	3	40	60	100
8.	22ECPE608	Computer Networks	PE	3	0	0	3	40	60	100
9.	22ECPE609	Software Defined Radio	PE	3	0	0	3	40	60	100
10.	22ECPE610	High Speed Networks	PE	3	0	0	3	40	60	100
11.	22ECPE611	Robotics	PE	3	0	0	3	40	60	100
12.	22ECPE612	Virtual Instrumentation	PE	3	0	0	3	40	60	100
13.	22ECPE613	Automotive Electronics	PE	3	0	0	3	40	60	100
14.	22ECPE614	Embedded C	PE	3	0	0	3	40	60	100
15.	22ECPE615	VLSI Physical Design	PE	3	0	0	3	40	60	100
16.	22ECPE616	RF & EMI/EMC Testing	PE	3	0	0	3	40	60	100
17.	22ECPE801	Multimedia Compression and Communication Techniques	PE	3	0	0	3	40	60	100
18.	22ECPE802	Wireless Sensor Networks	PE	3	0	0	3	40	60	100
19.	22ECPE803	Telecommunication and Switching Networks	PE	3	0	0	3	40	60	100
20.	22ECPE804	Deep Learning	PE	3	0	0	3	40	60	100
21.	22ECPE805	Network Security	PE	3	0	0	3	40	60	100
22.	22ECPE806	Satellite Communication	PE	3	0	0	3	40	60	100
23.	22ECPE807	Bio Medical Electronics	PE	3	0	0	3	40	60	100
24.	22ECPE808	Cognitive Radio	PE	3	0	0	3	40	60	100

Open Elective (OE)										
1	22ECOE01	Fundamentals of Electron Devices	OE	3	0	0	3	40	60	100
2	22ECOE02	Principles of Modern Communication Systems	OE	3	0	0	3	40	60	100
3	22ECOE03	Microcontrollers and its applications	OE	3	0	0	3	40	60	100
4	22ECOE04	Computer Networks	OE	3	0	0	3	40	60	100
5	22ECOE05	Basics of Embedded Systems	OE	3	0	0	3	40	60	100
6	22ECOE06	Basics of Internet of Things	OE	3	0	0	3	40	60	100
7	22ECOE07	Artificial Intelligence and Machine Learning	OE	3	0	0	3	40	60	100

ELECTRONICS AND COMMUNICATION ENGINEERING- FULL TIME

REGULATION 2022 – SYLLABUS

SEMESTER-I

<table>
<tr><td>22MC101</td><td colspan="2">INDUCTION PROGRAM</td><td colspan="2">Semester</td><td>I</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Category</td><td>MC</td><td colspan="2">Credit</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2"></td><td rowspan="2">Hours/Week</td><td>L</td><td>T</td><td>P</td><td>TH</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="7">INDUCTION PROGRAM (MANDATORY) - 3 WEEKS DURATION</td></tr>
<tr><td colspan="7">LIST OF EXPERIMENTS
● Physical activity.
● Creative Arts.
● Universal Human Values.
● Literary.
● Proficiency Modules.
● Lectures by Eminent People.
● Visits to local Areas.
● Familiarization to Dept./Branch & Innovations.</td></tr>
<tr><td colspan="7">Total = 21 Days</td></tr>
</table>

22EN101	COMMUNICATIVE ENGLISH		SEMESTER			I
PREREQUISTIES		**CATEGORY**	**HS**	**Credit**		**3**
Basic language skills listening, speaking, reading and writing		**Hours/Week**	**L**	**T**	**P**	**TH**
			2	**0**	**2**	**4**

COURSE OBJECTIVES

1.	To develop the communicative skills of learners by engaging them in reading, writing and grammar learning activities
2.	To inculcate learners' ability to read texts, summaries, articles and user manuals
3.	To assist learners to acquire writing skills for academic, social and professional purposes
4.	To improve learners' vocabulary and grammar to supplement their language use at different contexts

UNIT I		**6**	**0**	**6**	**12**

Listening – Interview with personal assistant, An interview with a business consultant, Describing changes in a company, Describing dimensions of products.

Speaking - Self-introduction, name, home background, study details, area of interest, hobbies, strengths and weaknesses, etc.

Reading - Reading for detailed comprehension, specific information, Understanding notices, messages, timetables, graphs relevant to technical contexts.

Writing – Dialogue writing in a business context.

Grammar - Parts of speech, Tenses, Voices, Common errors in English, Subject-Verb agreement, Noun-Pronoun agreement, Prepositions and Articles.

UNIT II		**6**	**0**	**6**	**12**

Listening – An interview about a production process, Telephone conversations, Making and changing appointments, Description of how a product is advertised.

Speaking - Personal interview, dress code, body language, required skills, corporate culture and mock interview.

Reading - Reading technical texts from journals, newspapers and technical blogs.

Writing - Writing checklists, Recommendations.

Grammar - Prefix and suffix, Synonyms, Antonyms, Verb forms - Auxiliary verbs, Modal verbs, Phrasal verbs, Pronouns, Adverbs and Adjectives.

UNIT III		**6**	**0**	**6**	**12**

Listening - Conversation between two employees, Interview about change in job and corporate gift giving, Creating good teams: a presentation.

Speaking - Role play - examiner and candidate, customer and sales manager, team leader and team member, interviewer and applicant, industrialist and candidate.

Reading - Reading advertisements, gadget reviews, user manuals.

Writing - Providing instruction, Writing E-mails - Attending workshops, Paper submission for seminars and conferences, Arranging and cancelling a meeting.

Grammar - Conditional statements, Redundancies, Collocations and Meanings of individual words.

UNIT IV		6	0	6	12

Listening – Working in an international team, Statistical information, Interview with investor relations, Radio interviews.

Speaking – Giving a speech, Describing given data, Discussing company information, Summarizing an article.

Reading - Reading longer technical texts, cause and effect essays, newspaper articles, company profiles.

Writing - Essay writing on social topics, Technical Report Writing – Status reports on projects, Feasibility reports and event reports on seminars, conferences, meeting.

Grammar - Compound words, Conjunctions, Sentence completion, Negation in statements and questions.

UNIT V		6	0	6	12

Listening – An interview with career advisor and recruitment agent, Feedbacks, Meeting extracts.

Speaking – Qualities required for employability, Improving employee productivity, presentation on problem-solving skills, teamwork, creativity and leadership quality.

Reading - Reading brochures, telephone messages, social media messages relevant to technical contexts.

Writing - Letter Writing – Formal Letters and Informal Letters - cover letter with resume, Mind maps, Charts - interpreting statistical data, charts, graphs and tables.

Grammar - One word substitution, Abbreviations and acronyms in technical contexts and technical vocabulary, Idioms.

Total (30L + 30P) = 60 Periods

REFERENCE BOOKS:

1.	Meenakshi Raman and Sangeeta Sharma. Professional English. Oxford University Press, New Delhi, 2019.
2.	Krishna Mohan, Meera Bannerji. Developing Communication Skills. Macmillan India Ltd, Delhi, 1990.
3.	Sanjay Kumar, Pushp Lata. English Language and Communication Skills for Engineers. Oxford University Press, 2018.

E-RESOURCES:

1.	https://learnenglish.britishcouncil.org/
2.	https://www.bbc.co.uk/learningenglish

COURSE OUTCOMES: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	comprehend the main ideas, key details and inferred meanings of technical texts	L2: Understanding
CO2	:	use language effectively at technical and professional contexts	L3: Applying
CO3	:	apply the academic and functional writing skills in formal and informal communicative contexts	L3: Applying
CO4	:	interpret pictorial representation of statistical data and charts	L3: Applying

COURSE ARTICULATION MATRIX															
COs /POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	0	0	0	1	0	0	0	0	1	3	0	1	0	0	1
CO2	0	0	0	1	0	0	0	0	1	3	0	2	0	0	2
CO3	0	0	0	2	0	0	0	0	1	3	0	1	0	0	1
CO4	0	0	0	3	0	0	0	0	1	3	0	1	0	0	1
Avg	0	0	0	1.75	0	0	0	0	1	3	0	1.25	0	0	1.25
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22MA101	MATRICES, CALCULUS AND ORDINARY DIFFERENTIAL EQUATION B.E. (Common to all Branches Except EEE)	SEMESTER	I

PREREQUISITES	Category	BS	Credit		4
Basic 12th level Matrices, Differential Calculus, Integral Calculus and ODE	Hours/Week	L	T	P	TH
		3	1	0	4

Course Learning Objectives

1	To know the use of matrix algebra needed by engineers for practical applications.
2	To understand effectively both the limit definition and rules of differentiation.
3	To familiarize in solving maxima and minima problems in two variables.
4	To obtain the knowledge of multiple integration and their related applications.
5	To obtain the knowledge to solve second order differential equations with constant and variable coefficients.

Unit I	MATRICES	9	3	0	12

System of linear equations – Characteristic equation of a Matrix – Eigenvalues and Eigenvectors – Properties – Cayley-Hamilton theorem (excluding proof) – Diagonalization of Matrices - Reduction of quadratic form to canonical form by orthogonal transformation.

Unit II	DIFFERENTIAL CALCULUS	9	3	0	12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules -Maxima and Minima of the function of a single variable.

Unit III	FUNCTIONS OF SEVERAL VARIABLES	9	3	0	12

Partial derivatives – Euler's theorem for homogeneous functions – Total Derivatives –Jacobians – Maxima, Minima and Saddle point – Method of Lagrangian multipliers – Taylor's series.

Unit IV	MULTIPLE INTEGRALS	9	3	0	12

Multiple integrals- Double integrals – Change of order of integration in double integrals – Change of variables (Cartesian to Polar) – Application to Areas – Evaluation of Triple integrals – Application to volumes.

Unit V	ORDINARY DIFFERENTIAL EQUATIONS	9	3	0	12

Second order linear differential equations with constant and variable coefficients –Cauchy-Euler equation and Cauchy-Legendre's linear equation - Method of variation of parameters –Simultaneous first order linear equations with constant coefficients.

Total (45+15) = 60 Periods

Text Books:

1	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2015.
2	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 3rd Edition, Narosa Publications, New Delhi, 2007.

Reference Books:

1	James Stewart, "Essential Calculus", 2nd edition, Cengage Learning, New Delhi, 2014.

2	P. Kandasamy, K. Thilagavathy and K. Gunavathy," Engineering Mathematics (For I year B.E., B. Tech)", 9th Edition, S. Chand & Co. Ltd. New Delhi, 2010.
3	Srimanta pal and Subath.C. Bhumia, "Engineering Mathematics", Oxford University Publications, New Delhi, 2015.
4	Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2007.
5	Siva Ramakrishna Das.P, Ruknmangadachari.E. "Engineering Mathematics", 2nd Edition, Pearson, Chennai & Delhi, 2013.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Learn the fundamental knowledge of Matrix theory.	Understand
CO2	Use both the limit definition and rules of differentiation to differentiable functions.	Apply
CO3	Apply differentiation to solve maxima and minima problems.	Apply
CO4	Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to a change of order and change of variables.	Apply
CO5	Apply various techniques in solving differential equations.	Apply

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO2	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO3	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO4	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO5	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
Avg	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PH102	MATERIALS SCIENCE FOR ENGINEERING	Semester			I
PREREQUISITES	Category	BS	Credit		3
Basic knowledge in electrical and thermal conductivity	Hours/Week	L	T	P	TH
		2	1	0	3

Course Learning Objectives

1	To introduce the theory of conducting materials and Fermi distribution function.
2	To give the basic ideas of semiconductors and its Fermi level.
3	To give an overview of Dielectric polarization, dielectric losses and application of dielectrics.
4	To insight into the magnetic nature of materials, superconductors and their applications.

UNIT I	CONDUCTING MATERIALS	6	3	0	9

Conduction in metals - mobility and conductivity – Classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann Franz law – Lorentz number – drawbacks of classical free electron theory – Quantum theory – Fermi distribution function - Effect of temperature on Fermi function – Density of states – Carrier concentration in metals – Band theory of solids - distinction between conductors, semiconductors and insulators

UNIT II	SEMICONDUCTING MATERIALS	6	3	0	9

Properties of semiconductor - Bonds in semiconductors - Intrinsic semiconductors - Extrinsic semiconductors - N-type and P-type semiconductors – Carrier concentration in intrinsic semiconductors(derivation) –Electrical conductivity and band gap determination in intrinsic semiconductors - Carrier concentration in N-type semiconductor(derivation) –- variation of Fermi level with temperature and doping concentration – Compound semiconductors –Direct and indirect band gap semiconductors - Hall effect - Determination of Hall coefficient – Applications

UNIT III	DIELECTRIC MATERIALS	6	3	0	9

Electrical susceptibility – Dielectric constant – Dielectric polarization – Electronic , Ionic, Orientational and Space charge polarization – frequency and temperature dependence of polarization – Internal field – Clausius – Mossotti relation (derivation) – dielectric loss – dielectric breakdown – Uses of dielectric materials (capacitor and transformer)-Polymeric dielectric materials.

UNIT IV	MAGNETIC AND SUPERCONDUCTING MATERIALS	6	3	0	9

Magnetic materials: Origin of magnetic moment – Bohr magneton – Dia, Para and Ferro magnetism – Domain theory of ferromagnetism – Hysteresis – Hard and soft magnetic materials – Antiferro magnetism.

Superconductivity:Properties – Type I & Type II superconductors - BCS theory - Applications – magnetic levitation – SQUID.

UNIT V	MODERN ENGINEERING MATERIALS	6	3	0	9

Metallic glasses - Preparation, properties, applications – Shape memory alloys(SMA) – Processing, characterization and applications.

Nanomaterials: Introduction – top down and bottom up approach – synthesis – Ball milling, Plasma arcing and Sol–Gel echnique – properties – applications – Carbon nanotubes – Properties.

Total (30L+15T)= 45 Periods

Text Books:

1	P.K.Palanisamy, ‘Materials Science’, Scitech Publications (India) pvt.ltd. Chennai, Second edition, 2009
2	M. Arumugam, ‘Materials Science’, Anuradha Publications, Kumbakonam, 2018.

3	Rajendran V and Marikani A, 'Materials Science', Tata McGraw Publications, New Delhi, 2012
4	Jayakumar S, 'Materials Science', RK Publishers, Coimbatore, 2011.
Reference Books:	
1	Charles Kittel, 'Introduction to Solid state Physics', John Wiley and Sons, 7th Edition, Singapore, 2019.
2	Charles P. Poole and Frank J. Ownen, 'Introduction to Nanotechnology', Wiley India, 2007.
3	M.S. Vijaya and G. Rangarajan, 'Materials Science', Tata McGraw Hill, New Delhi, 2012.
E-Reference	
1	https://nptel.ac.in/courses/115102025
2	https://nptel.ac.in/courses/115101012

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understanding the concept of conduction in materials and its carrier concentration.	L2: Understanding
CO2	The basics of semiconductor and variation of Fermi level with respect to different parameters.	L1: Remembering
CO3	Analyze the various mechanism involved in dielectric polarization and its applications.	L4: Analyzing
CO4	Applying the concept of superconductor in magnetic levitation and SQUID.	L3: Applying
CO5	Synthesis of modern engineering materials by using various techniques and its properties	L5: Evaluating

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	1	0	0	0	1	0	0	0	0	1	2	2	0
CO2	3	2	1	0	1	1	1	1	0	0	0	2	0	0	1
CO3	3	3	1	0	0	1	1	1	0	0	0	1	1	0	0
CO4	3	3	2	1	2	1	0	0	0	0	0	2	0	2	0
CO5	2	2	2	2	3	1	0	1	0	0	0	2	0	0	2
Avg	**2.8**	**2.4**	**1.4**	**1.5**	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**1.6**	**1.5**	**2**	**1.5**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22CY101	ENGINEERING CHEMISTRY		Semester			I
PREREQUISITES		Category	BS	Credit		4
Basic Chemistry		Hours/Week	L	T	P	TH
			3	1	0	4

Course Learning Objectives

1	Basic Principles of Spectroscopy and their applications.
2	Knowledge of different methods for water analysis and purification & Nanomaterials and its application.
3	Various adsorption techniques and basic knowledge of Phase equilibria.
4	Principles of electrochemistry, electrochemical cells, corrosion, and its control.
5	Basis of polymer preparations and applications and enhancement of the quantity and quality of fuels.

Unit I	SPECTROSCOPIC TECHNIQUES	9	3	0	12

Beer-Lambert's law (problem) -UV visible spectroscopy: Principle, Chromophores, auxochrome, electronic transitions and instrumentation (No applications). IR spectroscopy: Principles -instrumentation and applications of IR in H_2O, and CO_2.

Flame photometry -principle -instrumentation -estimation of sodium by flame photometer. Atomic absorption spectroscopy - principles -instrumentation -estimation of nickel by atomic absorption spectroscopy.

Unit II	WATER TECHNOLOGY AND NANOTECHNOLOGY	9	3	0	12

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water – Reverse Osmosis.

Nano chemistry – preparations and properties of nanomaterials – nanorods – nanowires – nanotubes – carbon nano tubes and their application.

Unit III	SURFACE CHEMISTRY AND PHASE EQUILIBRIA	9	3	0	12

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich ‘s adsorption isotherm – Langmuir‘s adsorption isotherm.

Phase rule: Introduction, definition of terms with examples, one component system -water system – reduced phase rule – thermal analysis and cooling curves – two component systems – lead-silver system – Pattinson process.

Unit IV	ELECTROCHEMISTRY	9	3	0	12

Electrode Potential- Oxidation and Reduction Potentials - Electrochemical series – Significance and application - Electrochemical cell, Cell potential, derivation of Nernst equation for single electrode potential, numerical problems on E, E_0, and E_{cell} - numerical problems.

Electrochemical theory of corrosion with respect to iron. Factors influencing the corrosion rate: physical state of the metal, nature of the metal, area effect, over voltage, pH, temperature, and nature of the corrosion product. Types of corrosion: galvanic series; (i) Differential aeration corrosion- oxygen concentration cell, (ii) Stress corrosion- explanation-caustic embrittlement. Corrosion control by i) Cathodic protection- sacrificial anode and impressed current methods i) Protective coatings-metal coatings- galvanizing and tinning.

Unit V	POLYMERS AND FUELS	9	3	0	12

Polymers – definition – polymerization – types – addition and condensation polymerization – free radical polymerizatio mechanism – plastics, classification – preparation, properties and uses of PVC, Teflon, polycarbonate, polyurethane, nylon-6,6 PET – Rubber- vulcanization of rubber, synthetic rubbers – butyl rubber, SBR – biopolymers – Nylon-2-Nylon-6 and PHBV

Fuels - classification with examples, calorific value-classification (HCV & LCV), determination of calorific value of solid and liquid fuels using Bomb calorimeter- Petroleum cracking -fluidized bed catalytic cracking. Knocking in IC engine, its ill effects and prevention of knocking. Anti-knocking agent: Leaded and unleaded petrol.

	Total (45+15) = 60 Periods

Text Books:	
1	S. S. Dara and S. S. Umare, ―A Textbook of Engineering Chemistry | S. Chand & Company LTD, New Delhi, 2015
2	P. C. Jain and Monika Jain, ―Engineering Chemistry | Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3	S. Vairam, P. Kalyani and Suba Ramesh, ―Engineering Chemistry | Wiley India PVT, LTD, New Delhi, 2013.
Reference Books:	
1	Friedrich Emich, ―Engineering Chemistry | Scientific International PVT, LTD, New Delhi, 2014.
2	Prasanta Rath, ―Engineering Chemistry | Cengage Learning India PVT, LTD, Delhi, 2015.
3	Shikha Agarwal, ― Engineering Chemistry-Fundamentals and Applications | Cambridge University Press, Delhi, 2015.
E- References :	
1	www.onlinecourses.nptel.ac.in/
2	www.ePathshala.nic.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Recall the basic principles of spectroscopy and their applications	Remembrance
CO2	Paraphrase the different methods for water analysis & purification and Nanomaterial & its applications	Understand
CO3	Apply the various adsorption techniques and basic knowledge of Phase equilibria	Apply
CO4	Integrate the principles of electrochemistry, electrochemical cells, corrosion, and its control	Create
CO5	Assess the basis of polymer preparations & applications and enhancement of the quantity & quality of fuels.	Evaluate

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	0	3	0	0	0	0	0	0	0	0	3	1	1
CO2	3	2	0	1	0	2	0	0	0	0	0	0	3	1	1
CO3	3	1	0	1	0	0	0	0	0	0	0	0	2	1	1
CO4	2	1	0	1	0	2	0	0	0	0	0	0	2	3	2
CO5	3	2	0	3	0	2	0	0	0	0	0	0	1	1	1
Avg	2.8	1.8	0	1.8	0	1.2	0	0	0	0	0	0	2.2	1.4	1.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22CS101	PROBLEM SOLVING AND C PROGRAMMING (Common to CSE, ECE, Civil, Mechanical and Metallurgy)	SEMESTER	I

PREREQUISITES	CATEGORY	ES	Credit		3
NIL	Hours/week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	To use general problem-solving techniques to device solutions to problems
2.	To understand the input-output relations of software involved in developing and converting a C program to a executable code.
3.	To provide complete knowledge about the programming concepts of C language.

UNIT I	SYSTEM SOFTWARE,PROBLEM SOLVING, AND C PROGRAMMING	9	0	0	9

High level programming language – Machine level language – Role of system software (Editor, Compiler, Assembler, Linker, Loader, and Operating System) in developing and executing a C program

C Programming: Character Set – Case sensitivity – Identifiers – Keywords –Literals – Data types – Declaration statement– Variables and their associated information– Formatted and unformatted console input-output statements – Type conversion – Operators – Precedence and Associativity – Pre-processor directives (#include and #define) – the main() function.

General problem-solving Techniques: Algorithm – Flow-chart – Pseudocode – Developing solutions for problems involving only operators and writing their equivalent C programs

UNIT II	CONTROL STATEMENTS	9	0	0	9

General problem-solving Techniques: Representing Decision making: if-else statement – switch-case statement – Looping statements: for loop, while loop and do-while loop – Branching statements: break and continue with Algorithm, Flow-chart, and Pseudocode.

C Programming: Decision Making: if-else statement – switch-case statement – Looping statements: for loop, while loop and do-while loop – Branching statements: break and continue – Nesting

Developing solutions for problems involving control statements using General problem-solving Techniques and their equivalent C programs

UNIT III	ARRAYS, POINTERS, AND STRINGS	9	0	0	9

One-dimensional and two-dimensional Arrays: Declaration – Initialization – Processing – Pointers: Declaration – Initialization – Processing – Relation between pointers and arrays – Strings – String operations – C Library support for String handling

Developing solution for problems involving arrays, pointers and strings using General problem-solving Techniques and their equivalent C programs

UNIT IV	FUNCTIONS	9	0	0	9

Function – Library functions and user-defined functions – Function prototypes and function definitions – Parameter passing mechanisms –Recursion – Storage classes – Working with multiple source files

Developing solution for problems involving functions using General problem-solving Techniques and their equivalent C programs.

UNIT V	STRUCTURES, UNIONS AND FILE	9	0	0	9

Structure: declaration – definition –Structure within a structure – Passing structures to functions – Array of structures – Pointers to structures – Union – File operations: reading and writing/appending to binary and text files.	
Total (45 L)= 45 Periods	
Text Books:	
1.	Balagurusamy E, "Programming in ANSI C", Tata Mcgraw-Hill, 8th Edition, 2022.
2.	Yashavant P. Kanetkar, "Let Us C", BPB Publications, 2016.
Reference Books:	
1.	Venugopal, "Mastering C", Second Edition, Tata McGraw-Hill Education. 2006
2.	R. G. Dromey, "How to solve it by computers", Prentice Hall, 2007
3.	Greg Perry and Dean Miller, "C Programming Absolute Beginner's Guide", Third Edition, Que Publishing, 2013.
4.	Brain W. Kernighan and Ritchie Dennis, "The C Programming Language", Second Edition, Pearson, 1988.
E-Reference:	
1.	https://www.learn-c.org/
2.	https://www.programiz.com/c-programming

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts of C programming and roles of system software in programming	L1 and L2
CO2	Use general problem-solving techniques to develop solutions to problems	L3
CO3	Apply the concepts of C programming to develop solutions by writing C programs	L3 and L4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3									3	1	
CO2	2	1	3		2							3	2	
CO3	2	1	3		2							3	3	
Avg	**2**	**1**	**3**		**2**							**3**	**2**	

3 / 2 /1 - indicates strength of correlation (3- High, 2- Medium, 1- Low)

22MC102	தமிழர்மரபு	Semester			I
PREREQUISITES	Category	HSMC	Credit		1
Basics of Tamil	Hours/Week	L	T	P	TH
		1	0	0	1

அலகு I	மொழி மற்றும் இலக்கியம்	1	0	0	1

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச்சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக்கருத்துக்கள் – தமிழ்க்காப்பியங்கள், தமிழகத்தில் சமணபௌத்த சமயங்களின் தாக்கம்–பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II	மரபு – பாறைஓவியங்கள்முதல்நவீன ஓவியங்கள் வரைசிற்பக்கலை	3	0	0	3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன்சிலைகள் – பழங்குடியினர் மற்றும் தயாரிக்கும் கைவினைப்பொருட்கள், பொம்மைகள் – தேர்செய்யும்கலை – சுடுமண்சிற்பங்கள் – நாட்டுப்புறத்தெய்வங்கள்- குமரிமுனையில் திருவள்ளுவர் சிலை- இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III	நாட்டுப்புறக்கலைகள்மற்றும்வீரவிளையாட்டுகள்	3	0	0	3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான்கூத்து, ஒயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV	தமிழர்களின்திணைக்கோட்பாடுகள்	3	0	0	3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V	இந்தியதேசியஇயக்கம்மற்றும்இந்தியபண்பாட்டிற்குத் தமிழர்களின்பங்களிப்பு	3	0	0	3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப்பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப்புத்தகங்களின் அச்சுவரலாறு.

Total= 15 Periods

Text Books / Reference Books:

1. தமிழகவரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு :தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்.
2. கணினித்தமிழ் – முனைவர்இல.சுந்தரம்.(விகடன்பிரசுரம்)

3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகரநாகரிகம்(தொல்லியல்துறைவெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல்துறைவெளியீடு)

22MC102	HERITAGE OF TAMILS	Semester			I
PREREQUISITES	Category	BS	Credit		1
Basics of Tamil	Hours/Week	L	T	P	TH
		1	0	0	1
Unit I	LANGUAGE AND LITERATURE	3	0	0	3
3 Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.					
Unit II	HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE	3	0	0	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	0	0	3
Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.					
Unit IV	THINAI CONCEPT OF TAMILS	3	0	0	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	0	0	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 Books:	
1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
5	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology&TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

22CS102	COMPUTER PRACTICE AND C PROGRAMMING LABORATORY (Common to CSE, ECE, EEE, Civil, Mechanical and Metallurgy)	Semester	I

PREREQUISITES	Category	ES	Credit		1.5
NIL	Hours/Week	L	T	P	TH
		0	0	3	3

Course Learning Objectives

1	To provide basic knowledge to work with word processing applications
2	To provide basic knowledge to work with spread sheet applications
3	To promote the programming ability to develop C applications

EXPERIMENTS

1. Creating and Formatting documents.
2. Creating Tables and Manipulation
3. Using Equation Editor
4. Inserting Pictures, Shapes and Charts
5. Using Mail merge

B. Spread Sheet

6. Creating sheets, using built in functions and user-defined formulae
7. Creating different type of charts from data

C. Simple C Programming

8. Program using different operators
9. Program using Control statements.
10. Program using Loops, Array and Strings.
11. Program using Functions and pointers
12. Program using Structures and Files.

For programming exercises Algorithm, Flow chart and pseudo code are essential

Total (45 P)= 45 Periods

Course Outcomes:		Bloom's Taxonomy Mapped
After the successful completion of the practical session, the students will be able to		
CO1	Demonstrate the usage of features supported by word processing applications.	CO1
CO2	Demonstrate the usage of features supported by spread sheet applications.	CO2
CO3	Apply general programming techniques to develop digital solutions to problems	CO3
CO4	Implement solutions developed with general programming techniques in C programming language.	CO4

COURSE ARTICULATION MATRIX														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1										3			1	
CO2	2	3											1	
CO3	2	3	3									3	2	
CO4	1	1	1									3	3	
Avg	**1.6**	**2.3**	**2**							**3**		**3**	**1.7**	
3 / 2 /1 - indicates strength of correlation (3- High, 2- Medium, 1- Low)														

22ME102	WORKSHOP MANUFACTURING PRACTICES	SEMESTER	I

PRE-REQUISITE	Category	ES	Credit		2
	Hours/Week	L	T	P	TH
		0	0	4	4

Course Objectives:

1.	To understand the basics of safety measures taken in the laboratory.
2.	To provide exposure to the students with hands-on experience on various basic engineering practices in Civil and Mechanical Engineering.
3.	To know about the various fitting joints and lathe operation.
4.	To gain knowledge in welding and fitting operation.
5.	To understand the fabrication of various models using sheet metals.

LIST OF EXPERIMENTS

1. Introduction to Safety measures and First aid.
2. Study of Lathe, drilling machine -Welding methods and equipment- Casting process and tools- Sheet metal and fitting tools- Carpentry tools and joints.
3. Fitting: V-fitting, square fitting, Curve fitting.
4. Lathe: Facing, turning, taper turning and knurling.
5. Welding: BUTT, LAP and T- joints.
6. Foundry: Greensand preparation- mould making practice.
7. Sheet metal: Cone, tray, cylinder.
8. Carpentry: CROSS, T and DOVETAIL joints.
9. Drilling: simple exercises.

Total = 60 Periods

Reference Books:

1.	Bawa, H.S, "Workshop Practice", Tata McGraw Hill Publishing Company Limited, 2007.
2.	Jeyachandran, K, Natarajan, K and Balasubramanian, S, "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3.	Jeyapoovan, T, SaravanaPandian, M and Pranitha, S, "Engineering Practices Lab Manual", Vikas Publishing House Pvt. Ltd, 2006.
4.	Dr. P.kannan, Mr. T, Satheeskumar&Mr .K .Rajasekar, "Engineering practices laboratory" manual first edition 2017
5.	Dr. V. Rameshbabu "Engineering practices laboratory" VRB publication pvt ld.

E-Reference:

1.	https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-me14/
2.	https://nptel.ac.in/courses/112107083

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Familiarize the working of various equipment and safety measures.	Understand
CO2	Prepare fitting of metal and wooden pieces using simple fitting and carpentry tools manually.	Apply
CO3	Fabrication of components using welding, lathe and drilling machine.	Analyze
CO4	Make the model using sheet metal works.	Analyze

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
CO2	0	3	0	2	1	0	0	0	0	0	0	0	0	0	2
CO3	0	3	0	2	1	0	0	0	0	0	0	0	0	0	2
CO4	0	3	0	2	1	0	0	0	0	0	0	0	0	0	2
CO5	0	3	0	2	1	0	0	0	0	0	0	0	0	0	2
Avg	**0**	**2.4**	**0**	**1.6**	**0.8**	**0.6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.6**

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

SEMESTER-II

22MA203	LINEAR ALGEBRA, PARTIAL DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS B.E. (ECE)	SEMESTER	II

PREREQUISTIES	CATEGORY	BS	Credit		4
Basic 12th level knowledge of Matrices, Vector Algebra, PDE, ODE and Integral Calculus.	Hours/Week	L	T	P	TH
		3	1	0	4

Course Objectives:

1.	To understand the concepts of vector space and linear transformations.
2.	To apply the concept of inner product spaces in orthogonalization.
3.	To understand the procedure to solve partial differential equations.
4.	To find the solutions of second order differential equation with constant coefficients by Laplace transform methods.
5.	To acquire the knowledge of vector differentiation and integration and its applications.

UNIT I	VECTOR SPACES	9	3	0	12

Vector spaces – Subspaces – Linear independence and linear dependence – Bases and dimensions.Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations.

UNIT II	INNER PRODUCT SPACES	9	3	0	12

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

UNIT III	PARTIAL DIFFERENTIAL EQUATIONS	9	3	0	12

Formation – Solutions of first order equations – Standard types and equations reducible to standard types – Singular solutions – Lagrange‘s linear equation – Integral surface passing through a given curve – Classification of partial differential equations - Solution of linear equations of higher order with constant coefficients.

UNIT IV	LAPLACE TRANSFORM	9	3	0	12

Laplace Transform- Properties of Laplace transform – Laplace Transform of periodic Functions – Finding inverse Laplace Transform by different methods, convolution theorem – Evaluation of integrals by Laplace transform- solving second order differential equations with constant coefficients by Laplace transform method.

UNIT V	VECTOR CALCULUS	9	3	0	12

Vector differentiation- Gradient- Directional derivative - Divergence - Curl , Vector integration- Line integration- work done – Surface and Volume integrals - Green’s theorem , Gauss divergence and Stokes theorem (without proof) – Simple applications involving cubes and rectangular parallelepipeds.

Total (45L+15T) = 60 Periods

Text Books:	
1.	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publications, Delhi, 2015.
2.	Friedberg, A.H., Insel, A.J. and Spence, L., "Linear Algebra", Prentice Hall of India, New Delhi, 2004.
3.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 3rd Edition, Narosa Publications, New Delhi, 2007.
Reference Books:	
1.	James Stewart, "Essential Calculus", 2ndEdition, Cengage Learning, New Delhi, 2013.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", 9thEdition, John Wiley & Sons, 2006.
3.	Kumaresan, S., "Linear Algebra – A Geometric Approach", Prentice-Hall of India, New Delhi, Reprint, 2010.
4.	Gilbert Strang, "Linear Algebra and its Applications", 4thEdition, Cengage Learning, New Delhi, 2014.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's TaxonomyMapped**
CO1	:	Use the concepts of vector space and linear transformations.	L3: Applying
CO2	:	Illustrate the concept of inner product spaces in orthogonalization.	L2: Understanding
CO3	:	Solve various types of partial differential equations in engineering problems.	L3: Applying
CO4	:	Apply the knowledge of Laplace transforms method to solve second order differential equations.	L3: Applying
CO5	:	Use Gauss, Stokes and Green's theorems for the verification of line, surface and volume integrals.	L3: Applying

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO2	3	2	0	3	0	0	0	0	0	0	0	0	2	0	0
CO3	3	1	0	2	0	0	0	0	0	0	0	0	2	0	0
CO4	3	1	0	3	0	0	0	0	0	0	0	0	3	0	0
CO5	3	1	0	2	0	0	0	0	0	0	0	0	2	0	0
Avg	**3**	**1.4**	**0**	**2.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2.2**	**0**	**0**

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22PH201	PHYSICS – ELECTROMAGNETISM	SEMESTER	II

PREREQUISITES	CATEGORY	BS	Credit	3
Knowledge in vector algebra	Hours/Week	L	T	P	TH
		2	1	0	3

Course Objectives:

1.	The concept of electrostatics, electric potential and their application.
2.	The concept of dielectrics, Capacitance, Poisson's and Laplace's equations.
3.	The concept of magnetostatics, magnetic fields in matter and their application.
4.	The concept of Faraday's law, Ampere's Law, Maxwell's Equation and their application.
5.	The concept of Electromagnetic waves, and Poynting vector.

UNIT I		6	3	0	9

Electric field and electric flux density - Gauss's Law - applications of Gauss's law - electric field due to infinite line charge- infinite sheet of charge-uniformly charged sphere; Electric potential - potential due to a point charge- electric potential energy of a system of point charges - relationship between electric field and electric potential; Energy density in electrostatic fields.

UNIT II		6	3	0	9

Classification of materials based on conductivity ; Electric dipole - electrostatic field and potential of a dipole; Dielectrics - induced dipoles - polarization in dielectrics - dielectric constant and strength; Capacitance - parallel plate capacitor - coaxial capacitor - spherical capacitor; Laplace's and Poisson's equations for electrostatic potential; Electrostatic boundary conditions for Dielectric–Dielectric, Conductor-Dielectric and Conductor-free Space.

UNIT III		6	3	0	9

Biot-Savart's Law - magnetic induction at point *P* due to a straight filamentary conductor;Ampere's circuit law - applications of ampere's law: infinite line current - infinite sheet of current; Magnetic Lorentz force- force on current carrying conductor - Magnetic Boundary conditions for Dielectric–Dielectric, Conductor-Dielectric and Conductor-free Space.

UNIT IV		6	3	0	9

Faraday's law in terms of emf produced by changing magnetic flux; Lenz's law; Transformer emf; Motional emf ; Electromagnetic breaking and its applications; Self Inductance- self inductance of a solenoid; Mutual Inductance - mutual Inductance of two tightly wound solenoids;Energy density in magnetic Fields; Displacement current - modified ampere's law; Maxwell's equation in vacuum and non-conducting medium.

UNIT V		6	3	0	9

The wave equation- plane electromagnetic waves in vacuum, their transverse nature, Energy carried by electromagnetic waves Flow of energy and Poynting vector; Radiation pressure.

Total (30L+15T)= 45 Periods

Text Books:

1.	Mathew N. O.Sadiku, 'Elements of Electromagnetics', Oxford University Press, Third Edition, 2007.
2.	Halliday, Resnick, Walker, 'Fundamentals of Physics-Electricity and Magnetism', Wiley India Pvt.Ltd., 2015.
3.	Gangadhar K.A, Ramanthan P.M, 'Field Theory', Khanna Publications, 2002.

Reference Books:

1.	David J. Griffiths, 'Introduction to Electrodynamics', Prentice-Hall, Inc.,2020.
2.	Kraus and Fleish, 'Electromagnetics with Applications', McGrawHill International Editions, Fifth edition, 2010.
E-Reference	
1	https://nptel.ac.in/courses/115101004
2	https://nptel.ac.in/courses/115101005

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's TaxonomyMapped**
CO1	:	Understand the concepts of electrostatics, electrical potential, and their applications.	L2: Understanding
CO2	:	Interpret the concepts of dielectrics, capacitance and apply Poisson's or Laplace's equations to various electrostatic problems	L4: Analyzing
CO3	:	Apply the concepts of magnetostatics, magnetic fields in matter and their application.	L3: Applying
CO4	:	Apply the concepts of Faraday's laws, Ampere's Law, Maxwell's Equation.	L3: Applying
CO5	:	The concepts of electromagnetic waves and Poynting vector.	L1: Remembering

L1	Remembering
L2	Understanding
L3	Applying
L4	Analyzing
L5	Evaluating
L6	Creating

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	1	0	1	0	0	0	0	0	1	1	0	0
CO2	3	2	2	3	0	1	0	0	0	0	0	2	2	1	1
CO3	2	2	1	1	0	0	0	0	0	0	0	1	1	0	0
CO4	3	3	2	2	0	1	0	0	0	0	0	2	2	1	1
CO5	3	2	2	2	0	0	0	0	0	0	0	2	1	0	2
Avg	2.6	2.4	1.6	1.8	0	0.6	0	0	0	0	0	1.6	1.4	0.4	0.8

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22HS201	UNIVERSAL HUMAN VALUES		SEMESTER			II
PRE-REQUISITE:		Category	HS	Credit		3
		Hours/Week	L	T	P	TH
			2	1	0	3

Course Objectives:

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.

UNIT I		6	3	0	9

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education. Purpose and motivation for the course, recapitulation from Universal Human Values-I. Self-Exploration–what is it? - 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.

UNIT II		6	3	0	9

Understanding Harmony in the Human Being - Harmony in Myself! 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.

UNIT III		6	3	0	9

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship 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.

UNIT IV		6	3	0	9

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence. 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.

UNIT V		6	3	0	9

Implications of the above Holistic Understanding of Harmony on Professional Ethics. Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics, Strategy for transition from the present state to Universal Human Order.

Total (30L + 15T) = 45 Periods

Reference Books:

1.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books:	
1.	JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	The Story of Stuff (Book)
4.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5.	Small is Beautiful - E. F Schumacher.
6.	Slow is Beautiful - Cecile Andrews
7.	Economy of Permanence - J C Kumarappa
8.	Bharat Mein Angreji Raj - PanditSunderlal
9.	Rediscovering India - by Dharampal
10.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11.	India Wins Freedom - Maulana Abdul Kalam Azad
12.	Vivekananda - Romain Rolland (English)
13.	Gandhi - Romain Rolland (English)

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Become more aware of themselves, and their surroundings (family, society, nature) and become more responsible in life	Evaluate
CO2	Handle problems with sustainable solutions, while keeping human relationships and human nature in mind	Apply
CO3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society)	Evaluate
CO4	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.	Apply

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	0	1	0	0	1	0	2	0	1	0	3	2	0	1
CO2	0	0	1	0	0	3	0	1	0	1	0	3	1	0	1
CO3	0	0	1	0	0	2	0	1	0	1	0	3	1	0	2
CO4	0	0	2	0	0	1	0	1	0	1	0	3	1	0	1
Avg	**0**	**0**	**1.25**	**0**	**0**	**1.75**	**0**	**1.25**	**0**	**1**	**0**	**3**	**1.25**	**0**	**1.25**

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22EE201	PRINCIPLES OF ELECTRICAL ENGINEERING	SEMESTER			II
PREREQUISITES	**CATEGORY**	**ES**	**Credit**		**4**
Engineering Physics	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**1**	**0**	**4**

Course Objectives:

1.	To understand the basic concepts of electric circuits, measurements techniques and instruments
2.	To study the working principles of DC and AC machines
3.	To understand the components of Electrical installations

UNIT I	**DC CIRCUITS**	**9**	**3**	**0**	**12**

Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin, Norton and Maximum power transfer theorems, Time-domain analysis of first-order RL and RC circuits.

UNIT II	**AC CIRCUITS**	**9**	**3**	**0**	**12**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of RL, RC, RLC combinations (series and parallel), resonance, Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III	**TRANSFORMERS**	**9**	**3**	**0**	**12**

Construction – Working principle – EMF equation – Ideal and Practical transformer – Transformer on no-load – Transformer on load - Equivalent circuit - Losses and Efficiency of transformers – Regulation - Auto-transformer: Saving of Copper, Uses.

UNIT IV	**ELECTRICAL MACHINES**	**9**	**3**	**0**	**12**

Construction, working and speed control of DC shunt motor, Construction and working of a three phase induction motor, Starting and speed control of three phase induction motor, Working of single phase induction motor and its applications, Construction and working of synchronous generators.

UNIT V	**ELECTRICAL INSTALLATIONS**	**9**	**3**	**0**	**12**

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing, Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Total (45L+15T) = 60 Periods

Text Books:

1.	Basic Electrical Engineering - D.P. Kothari and I.J. Nagrath, 3rd edition, Tata McGraw Hill, 2010.
2.	Basic Electrical Engineering - D.C. Kulshreshtha, Tata McGraw Hill, 2019.

Reference Books:

1.	Fundamentals of Electrical Engineering, L.S. Bobrow, Oxford University Press, 2011
2.	Electrical and Electronics Technology, E. Hughes, 10th Edition, Pearson, 2010
3.	Electrical Engineering Fundamentals, Vincent Deltoro, Second Edition, Prentice Hall India, 1989

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Analyze DC and AC circuits.	L4. Analyzing
CO2	:	Apply electrical circuit theorems to DC circuits.	L3. Applying
CO3	:	Discuss the concepts and working of two-winding and auto-transformers.	L2. Understanding
CO4	:	Explain the working principles of DC and AC Electrical Machines.	L2. Understanding
CO5	:	To choose components of Low Voltage Electrical Installations	L5. Remembering

COURSE ARTICULATION MATRIX

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	1	1	1	1	2	1	1	1	1	2	2	3	1
CO2	3	3	2	1	2	1	2	1	1	1	1	2	3	3	2
CO3	3	3	3	3	2	1	3	1	1	1	1	1	2	2	1
CO4	3	3	3	3	3	1	3	1	1	1	1	2	2	3	2
CO5	2	3	3	3	3	1	3	1	1	1	1	1	2	2	1
CO6	1	1	1	3	2	1	3	1	1	1	1	1	2	3	1
Avg	2.17	2.33	2.17	2.33	2.17	1	2.67	1	1	1	1	1.50	2.17	2.67	1.33

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22ME101	ENGINEERING GRAPHICS AND DESIGN	Semester			II
PREREQUISITES	**Category**	**ES**	**Credit**		**3**
Students should know about the basics of drawings. Students should be able to construct geometric shapes	**Hours/Week**	**L**	**T**	**P**	**TH**
		1	**0**	**4**	**5**

Course Learning Objectives

1	To impart knowledge on graphical skills for communications of concepts, ideas and design of engineering products and to provide exposure to design.
2	To expose them to existing national standards related to technical drawings.
3	To understand the basics of points, lines, planes and solids.
4	To understand the basics of the surface of an object.
5	To expose them to isometric and perspective views of simple solids.

Unit I	**PROJECTION OF POINTS, LINES AND PLANE SURFACES**	**3**	**0**	**12**	**15**

General principles of orthographic projection- Projection of points, located in all quadrants – Projection of straight lines located in the first quadrant – Determination of true lengths and true inclinations – Projection of polygonal surface and circular lamina inclined to both reference planes.

Unit II	**PROJECTION OF SOLIDS**	**3**	**0**	**12**	**15**

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular to one reference plane and also inclined to one reference plane by change of position method.

Unit III	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**	**3**	**0**	**12**	**15**

Sectioning of above solids in a simple vertical position by cutting planes inclined to one reference plane and perpendicular to other – solids inclined position with cutting planes parallel to one reference plane- Obtaining true shape of the section.

Development of lateral surfaces of simple and truncated solids – Prisms, pyramids cylinders and cones- Development of lateral surfaces of solids with square and cylindrical cutouts, perpendicular to the axis.

Unit IV	**ORTHOGRAPHIC AND ISOMETRIC PROJECTION**	**3**	**0**	**12**	**15**

Orthographic Projection - Visualization concepts and Freehand sketching - Visualization principles - Representation of three-dimensional objects - Layout of views - Freehand sketching of multiple views from pictorial views of objects.

Principles of isometric projection – isometric scale - isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.

Unit V	**PERSPECTIVE PROJECTION**	**3**	**0**	**12**	**15**

Perspective projection of prisms, pyramids and cylinders by visual ray and vanishing point methods.

Total (15+60) = 75 Periods

Text Books:

1	Bhatt, N.D.,Panchal V M and Pramod R. Ingle, "Engineering Drawing", Charotar Publishing House, 53rd Editio 2014.
2	Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

Reference Books:

1	Agrawal, B. and Agrawal C.M., "Engineering Drawing", Tata McGraw, N.Delhi, 2008.
2	Gopalakrishna, K. R., "Engineering Drawing", Subhas Stores, Bangalore, 2007.
3	Natarajan, K. V., "A text book of Engineering Graphics", 28th Ed., Dhanalakshmi Publishers, Chennai, 2015.
4	Shah, M. B., and Rana, B. C., "Engineering Drawing", Pearson, 2nd Ed., 2009.
5	Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", New Age, 2008.
E-References	
1.	https://nptel.ac.in/courses/112102304
2.	https://home.iitk.ac.in/~anupams/ME251/EDP.pdf
3.	https://static.sdcpublications.com/pdfsample/978-1-58503-610-3-1.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Familiarize with the fundamentals and standards of engineering graphics.	Understand
CO2	Ability to understand the fundamental concepts of projection of points, lines and planes.	Analyze
CO3	Project the solids and section of solids.	Analyze
CO4	Familiarize and develop the lateral surfaces of solids	Analyze
CO5	Visualize and project the orthographic, isometric and perspective sections of simple solids.	Analyze

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	0	0	0	0	0	0	0	0	0	0	3	1	0
CO2	3	1	0	0	0	0	0	0	0	0	0	0	3	1	0
CO3	3	1	0	0	0	0	0	0	0	0	0	0	3	1	0
CO4	3	1	0	0	0	0	0	0	0	0	0	0	3	1	0
CO5	3	1	0	0	0	0	0	0	0	0	0	0	3	1	0
Avg	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1**	**0**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22MCIN01	ENGINEERING SPRINTS	Semester			II
PREREQUISITES	Category	EE	Credit		1
	Hours/Week	L	T	P	TH
		0	0	2	2

Course Learning Objectives

1	To Strengthen conceptual understanding of fundamental engineering concepts.
2	To Spark curiosity in students Minds.
3	To focus on teaching through a problem-solving approach using Street Fight Engineering principles pioneered.
4	To foster the growth of functional independence and self-driven learning habits.
5	To maximize the interest levels towards learning - as students aspire to create meaningful changes in the world.

Unit I	STREET FIGHTING ENGINEERING	0	6	0	6

Why streetfight engineering - How to street fight engineering - Decode real-world problems - Observe key patterns - relationship study - Derive actionable inferences - Perform data - driven insights - Generate concepts and case studies.

Unit II	PROGRAMMING PARADIGM	0	6	0	6

Need for programming - Outside box thinking to solve problems- Need for algorithms and data structures - Flowcharts & Algorithms - Memory Allocation - Conditions and loops - Creating effective functions - Case studies - Visual Programming - Types of programming languages & paradigms - Getting started with development - Build & test an algorithm - Best practices.

Unit III	BRAINS OF MACHINES	0	6	0	6

Key innovations in Tesla Electric car - Case study - Brains of Electric cars - Transdisciplinary systems - Adapting Transdisciplinary systems to Accelerate Innovation - Idea Hexagon - Exercise to think of new innovations using Idea Hexagon - Brains of Digital camera.

Unit IV	MACHINES THAT MAKE-UP THE WORLD	0	6	0	6

Basics of Electronics passive components - Need for sensors & Actuators - Analyzing & Understanding electronic circuits - How to Build a Basic Custom Hardware - Bootloader & its purposes.

Unit V	ENGINEERING THE REAL WORLD	0	6	0	6

Real-world as systems - Introducing to Systems Thinking - Stock and Flow Diagrams - System Traps - Intervening circuits - Living in a World of Systems.

Total = 30 Periods

Text Books:

1	Sanjoy Mahajan - Street Fighting Mathematics
2	Donald Knuth - The Art of Computer Programming
3	Think like a programmer - An introduction to creative problem solving
4	Thinking in Systems - A Primer

Reference Books:

1	Learning to code : How to think like a programmer
2	How to find innovative ideas : Ramesh Raskar’s note

3	Case Study ; How Tesla changed the auto industry
4	Ultimate Guide : How to develop a new electronic hardware product

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Apply street fight engineering concepts	
CO2	Construct Flowchart & block diagrams for algorithms	
CO3	Apply the idea Hexagon Tool to understand basic electronics for building basic hardware	
CO4	Examine real-world problems with a system view	

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO 3**
CO1															
CO2															
CO3															
CO4															
CO5															
Avg															
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22MC201	TAMILS AND TECHNOLOGY	Semester			II
PREREQUISITES	Category	HS MC	Credit		0
	Hours/Week	L	T	P	TH
		1	0	0	1

Course Learning Objectives

1	
2	
3	
4	
5	

Unit I	WEAVING AND CERAMIC TECHNOLOGY	3	0	0	3

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

Unit II	DESIGN AND CONSTRUCTION TECHNOLOGY	3	0	0	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)- ThirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

Unit III	MANUFACTURING TECHNOLOGY	3	0	0	3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and goldCoins 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	0	0	3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu 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	0	0	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 Books:

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)

5	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology&TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

22NC201	NCC COURSE-I (Only for NCC Students)	Semester			II
PREREQUISITES	**Category**	**NC**	**Credit**		**3**
NIL	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To maintain the unity and disciplines to the students

Unit I	**NCC GENERAL & NATIONAL INTEGRATION AND AWARENESS**	**9**	**0**	**0**	**9**

Aims, Objectives and Org of NCC – Incentives to NCC cadets – Duties of NCC Cadets – NCC Camps: Types & Conduct; National Integration: Importance and Necessity – Factors affecting National Integration – Unity in Diversity – Threats to National Security.

Unit II	**PERSONALITY DEVELOPMENT & LEADERSHIP DEVELOPMENT**	**9**	**0**	**0**	**9**

Personality Development Capsule -Self Awareness Empathy, Creative& Creative Thinking, Decision Making - Communication Skills - Group Discussion - Stress emotions, Change Your Mindset, Inter Personal Relations& Team work, Time Managements, Civil Sense - Career Counselling, SSB Procedures & Interview Skills; Leadership Capsule - Traits, Indicators, Motivation, Ethics &Honour code - Case Studies-Shivaji, APG Abdul Kalam & Deepa Malik, MaharanaPratap, Ratan Tata, KiranMajumdar, Jhansi Ki Rani, Narayan Murty, PrakashPadukone, Tipu Sultan, Rabindranath Tagore.

Unit III	**DISASTER MANAGEMENT AND HEALTH & HYGIENE**	**9**	**0**	**0**	**9**

Disaster Management Capsule- SochVichar, Types - Organisation, Capability & Role of NCC Cadets – Fire Service & Fire Fighting – Initiative Training, Organisation Skills, Do's and Don'ts – Natural Disasters, Man Made Disasters; Health & Sanitation – First aid in Common Medical Emergencies, Treatment & Care of Wounds – Introduction to Yoga & Exercises.

Unit IV	**PRINCIPLES OF FLIGHT & GENERAL SERVICE KNOWLEDGE**	**9**	**0**	**0**	**9**

Laws of Motion – Glossary Terms – Bernoulli's Principle – Aerofoil – Forces acting on Aircraft – Lift & Drag – Flaps & Slats – Stall – Thrust; Armed Forces & IAF Capsule – Modes of Entry in IAF, Civil Aviation – Aircraft Recognition – Latest Trends & Acquisitions.

Unit V	**NAVIGATION, AEROENGINES, AIRCOMPAIGNS & AIRMANSHIP**	**9**	**0**	**0**	**9**

Requirements of Navigation – Glossary terms – Maps – Map Reading; Basic Theory – Types of Engines – Piston Engines – Jet Engines – Turbo Prop Engines; Indo Pak war 1971 – Operation Safed Sagar – Famous Air Heroes; Airmanship – Airfield Layout – Rules of the Air – Circuit Procedures – ATC RT Procedures – Aviation Medicine - Survival.

Total = 45 Periods

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Acquired knowledge about the history of NCC, its organization, incentives of NCC, duties, different NCC camps	Analyze
CO2	Understand the concept of national integration and its importance	Understand
CO3	Understand the importance disaster management and health and hygiene.	Understand
CO4	Understand the importance principal of Flight and knowledge about armed services.	Understand
CO5	Understand and learn the importance of navigation, Aero engines & Airmanship work.	Understand

22EN102	PROFESSIONAL SKILLS LABORATORY	SEMESTER	II
PRE-REQUISITE	CATEGORY	HS	Credit 1

	Hours/Week	L	T	P	TH
		0	0	2	2

Course Objectives:

1.	To enable learners to improve their reading skills
2.	To make learners show variations while reading
3.	To assist learners to acquire speaking competency in English
4.	To enable learners to strengthen their fluency in speaking

UNIT I	**0**	**0**	**9**	**9**

Reading – Reading a short story – learning pronunciation, intonation, and splitting of sentences to form meaningful units.

Speaking – Narrating a story without any help of handouts.

UNIT II	**0**	**0**	**9**	**9**

Reading – Reading a poem – learning the skill of reciting, appreciate rhyme and music, change in tone as per the emotion of the poem.

Speaking – Power-point presentation on a general topic.

UNIT III	**0**	**0**	**9**	**9**

Reading – Reading newspaper article – learning vocabulary and language pattern of official communication.

Speaking - Oral presentation on a topic from basic engineering pertained to their branch.

UNIT IV	**0**	**0**	**9**	**9**

Reading – Reading dialogue scripts – learning expression, tone, stress and co-operative reading.

Speaking –Proposing welcome address, vote of thanks and organizing events.

UNIT V	**0**	**0**	**9**	**9**

Reading – Reading technical descriptions of gadgets – learning the different parts of devices.

Speaking – Describing a process – everyday technical activities like taking printouts, purchasing equipment for a company, booking a hall for meetings etc.,

Total (0T+45P) = 45 Periods

Text Books:

1.	Norman Whitby. Business Benchmark – Pre-Intermediate to Intermediate, Students book, Cambridge University Press, 2014.

Reference Books:	
1.	Reading Fluency. Switzerland, MDPI AG, 2021.
2.	McJacobs, Wade. Dare to Read: Improving Your Reading Speed and skills. Sustralia, Friesen Press, 2021
3.	Hoge, A. J. Effortless English: Learn to Speak English Like a Native. United States, Effortless English LLC, 2014.
E-References:	
1.	https://www.talkenglish.com/
2.	https://www.readingrockets.org/

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	To read passages fluently with good pronunciation	Remembering
CO2	To develop an expressive style of reading	Creating
CO3	To make effective oral presentations in technical and general contexts	Creating
CO4	To excel at professional oral communication	Evaluating

COURSE ARTICULATION MATRIX

CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	0	0	0	1	0	0	0	0	2	3	0	1	0	0	1
CO2	0	0	0	1	0	0	0	0	2	3	0	1	0	0	1
CO3	0	0	0	2	0	0	0	0	2	3	0	1	0	0	1
CO4	0	0	0	2	0	0	0	0	2	3	0	1	0	0	3
Avg	**0**	**0**	**0**	**1.5**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**1**	**0**	**0**	**1.5**

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22PH103	PHYSICS LABORATORY	SEMESTER			II
PRE-REQUISITE	**CATEGORY**	**BS**	**Credit**		**1.5**
There are no prerequisites for this course	**Hours/Week**	**L**	**T**	**P**	**TH**
		0	**0**	**3**	**3**

Course Objectives:

1.	To handle different measuring instruments.
2.	To understand the basic concepts of interference, diffraction, heat conduction and to measure the important parameters.

LIST OF EXPERIMENTS

1. Newton's rings – Determination of radius of curvature of a Plano convex lens.
2. Carey Foster's bridge – Determination of specific resistance of the material.
3. Poiseuille's flow – Determination of the Coefficient of viscosity of a liquid.
4. Spectrometer – Grating – Normal incidence – Determination of Wavelength of Mercury lines.
5. Lee's disc – Determination of thermal conductivity of a Bad conductor.
6. Ultrasonic interferometer – Determination of velocity of Ultrasonic Waves in Liquid.
7. Non-uniform bending – Determination of young's modulus of the wooden bar.
8. Determination of Band gap of a given semiconductor.
9. Determination of Wavelength of laser using grating and determination of particle size using Laser.
10. Determination of Acceptance angle and Numerical Aperture of fiber.

Total (45P) = 45 Periods

Text Books:	
1.	C. S. Robinson, Dr. Ruby Das, ' A Textbook of Engineering Physics Practical', Laxmi Publication Pvt. Ltd., 2016.
2.	S. Panigrahi, 'Engineering Practical Physics', Cengage Learning India, 2015.
Reference Books:	
1.	M.N. Srinivasan, 'Text Book of Practical Physics', Sultan Chand & Sons, 2013
2.	Singh Harman, 'B.Sc. Practical Physics', S Chand & Company Ltd, 2022.
E-References:	
1.	https://nptel.ac.in/courses/115105110
2.	https://nptel.ac.in/courses/115105120

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Handle different measuring instruments and to measure different parameters.	Applying
CO2	Calculate the important parameters and to arrive at the final result based on the experimental measurements.	Analyzing

COURSE ARTICULATION MATRIX															
CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	0	3	3	0	0	0	3	1	0	2	1	1	1
CO2	3	2	0	2	1	0	0	0	2	0	0	1	1	1	1
Avg	**3**	**2**	**0**	**2.5**	**2**	**0**	**0**	**0**	**2.5**	**1**	**0**	**1.5**	**1**	**1**	**1**
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22CY102	CHEMISTRY LABORATORY		SEMESTER			II
PRE-REQUISITE		**CATEGORY**	**BS**	**Credit**		**1.5**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Objectives:

1.	To gain practical knowledge by applying theoretical principles and performing the following experiments.

LIST OF EXPERIMENTS

1. Estimation of hardness of Water by EDTA
2. Estimation of Copper in brass by EDTA
3. Estimation of Alkalinity in water
4. Estimation of Chloride in water sample (Iodimetry)
5. Estimation of Iron content in the given salt by using external indicator
6. Conductometric titration of Strong Acid and Strong Base
7. Conductometric titration of Mixture of acids and Strong base
8. Determination of strength of Iron by Potentiometric method
9. Estimation of Iron by Spectrophotometry
10. Estimation of Copper by Colorimeter
11. Determination of molecular weight and degree of Polymerization by Viscometry
12. Determination of pKa of the given weak acid by pH meter
13. Estimation of the amount of given HCl using pH meter

Total (45P) = 45 Periods

E-References:

1.	www.scuolab.com/en/chemistry/
2.	www.onlinelabs.in/chemistry
3.	www.virtuallabs.merlot.org/vl_chemistry

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	To summarize the applicability of the practical skill gained in various fields.	Understanding
CO2	To calculate the composition of brass quantitatively and the molecular weight of polymers.	Applying
CO3	To understand the principle and applications of conductometric and pH titrations, spectrometer, and potentiometric titrations.	Understanding

COURSE ARTICULATION MATRIX															
CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	0	3	0	0	0	0	0	0	0	0	2	0	0
CO2	1	2	0	3	0	0	0	0	0	0	0	0	2	0	0
CO3	2	2	0	3	0	0	0	0	0	0	0	0	2	0	0
Avg	**1.3**	**1.7**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)															

22EE202	PRINCIPLES OF ELECTRICAL ENGINEERING LABORATORY	SEMESTER	II

PREREQUISITES	CATEGORY	ES	Credit		1.5
Engineering Physics	Hours/Week	L	T	P	TH
		0	0	3	1.5

Course Objectives:

1.	To study hands-on experiments related to electric circuits.
2.	To understand the working of measuring instruments and electrical machines.

List of Experiments:

1. Study of basic safety precautions, measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope and Electrical components.
2. Verification of Kirchhoff's laws.
3. Verification of Superposition theorem.
4. Verification of Thevenin's theorem.
5. Measurement of time constant of an R-C circuit.
6. Measurement of core loss and full-load copper loss in a single phase transformer.
7. Load test on a single phase transformer.
8. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage.
9. Series/Parallel Resonance in R-L-C circuits.
10. Measurement of three-phase power in three-phase circuits.
11. Demonstration of cut-out sections of DC machine, 3-phase induction motor, and 3-phase alternator.

Total (0T+ 45P)= 45 Periods

Reference Books:

1.	Basic Electrical Engineering - D.P. Kothari and I.J. Nagrath, 3rd edition, Tata McGraw Hill, 2010.
2.	Basic Electrical Engineering - D.C. Kulshreshtha, Tata McGraw Hill, 2019.

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Discuss the working of measuring instruments and electrical machines.	L2. Understanding
CO2	:	Apply fundamental laws and theorems to electric circuits.	L3. Application
CO3	:	Estimate parameters in single phase and three phase AC circuits.	L5. Evaluation
CO4	:	Analyze resonance in single phase AC circuits.	L4. Analysis
CO5	:	Judge the steady state responses of single phase AC circuits.	L5. Evaluation

COURSE ARTICULATION MATRIX															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	2	1	1	1	2	1	1	1	2	2	2	2	1
CO2	1	2	1	1	1	1	1	1	1	1	2	2	3	3	2
CO3	1	2	2	2	1	1	1	1	2	2	1	2	2	3	1
CO4	1	2	2	2	1	1	2	1	1	2	2	2	3	3	2
CO5	1	2	2	2	1	1	2	1	1	2	2	2	2	3	1
Avg	**1.0**	**2.0**	**1.8**	**1.6**	**1.0**	**1.0**	**1.6**	**1.0**	**1.2**	**1.6**	**1.8**	**2.0**	**2.4**	**2.8**	**1.4**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

SEMESTER III

22MA304	FOURIER SERIES, COMPLEX VARIABLES AND TRANSFORMS	SEMESTER			III
PREREQUISITES	**CATEGORY**	**BS**	**Credit**		**4**
NIL	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**1**	**0**	**4**

Course Objectives:

1.	To introduce the concept of Fourier series.
2.	To familiarize with Fourier, transform of a function and its sine and cosine transforms.
3.	To know about analytic functions with properties, construction of analytic functions and conformal transformations.
4.	To obtain the knowledge of Cauchy's integral theorems, calculus of residues and complex integration around unit circle and semi-circle.
5.	To gain the skills to form difference equations and find its solution by using Z-transform method.

Unit I	**FOURIER SERIES**	**9**	**3**	**0**	**12**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's Identity – Harmonic Analysis.					
Unit II	**FOURIER TRANSFORM**	**9**	**3**	**0**	**12**
Statement of Fourier integral theorem – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's Identity.					
Unit III	**COMPLEX DIFFERENTIATION**	**9**	**3**	**0**	**12**
Functions of a complex variable – Analytic functions – Cauchy – Riemann equation and sufficient conditions (excluding proof) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Conformal mappings: $w = z + c$, $c z$, $1/z$, z^2 and Bilinear transformations.					
Unit IV	**COMPLEX INTEGRATION**	**9**	**3**	**0**	**12**
Cauchy's integral theorem - Cauchy's integral formula – Taylor's and Laurent's theorems (Statements only) and expansions – Poles and Residues – Cauchy's Residue theorem – Contour integration: Circular and semi-circle contours with no poles on the real axis.					
Unit V	**Z -TRANSFORM AND DIFFERENCE EQUATIONS**	**9**	**3**	**0**	**12**
Z-transform of simple functions and properties – Inverse Z – transform –initial and final value theorems- Convolution theorem -Formation of difference equations – Solution of difference equations using Z – transform technique.					
Total (45L+15T)= 60 Periods					

Text Books:

1.	Veerarajan T, "Engineering Mathematics (For Semester III)", 3rd Edition, Tata McGraw Hill Education Pvt . Ltd., New Delhi, 2009.
2.	P. Kandasamy, K. Thilagavathy and K. Gunavathy, "Engineering Mathematics, Volume III", S. Chand & Company ltd., New Delhi, 1996.
3.	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, (2015).
4.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.

Reference Books:

1.	Srimanta pal and Subath C. Bhumia, "Engineering Mathematics", Oxford university publications, New Delhi, 2015
2.	Ewinkreyzig, "Advanced Engineering Mathematics", 9th edition, John Wiley & Sons, 2006.
3.	Grewal, B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
4.	Wylie C. Ray and Barrett Louis, C., "Advanced Engineering Mathematics", Sixth Edition, McGraw-Hill, Inc., New York, 1995.
5.	Andrews, L.A., and Shivamoggi B.K., "Integral Transforms for Engineers and Applied Mathematicians", MacMillan, New York, 1988.

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Acquire the knowledge about Fourier series.	L2
CO2	:	Apply the knowledge of Fourier transform in engineering problems.	L3
CO3	:	Familiar with the concept of Conformal and Bilinear transformations.	L2
CO4	:	Acquire the knowledge of Contour integration over unit circle and semi-circle.	L2
CO5	:	Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO3
CO1	3	2		2									2		
CO2	3	2		2									2		
CO3	3	2		2									2		
CO4	3	2		2									2		
CO5	3	2		2									2		
Avg	**3**	**2**		**2**									**2**		
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC301	SEMICONDUCTOR DEVICES AND CIRCUITS	SEMESTER III

PREREQUISITES	CATEGORY	PC	Credit		3
NIL	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	To understand the fundamentals of electron devices and apply the knowledge in electronic circuits.
2.	To design and analyse single stage and multistage amplifier circuits.
3.	To understand and classify different kinds of power and feedback amplifiers.

Unit I	SEMICONDUCTOR DIODES	9	0	0	9

Semiconductors – Intrinsic Semiconductors – Doped Semiconductors – Current flow in semiconductors – PN junction diode – Current equations – Energy Band diagram – Diffusion and drift current densities – forward and reverse bias characteristics – Transition and Diffusion Capacitances – Switching Characteristics – Breakdown in PN Junction Diodes – Schottky barrier diode – Zener diode – Varactor diode –Tunnel diode – Photodiode.

Unit II	DIODE APPLICATIONS AND POWER SUPPLY	9	0	0	9

Clipper and clamper circuits, Half-wave, full-wave and bridge rectifiers with resistive load. Analysis for V dc and ripple voltage with C, L, L-C and C-L-C filters. Voltage multipliers, Voltage Regulators – Zener diode regulator. Switched Mode Power Supply (SMPS).

Unit III	TRANSISTOR AMPLIFIERS	9	0	0	9

Bipolar Junction Transistor- device structure and physical operation – Current-Voltage characteristics – Ebers -Moll Model – MOSFET-device structure and physical operation – Current-Voltage characteristics – Biasing schemes for BJT and FET amplifiers – bias stability – various configurations (such as CE/CS, CB/CG, CC/CD) and their features.

Unit IV	FREQUENCY RESPONSE OF AMPLIFIERS	9	0	0	9

Small signal operation and models of MOSFET and BJT – general shape of frequency response of amplifiers – Low - Frequency Response of Discrete-Circuit Common-Source and Common-Emitter Amplifiers – Internal Capacitive Effects and the High-Frequency Model of the MOSFET and the BJT – High-Frequency Response of the CS and CE Amplifiers – General expression for frequency response of multistage amplifiers - Calculation of overall upper and lower cut off frequencies of multistage amplifiers – The cascade amplifier.

Unit V	POWER AND FEEDBACK AMPLIFIERS	9	0	0	9

Power amplifiers-various classes of operation (Class A, Class B, Class AB, and Class C), their power-conversion efficiency and power dissipation calculations – cross-over distortion – Feedback topologies: Voltage series, current series, voltage shunt, current shunt – effect of feedback on gain, bandwidth etc., calculation with practical circuits – concept of stability, gain margin and phase margin.

Total (45L)= 45 Periods

Text Books:

1.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.
2.	S. Salivahanan and N. Suresh kumar, “Electronic Devices and Circuits”, 4e, McGraw Hill Education, 2017.

E-References:

1.	https://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/117103063
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the characteristics of diodes and special semiconductor devices.	L2
CO2	:	Design and analyze clipper, clamper and power supply circuits.	L4
CO3	:	Acquire knowledge on working principles, characteristics and applications of BJT and FET.	L1
CO4	:	Analyse the frequency response characteristics of amplifiers.	L4
CO5	:	Design and analyze power and feedback amplifiers and derive their performance specifications.	L4

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	3	1	2									1	1	1
CO2	3	3	2	3									2	2	1
CO3	3	2	2	3									1	1	1
CO4	2	3	2	3									1	2	1
CO5	2	3	2	3									2	1	1
Avg	2.2	2.8	1.8	2.8									1.4	1.4	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC302	DIGITAL SYSTEM DESIGN	SEMESTER III

PREREQUISITES	CATEGORY	PC	Credit	3
	Hours/week	L	T	P	TH
		3	0	0	3

Course Objectives:

1	To make the student understand the number system, logic families and Boolean algebra.
2	To design combinational and sequential circuits using gates and flip flops.
3	Deliver the concept of Memories and Programmable Logic Devices and apply the knowledge of these devices in the design of Digital electronic circuits.

Unit I	NUMBER SYSTEMS AND LOGIC GATES	9	0	0	9

Binary – Decimal – Octal - Hexadecimal - Binary codes: BCD– Gray code - Boolean Algebra and Minimization Techniques – Canonical forms – Conversion between canonical forms – Simplifications of Boolean expressions using Karnaugh map – Logic Gates: Implementations of Logic Functions using gates – Logic Families: TTL NAND gate – Specifications – Noise margin - Propagation delay - fan - in - fan - out Tristate TTL - ECL.

Unit II	COMBINATIONAL CIRCUITS	9	0	0	9

Design procedure – Adders / Sub tractor – Serial adder/ Sub tractor - Parallel adder / Sub tractor – Carry look ahead adder - BCD adder - Magnitude Comparator - Multiplexer / De-multiplexer- Encoder / Decoder – Parity checker– Code converters - Implementation of combinational logic using MUX and Decoder.

Unit III	SEQUENTIAL CIRCUITS	9	0	0	9

Design Procedure- Flip flops: SR,JK,T,D and JK Master Slave–Triggering of Flip-flop-Realization of flip flops – Mooreand Mealy circuits–Counters: Asynchronous / Ripple counters – Synchronous counters – Module on counter – Design of Synchronous counters – Register - Shift registers-:Universal shift register–Shift Register counters.

Unit IV	ASYNCHRONOUSS EQUENTIAL CIRCUITS	9	0	0	9

Design of fundamental mode circuits – Primitive state / flow table – Minimization of primitive state table – state assignment – Excitation table – Excitation map - Problems in Asynchronous Circuits: Cycles – Races – Hazards – Design of Hazard Free Switching Circuits: Static – Dynamic - Essential Hazards and Hazard elimination.

Unit V	MEMORY DEVICES	9	0	0	9

Classification of memories – RAM organization — ROM organization — Flash Memory - Programmable Logic Devices: Programmable Logic Array (PLA) - Programmable Array Logic (PAL)- Implementation of combinational logic using ROM,PA Land PLA.

Total(45L) =45 Periods

Text Books:

1. M. Morris Mano," Digital Design",4th Edition, Pearson Education(Singapore)Pvt. Ltd., NewDelhi,2008.
2. R.P. Jain," Modern digital Electronics" ,Tata McGraw Hill, 4thEdition, 2009

Reference Books:	
1.	W.H.Gothmann,"Digital Electronics – An introduction to theory and practice", PHI, 2nd edition,2006.
2.	D.V. Hall," Digital Circuits and Systems", Tata McGraw Hill, 1989
3.	S.Salivahanan and S.Arivazhagan ," Digital Circuits and Design", 2nd edition,VikasPublishingHousePvt.Ltd,NewDelhi,2004.
4.	Charles H .Roth." Fundament also f Logic Design",Thomson Publication Company,2003.

E-References:	
1.	http://nptel.ac.in/noc/individual_course.php?id=noc15-ec01
2.	https://nptel.ac.in/courses/117105080/6
3.	https://nptel.ac.in/courses/117105080/12

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the number system and the functioning of logic gates with various logic families.	L2, L4
CO2	:	Design and analyse combinational logic circuits and Logic gates.	L4
CO3	:	Design the sequential logic circuits using Flip flops	L3, L4
CO4	:	Design and analyse asynchronous sequential logic circuits	L6
CO5	:	UnderstandtheconceptsofmemoriesandPLDsandimplementationofcircuitsusingmemoryandPLDs.	L2

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	3	2					2	1	
CO2	3	3	2	2	3	3	2	1	1				3	2	
CO3	2	2	3	3	2	1	2	1	1				2	2	
CO4	2	1	2	1	2	2	3	1					2	1	
CO5	2	1	2	1	3	2	1	2					3	2	
Avg	2.4	1.8	2.2	1.8	2.6	2	2.2	1.4	0.4				2.4	1.6	
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC303	NETWORK THEORY AND SYNTHESIS	SEMESTER III

PREREQUISITES	CATEGORY	PC	Credit		3
NIL	Hours/Week	L	T	P	TH
		3	0	0	3

Course objectives:

1. To impart knowledge on solving circuits using network theorems.
2. To educate on obtaining the transient response of circuits and resonance in coupled circuits.
3. To impart knowledge on two-port networks and network synthesis.

Unit I	NETWORK ANALYSISTECHNIQUESANDTHEOREMS	9	0	0	9

Revision of Mesh and Nodal Analysis - Comparison of Node and Mesh Analysis - Delta — Wye Transformation – Source Transformation and Duality - Network theorems (for both DC and AC circuits): Superposition – Theven in's - Norton's – Maximum Power Transfer – Tellegen's theorem.

Unit II	TRANSIENT ANALYSIS AND CIRCUIT ANALYSIS INs – DOMAIN	9	0	0	9

Transient study in RL, RC, and RLC networks: Response to Step, Impulse and Sinusoidal inputs - Concept of Complex frequency :Driving points and Transfer Functions - Poles and zero so fImmittance function — Properties - Sinusoidal response from pole - zero locations - Convolution theorem.

Unit III	MAGNETIC RESONANCE CIRCUITS	9	0	0	9

Series and parallel resonance - Variation of impedance with frequency- Bandwidth of RLC circuit — Q factor – Impedance of RLC circuit near resonance - Selectivity–Magnification- Self - inductance — Mutual inductance - Coefficient of coupling-Dot convention - Analysis of multi - winding coupled circuits — Series and parallel connection – Ideal transformer-Tuned circuits.

Unit IV	TWOPORT NETWORKS	9	0	0	9

One port and Two port networks — Z parameters — Y parameters – h parameters – ABCD parameters – Symmetrical and Asymmetrical networks – Characteristic impedance.

Unit V	PASSIVE NETWORK SYNTHESIS	9	0	0	9

Elements of Realizability Theory : Stability - Hurwitz Polynomials - Positive Real Functions: Definition – Necessary and sufficient conditions for a function to be positive real - Elements of circuit synthesis - Foster and Cauer forms of LC Networks - Synthesis of RC and RL networks.

Total(45L)=45 Periods

Text Books:

1. S.K. Bhattacharya and Manpteet Singh," Network analysis and Synthesis",1st edition,Pearson Publication,2015.
2. AbhijitChakrabarthy,"Circuit Theory Analysis and Synthesis" ,Dhanpath Rai & Sons,NewDelhi,2011.

Reference Books:

1. Alexander C. and Sadiku M . N. O.," Fundamentals of Electric Circuits ",Tata McGraw Hill, NewDelhi,2013.
2. Sudhakar A. and Shyammohan S. Pillai ,"Circuits and Networks Analysis and Synthesis",McGrawHill,NewDelhi,2015.
3. John .D. Ryder, "Networks Lines and Fields"-PHI 2nd edition, 2003.
4. VanValkenburg "Introduction to Modern Network Synthesis", New Age International Publisher, NewDelhi,2001.

E-References:

1. https://nptel.ac.in/courses/108102042/
2. https://nptel.ac.in/courses/106105154/2
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/lecture-2/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyse the electric circuit using best suited network theorem	L4
CO2	:	Apply the knowledge of Fourier Series, Fourier Transform and Laplace Transform to analyse the circuit	L3
CO3	:	Understand and analyse the resonance behaviour of circuit and apply the knowledge to design band limited circuits according to the application.	L2, L4
CO4	:	Analyse the linear network parameters, and their interaction with other networks.	L4
CO5	:	Design RLC from a given differential equation and can say the feasibility of the design.	L6

COURSE ARTICULATION MATRIX

CO//PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3		2	1								3	1	
CO2	3	3		2	1								3	1	
CO3	3	3		2	1								3	1	
CO4	3	3		2	1								3	1	
CO5	3	1	1	2	1								3	1	
Avg	3	2.6	0.2	2	1								3	1	
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC304	TRANSMISSION LINES AND WAVEGUIDES	SEMESTER			III
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**3**
1.Physics – Electromagnetism	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course objectives:

1.	To introduce the various types of transmission lines and to discuss the losses.
2.	To compute various parameters for loaded transmission lines using Smith chart and acquire knowledge of stub matching in Transmission Lines.
3.	To impart knowledge on different types of waveguides, planar transmission lines and waveguide resonators

Unit I	**TRANSMISSION LINE THEORY**	**9**	**0**	**0**	**9**

Introduction to Different types of transmission lines – Characteristic impedance and Propagation Constant – General Solution of the transmission line – Input and Transfer Impedance-Open and Short-circuited lines - Wavelength and Velocity of Propagation - Waveform distortion – Distortion less transmission line – Loading and different methods of loading-Reflection on a line not terminated by Zo – Reflection coefficient –Reflection factor and reflection loss

Unit II	**THE LINE AT RADIO FREQUENCIES**	**9**	**0**	**0**	**9**

Parameters of open wire line and co-axial line at high frequencies - Input impedance of dissipation less line- open and short circuited line – Standing waves and standing wave ratio on a line – λ/8 line – λ/4 line– λ/2 line- The Smith Chart – Applications of the Smith Chart - Solutions of problems using Smith chart – single stub matching and double stub matching.

Unit III	**RECTANGULAR WAVEGUIDES**	**9**	**0**	**0**	**9**

Waves between parallel planes of perfect conductors – Transverse electric waves - transverse magnetic waves – characteristics of TE and TM Waves – Transverse Electromagnetic waves: Transverse Magnetic waves in rectangular wave guides – Transverse Electric Waves in Rectangular Waveguides – Characteristic of TE and TM Waves – Cut off wavelength and phase velocity – Impossibility of TEM waves in waveguides – Dominant mode in rectangular waveguide – Attenuation of TE and TM modes in rectangular waveguides – Wave impedances– Excitation of modes.

Unit IV	**CIRCULAR WAVE GUIDES AND RESONATORS**	**9**	**0**	**0**	**9**

Bessel functions – Solution of field equations in cylindrical co-ordinates – TM and TE waves in circular guides – wave impedances and characteristic impedance – Dominant mode in circular waveguide – excitation of modes – Microwave cavities - rectangular cavity resonators - circular cavity resonator.

Unit V	**PLANAR TRANSMISSION LINES**	**9**	**0**	**0**	**9**

Introduction to planar transmission lines-strip lines, Micro strip lines-coupled lines-slot line, coplanar waveguide (CPW). Micro strip lines-filed distribution-design equations-losses in micro strip lines. Coaxial transmission line (distributed parameters)

Total (45L) = 45 Periods

Text Books:

1.	J.D. Ryder "Networks, Lines and Fields", PHI, New Delhi, 2006.
2.	E.C. Jordan and K.G. Balmain "Electro Magnetic Waves and Radiating System, PHI, New Delhi, 2010.

Reference Books:

1.	David M.Pozar: "Microwave Engineering", 4th Edition ,John Wiley, 2012
2.	Annapurna Das and SisirK. Das, " Microwave Engineering", TMH, 2000.
3.	Umesh Sinha, "Tranmission Lines & Networks" Sathya Prakashan publication, 2002
4.	David K.Cheng, "Field and Waves in Electromagnetism", Pearson Education, 1989.

E-References:

1.	https://www.youtube.com/watch?v=0OwmYAljz4A&list=PL0925FD10648D664E
2.	https://nptel.ac.in/courses/117101056
3.	https://link.springer.com/chapter/10.1007/978-1-4615-6459-1_28

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyse the propagation of signals through transmission lines.	L4
CO2	:	Calculate reflection and transmission coefficients, standing wave ratio and power for transmission lines using HF applications.	L5
CO3	:	Compute various parameters for loaded transmission lines using Smith chart and acquire knowledge of stub matching in Transmission Lines.	L5
CO4	:	Analyse the field components of different waveguides based on various modes of E and H filed.	L4
CO5	:	Understand the concept of planar transmission lines and analyse its field distribution.	L2, L4

COURSE ARTICULATION MATRIX

CO//PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS
CO1	1	3	2	2							2		2	3	2
CO2	1	3	2	3							2		2	3	2
CO3	1	3	3	3							3		1	3	1
CO4	1	3	3	3							3		2	2	2
CO5	1	3	3	3							3		2	2	2
Avg	1	3	2.6	2.8							2.6		2	2.6	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC305	ANALOG COMMUNICATION	SEMESTER			III
PREREQUISITES	CATEGORY	PC	Credit		3
NIL	Hours/Week	L	T	P	TH
		3	0	0	3

Course objectives:

1.	Familiarize the concepts of various analog modulation and demodulation techniques.
2.	To understand the sources of noise and its effects in Communication systems and to analyze the performance of receiver in the presence of noise.
3.	To study the limits set by Information Theory.

Unit I	AMPLITUDE MODULATION	9	0	0	9

Introduction to communication systems – Need for modulation – Generation and demodulation of AM, DSB-SC, SSB-SC - VSB signals - Filtering of sidebands - Comparison of amplitude modulation systems - Frequency translation - Frequency division multiplexing - AM Super hetrodyne receiver.

Unit II	ANGLE MODULATION	9	0	0	9

Angle modulation: Phase and Frequency modulation - Narrowband and Wideband FM - Transmission bandwidth of FM signals - Generation of FM signal – Direct FM – Indirect FM - Demodulation of FM signals - FM stereo multiplexing - PLL – Nonlinear model and linear model of PLL - FM Super hetrodyne receiver.

Unit III	NOISE PERFORMANCE OF DSB, SSB RECEIVERS	9	0	0	9

Noise: Types of Noise - Noise figure - Noise temperature - Noise Equivalent Bandwidth – Noise in cascaded systems - Representation of Narrowband Noise in terms of In-phase and Quadrature components - Receiver Model - Noise in DSB-SC Receiver - Noise in SSB Receiver.

Unit IV	NOISE PERFORMANCE OF AM AND FM RECEIVERS	9	0	0	9

Noise in AM receivers: Threshold effect - Noise in FM receivers: Capture effect - FM threshold effect - FM threshold reduction - Pre-emphasis and De-emphasis in FM – Comparing the performance of AM and FM.

Unit V	INFORMATION THEORY	9	0	0	9

Uncertainty - Information and entropy - Rate of information - Joint Entropy and Conditional Entropy - Mutual information - Discrete memory less channel - Channel Capacity - Shannon's Theorem - Continuous Channel - Shannon - Hartley Theorem - BW and S/N Trade-off - Huffman and Shannon – Fanocodes.

Total (45L)= 45 Periods

Text Books:

1.	Simon Haykin,"Communication Systems", 5th Edition,International Student Version, John Wiley & sons, NY, 2010.
2.	R.P. Singh &S.D.Spare, "Communication Systems, Analog & Digital", Tata McGraw Hill, 1995.

Reference Books:

1.	Taub and Schilling, "Principles of communication systems", TMH, New Delhi, 2008
2.	Roddy and Coolen, "Electronic communication", 4thEdition , PHI, New Delhi, 2003.
3.	Bruce Carlson.A, Paul B.Crilly, "Communication systems", 5thEdition, McGraw-Hill Int. , 2009.
4.	Anokhsingh, "Principles of Communication Engineering", S. Chand & Company Ltd. 2006.

E-References:

1.	https://www.telecommunications-tutorials.com/
2.	http://www.nptelvideos.in/2012/11/communication-engineering.html
3.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Gain knowledge on the principles of AM and FM communication systems.	L1
CO2	:	Ability to design AM and FM receiver.	L3
CO3	:	The exposure to the sources of noise and its effects in Communication systems.	L2
CO4	:	Ability to analyze the performance of receiver in the presence of noise.	L4
CO5	:	Ability to measure the capacity of a channel based on the information theory.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3										1	1	1
CO2	2	1	3										1	2	1
CO3	2	2	2	1									1	2	1
CO4	2	2	2	1									1	2	1
CO5	3	1	1										1	2	1
Avg	2.2	1.4	2.2	0.4									1	1.8	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22MC301	INDIAN CONSTITUTION		SEMESTER			III
PREREQUISITES		CATEGORY	MC	Credit		0
NIL		Hours/Week	L	T	P	TH
			2	0	0	2

(Common to all branches)

Course Objectives:

1.	learn the salient features of the Indian Constitution
2.	list the Fundamental Rights and Fundamental Duties
3.	present a systematic analysis of all dimensions of Indian Political System
4.	understand the power and functions of the Parliament, the Legislature and the Judiciary

UNIT I		**6**	**0**	**0**	**6**
Union and its Territory – Citizenship–Fundamental Rights–Directive Principles of State Policy–Fundamental Duties					
UNIT II		**6**	**0**	**0**	**6**
The Union–The States–The Union Territories–The Panchayats – The Municipalities					
UNIT III		**6**	**0**	**0**	**6**
The Co-operative Societies–The scheduled and Tribal Areas–Relations between the Union and the States–Finance, Property, Contracts and Suits–Trade and Commerce within the territory of India					
UNIT IV		**6**	**0**	**0**	**6**
Services under the Union, the States – Tribunals – Elections– Special Provisions –Relating to certain Classes					
UNIT V		**6**	**0**	**0**	**6**
Languages–Emergency Provisions – Miscellaneous–Amendment of the Constitution					
Total (6L) = 30 Periods					

Text Books:

1.	Subhash C.Kashyap, Our Constitution, National Book Trust, 2017
2.	Durga Das Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.
3.	M.V.Pylee, Constitutional History of India, S.Ch and publishing, 2010
4.	Granville Austin, The Indian Constitution: Cornerstone of a Nation, Oxford University Press, 1999

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the emergence and evolution of the Indian Constitution	
CO2	:	Explain the key concepts of Indian Political System	
CO3	:	Describe the role of constitution in a democratic society.	
CO4	:	Present the structure and functions of the Central and State Governments, the Legislature and the Judiciary	

22MCIN02	INNOVATION SPRINTS				SEMESTER III
PRE-REQUISITE:		CATEGORY	EE	Credit	1
		Hours/Week	L	T	P	TH
			0	0	2	2

Course Objectives:

1.	To understand the fundamentals of Design thinking & apply in ideating solutions for real-world problems.
2.	To solve challenges through problem curation, problem validation and customer discovery problems.

UNIT I	CHALLENGE CURATION	3	0	0	3

Introduction: Design Thinking Principles - Design Thinking Values - Design Thinking Methods - Challenge impact setting - Framing the design challenge.

UNIT II	CUSTOMER-CENTRIC INNOVATION	3	0	0	3

Understanding Customer needs - Empathy building techniques - gap analysis - adoption barriers - observations and insights - Translating Insights into Innovation Opportunities

UNIT III	IDEA GENERATION	3	0	0	3

Identifying pains & gains - crafting value proposition - Ideation - Divergent Thinking - Ideation methods- Rules of brainstorming - Managing risks - Concept of minimum usable prototypes - Generating solution concepts

UNIT IV	PROTOTYPING	3	0	0	3

Prototyping concepts -- Palm Pilot Experiment - Fake it before make it - Prototyping - The Law of Failure - Building a Prototype - Testing the Prototypes

UNIT V	PITCH & PRESENTATION	3	0	0	3

Science of Storytelling - the blueprint for storytelling - Pitch Script - Pitch Presentations - Best practices to creating a compelling pitch - communication fundamentals

Total (15L) = 15 Periods

Text Books:

1.	Tim Brown (2019), “Change by Design: How design thinking transforms organizations and inspires innovation”
2.	Jan Chipchase& Simon Steinhardt(2013), “Hidden in Plain Sight: How to Create extraordinary Products for Tomorrow’s Customers”, Harper Business 2013
3.	Christian Madsbjerg&Mikkel B. Rasmussen(2014), “The Moment of Clarity”, Harvard Business Review Press
4.	IdrisMootee(2013), Design Thinking for Strategic Innovation,Willey

5.	Alexander Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want (Strategyzer) - John Wiley & Sons, 2014
Reference Books:	
1.	avoia. Alberto, 2009 The Pretotyping Manifesto -
2.	https://sites.google.com/a/pretotyping.org/www/the-pretotyping-manifesto
3.	Jazz Factory, All about Presentations - http://blog.jazzfactory.in/
4.	Pretotyping Methodology - https://www.pretotyping.org/methodology.html

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Identify real-world problems	Understand
CO2	Apply the challenge curation techniques to real-world problems.	Apply
CO3	Analyze the problems and generate solutions to address the challenges	Analyze
CO4	Build solutions using pertotyping tools & techniques	Apply
CO5	Develop an innovation pitch to effectively communicate the idea to solve the identified problem	Analyze

COURSE ARTICULATION MATRIX

CO/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	0	3	0	0	0	2	1	0	2	0	0	0	0	0	2
CO2	0	3	0	2	0	0	0	0	2	0	0	0	0	0	2
CO3	0	0	3	2	0	0	0	0	2	0	0	0	0	0	2
CO4	2	0	3	0	0	0	0	1	2	0	0	0	0	0	2
CO5	0	0	0	0	0	0	0	0	2	3	0	0	0	0	2
Avg	**0.4**	**1.2**	**1.2**	**0.8**	**0**	**0.4**	**0.2**	**0.2**	**2**	**0.6**	**0**	**0**	**0**	**0**	**2**

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22NC301	NCC COURSE-II (Only for NCC Students)		SEMESTER III			
PRE-REQUISITE:		**Category**	**NC**	**Credit**		**0**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1. To maintain the unity and disciplines to the students

UNIT I	SOCIAL SERVICE & COMMUNITY DEVELOPMENT	9	0	0	9

Basic of social service and it's need - Rural Development Program – NGOs Roles & Contribution – Drug abuse and Trafficking – Civic Responsibilities – Causes & prevention of AIDS/HIV – Counter Terrorism – Corruption – Social Evil – RTI & RTE – Traffic Control Organization – Anti Drunken Driving.

UNIT II	GENERAL AWARENESS & ADVENTURE	9	0	0	9

General Knowledge – Logical & Analytical Reasoning - Modes of Entry to Army, CAPF, Police – SSB Procedure; Para Sailing – Slithering – Rock climbing – Cycling and Trekking.

UNIT III	AEROENGINES & NAVIGATION	9	0	0	9

Introduction to aero engines and its type – Components of aero engines – Principles of Propulsion – Basic Terminology – Jet engines – Brayton Cycle – Turbo prop engines and its types; Requirements of Navigation - Lines on Earth – Maps and its types - Symbols used in map – Scales of map – Map reading procedure and its aids.

UNIT IV	AIRFRAME & METEOROLOGY	9	0	0	9

Aircraft Control – Primary and Secondary –Fuselage – Main Plain and Tail Plain – Ailerons, Elevators& Rudders – Landing Gear; Importance of METT in Aviation – Atmosphere – Clouds and Precipitation – Flying Hazards.

UNIT V	FLIGHT INSTRUMENTS & AEROMODELLING	9	0	0	9

Airspeed Indicator – Altimeter – Artificial Horizon – Radar and Its Type – Instruments Battery Test, Compass; History of Aero Modeling – Basic Materials & Tools – Types of Aero Modelling – Flying/Building of Aero Models – General Safety Procedure.

Total = 45 Periods

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Acquired knowledge about social and legal responsibilities.	Understand
CO2	Understand the adventure activities and verbal training on defense examinations.	Remember and Understand
CO3	Understand the technical knowledge on aero engines and map reading.	Understand
CO4	Understand the structure and control of an aircraft.	Understand
CO5	Understand and learn the importance of avionic instruments on aircraft control.	Remember and Understand

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	0	0	0	0	0	0	0	0	0	0	3	1	1
CO2	3	3	2	3	0	0	0	0	0	0	0	0	3	2	1
CO3	3	2	3	1	0	2	0	0	0	0	0	0	3	2	1
CO4	3	2	2	2	0	0	0	0	0	0	0	0	3	2	1
CO5	3	0	0	0	0	1	0	0	0	0	0	0	3	3	1
Avg	**3**	**1.6**	**1.4**	**1.2**	**0**	**0.6**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**1**

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22EC306	SEMICONDUCTOR DEVICES AND CIRCUITS LABORATORY	SEMESTER III			
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**2**
NIL	**Hours/Week**	**L**	**T**	**P**	**TH**
		0	**0**	**4**	**4**

Course objectives:

1.	To provide an insight into the characteristics of electron devices.
2.	To design and analyse various amplifier circuits.
3.	To study the operation of rectifiers and filters.

EXPERIMENTS

1.	Characteristics of PN Junction Diode and Zener Diode.
2.	Characteristics of photodiode.
3.	Design of Clippers and Clampers.
4.	Measurement of ripple factor of Rectifiers with and without capacitor filter.
5.	Characteristics of CE/CB/CC configurations of Bipolar transistors.
6.	Characteristics of MOSFET.
7.	Frequency response of BJT Amplifier using voltage divider bias (self-bias) with and without emitter by pass capacitor.
8.	Frequency response of Multi stage amplifiers.
9.	Determination of efficiency of Class A power amplifier.
10.	Observation of the output of Class B Complementary symmetry power amplifier with and without crossover distortion.
11.	Design and Analysis of Series feedback amplifiers.
12.	Design and Analysis of Shunt feedback amplifiers.

Total (P)= 60 Periods

Text Books:

1.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.
2.	S. Salivahanan and N. Suresh kumar, "Electronic Devices and Circuits", Fourth edition, McGraw Hill Education, 2017.

Reference Books:

1.	Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" 11th edition, PHI, 2017.
2.	Ben G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2015.
3.	S.Poorna Chandra, B.Sasikala, "Electronics Laboratory Primer", S.Chand & Company Ltd, 2010.
4.	L.K. Maheshwari, M.M.S. Anand, "Laboratory Manual for Introductory Electronics Experiments", New age International (P) Limited Publishers, 2010.

E-References:

1.	ttps://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/108101091
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyze the characteristics of diodes and transistors.	L4
CO2	:	Design electronic circuits such as rectifiers and analyse their performance.	L5
CO3	:	Analyze the frequency response of small signal and power amplifiers using discrete components.	L5
CO4	:	Design and analyze the frequency response of feedback amplifiers.	L5
CO5	:	Implement electronic circuits and test their performance.	L6

COURSE ARTICULATION MATRIX

CO// PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	2	3	2	2	2								1	1	1
CO 2	3	3	2	2	2								1	2	1
CO 3	3	3	2	2	2								2	2	1
CO 4	3	3	3	2	2								1	1	1
CO 5	3	3	3	2	2								2	2	1
Av g	2.8	3	2.4	2	2								1.4	1.6	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC307	DIGITAL SYSTEM DESIGN LAB	SEMESTER				III
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**4**	**4**

Course objectives:

1.	To understand the principles and methodology of digital logic design at the gate and switch level.
2.	To design and testing of combinational circuits, sequential circuits, digital logic families and programmable logic devices.
3.	To get practical experience in design, realization and verification of memory devices.

EXPERIMENTS

1.	Study of Logic Gates.
2.	Implementation of logic circuits using NAND gate and NOR gate.
3.	Design and construct Adders and sub tractors.
4.	Design and implementation of Multiplexer and De multiplexer using logic gates and IC74159 and IC74154.
5.	Design and construct encoder and decoder using logic gates and study of IC7445 and IC74147.
6.	Study of Flip-Flops.
7.	Construction and verification of 4 bit ripple counter and Mod- N Ripple counters.
8.	Design and implementation of 3-bit synchronous up/down counter.
9.	Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops.
10.	Design and implementation of Hazard free circuits.
11.	Implementation of combinational logic circuits using Multiplexer and Decoder.
12.	Implementation of combinational logic functions using ROM, PLA and PAL.

Total (P)= 60 Periods

References:

1.	R.P. Jain, “Modern digital Electronics”, 4th Edition, Tata McGraw Hill, 2009.
2.	M. Morris Mano, “Digital Design”, 4th Edition, Pearson Education (Singapore) Pvt . Ltd., New Delhi, 2008.

Reference Books:

1.	W.H.Gothmann,“DigitalElectronics-Anintroductiontotheoryandpractice”, PHI, 2nd edition,,2006.
2.	D.V. Hall,“ Digital Circuits and Systems”, Tata McGraw Hill, 1989
3.	S.SalivahananandS.Arivazhagan,“Digital Circuits and Design”, 2nd edition, Vikas Publishing HousePvt.Ltd,NewDelhi,2004.
4.	Charles H. Roth. “Fundament also f Logic Design”,Thomson Publication Company,2003.

E-References:

1.	https://nptel.ac.in/courses/117105080/24
2.	https://nptel.ac.in/courses/117106086/
3.	https://www.youtube.com/watch?v=CeD2L6KbtVM

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Demonstrate the truth table of various expressions and combinational circuits using logic gates.	L2
CO2	:	Design various combinational circuits such as adders, sub tractors, comparators, multiplexers and demultiplexers.	L1, L4
CO3	:	Design and Construct counters and shift registers.	L4
CO4	:	Understand the concept of flip flops and Hazard free Circuit.	L2
CO5	:	Understand the concept ROM, PLA and PAL.	L2, L4

COURSE ARTICULATION MATRIX

CO//PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	1	2					2	2	
CO2	2	3	2	2	1	3	2	1					3	1	
CO3	2	2	2	3	2	2	2	1					2		1
CO4	2	1	2	1	2	2	3	1					2	1	
CO5	2	2	3	2	1	2	1	2						2	1
Avg	2.2	2	2.2	2	1.8	2.2	1.8	1.4					1.8	1.2	0.4

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

SEMESTER IV

22MA402	PROBABILITY AND STOCHASTIC PROCESSES		SEMESTER			IV
PREREQUISITES		**CATEGORY**	**BS**	**Credit**		**4**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**1**	**0**	**4**

Course Objectives:

1.	To learn the axioms of probability and use of Baye's theorem and its applications.
2.	To learn the standard Probability distribution and its application.
3.	To learn the two-dimensional random variables.
4.	To understand the convergence of random sequences and the concepts of strong and weak laws of large numbers and central limits.
5.	To understand effectively about the stochastic processes and the applications of correlation, spectral densities of the random process.

Unit I	**PROBABILTY AND ONE DIMENSIONAL RANDOM VARIBLE**	**9**	**3**	**0**	**12**
Axioms of probability – Conditional probability – Total probability- Bayes' theorem- Random variable- Probability mass function- Probability density function- Probability distribution function- Moments- moment generating functions and their properties-Characteristic functions.					
Unit II	**STANDARD DISTRIBUTION**	**9**	**3**	**0**	**12**
Binomial, Poisson, Geometric, Uniform, Normal Distributions and their properties- Functions of a random variable.					
Unit III	**TWO DIMENSIONAL RANDOM VARIABLES**	**9**	**3**	**0**	**12**
Joint Distribution- Marginal and Conditional distributions- Markov, Chebyshev, Chern off bounds.					
Unit IV	**RANDOM PROCESSES**	**9**	**3**	**0**	**12**
Random sequences and modes of convergence (everywhere, almost everywhere, Probability distribution and mean square) – Strong and Weak laws of large numbers- Central limit theorem.					
Unit V	**CORRELATION AND SPECTRAL DENSITIES**	**9**	**3**	**0**	**12**
Classification- Stationary Process- Mean and Covariance functions- Ergodicity-Transmission of Random Processes through LTI- Auto correlation- Cross correlation- Properties- Power spectral density.					
Total (45L+15T)= 60 Periods					

Text Books:

1.	Veerarajan.T, "Probability, Statistics and Random process", Tata McGraw- Hill publications, second edition, New Delhi, 2002.
2.	Ross. s, "A First course in Probability", 5th Edition, Pearson Education, Delhi, 2002.

Reference Books:

1.	H. Stark and John W. Woods "Probability and Random processes with Applications to
2.	Signal processing", Pearson Education, Third Edition, Delhi 2002.
3.	Peebles Jr. P.Z. "Probability Random Variables and Random Signal Principles", Tata McGraw- Hill Publishers, 4th Edition, New Delhi 2002. (Chapter 6, 7 and 8)
4.	K.L. Chung, "Introduction to Probability theory with Stochastic processes", Springer International.
5.	Ochi, M. K, "Applied Probability and Stochastic process", John Wiley & sons, New York, 1990.

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Learn the fundamental knowledge of the Probability concepts	L2
CO2	:	Apply the standard distributions	L3
CO3	:	Analyze the two-dimensional random variables	L4
CO4	:	Understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.	L2
CO5	:	Acquire the knowledge of Random Processes and Spectral densities.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2									2		
CO2	3	2		2									2		
CO3	3	2		2									2		
CO4	3	2		2									2		
CO5	3	2		2									2		
Avg	3	2		2									2		
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC401	ANALOG CIRCUITS	SEMESTER IV				
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	Togiveacomprehensiveexposuretoalltypesofdiscreteamplifiersandoscillators.Todevelopastrongbasisforlinearanddigitalintegratedcircuits.
2.	To understand the various linear and non-linear applications of op-amp.
3.	To understand the operation of the D/A &A/D converter types and its applications.

Unit I	**OSCILLATORS**	**9**	**0**	**0**	**9**

Feedback Amplifier: Block diagram - Gain with feedback - Bark hausen Criterion - Mechanism for start of oscillation and stabilization of amplitude - Analysis of Oscillator using Cascade connection of RC and LC filters -RC phase shift Oscillator – Wien bridge Oscillator and Twin - TO scillators - Analysis of LCO scillators : Colpitts — Hartley — Clapp- Miller and Pierce oscillators - Frequency range of RC Oscillators- Electrical equivalent circuit of Crystal.

Unit II	**TUNED AMPLIFIERS AND MULTI VIBRATORS**	**9**	**0**	**0**	**9**

Analysis of single tuned and synchronously tuned amplifiers- Class C tuned amplifiers and their applications -Efficiency of Class C tuned Amplifier-Collector coupled and Emitter coupled As table Multi vibrator -MonostableMultivibrator-BistableMultivibrator-Triggeringmethods-MonostableandAstableBlockingOscillatorsusing Emitter and base timing.

Unit III	**CIRCUIT FOR LINEARIC'S**	**9**	**0**	**0**	**9**

Current mirror: Basic topology and its variants - Differential amplifier: Basic structure and principle of operation -Calculation of differential gain - Common Mode gain, CMRR - OP-AMP design -Design of Differential amplifier - Designofgainstagesandoutputstages—compensation-DCandACcharacteristicsofOP-AM-slew rate.

Unit IV	**APPLICATION SOFOPERATIONAL AMPLIFIER**	**9**	**0**	**0**	**9**

Inverting and non-inverting amplifiers-Integrator and Differentiator -Summing amplifier -Precision rectifier -Schmitt trigger and its applications - Active filters: Low pass, high pass, band pass and band stop filters - Sine wave oscillators—Comparator-Multi vibrator.

Unit V	**DATA CONVERTERS AND SPECIAL FUNCTIONICs**	**9**	**0**	**0**	**9**

Digital-to-Analog converters (DAC): Weighted resistor - R-2R ladder - Analog to-Digital converters (ADC): Single slope - dual slope - Successive Approximation - Flash type - IC 555 timer and its applications - IC723 Volta geregulators.

Total(45L) =45Periods

Text Books:

1.	B.VisvesvaraRao,K.RajaRajeswari,P.ChalamRajuPantulu,K.BhaskaraRamaMurthy,"ElectronicCircuits-II",PearsonEducation,2012
2.	D.RoyChoudhry,ShailJain,"Linear IntegratedCircuits",NewAgeInternationalPvt.Ltd.,2011.

Reference Books:

1.	Millman J. And Taub H., "Pulse Digital and Switchingwaveform",3rd Edition, McGraw-Hill International, 2011.
2.	Sedera & Smith,"Micro ElectronicCircuits",4thEdition, Oxford University Press, Chennai.
3.	MichaelJacob,'Applications and Design with Analog Integrated Circuits',PrenticeHallofIndia,1996.
4.	K.R.Botkar,'Integrated Circuits',10thedition ,Khanna Publishers,2010.

E-References:

1.	http://nptel.ac.in/courses/117105080/40
2.	http://freevideolectures.com/Course/2915/Linear-Integrated-Circuits
3.	http://nptel.ac.in/courses/117108038/1

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyze different types of amplifier, oscillator and multi vibrator circuits.	L4
CO2	:	Construct and analyse tuned amplifier sand multi vibrators.	L6
CO3	:	Develop competence in linear and nonlinear Op amp circuit analysis.	L3,L4
CO4	:	Understand the concepts of waveform generation and introduce some special function ICs	L2,L4
CO5	:	Differentiate A/D and D/A converter, underst and their types and analyse their applications.	L3,L6

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	3	3	2		2		2					1	2	
CO2	2	3	3	2		2	2	1					2	2	
CO3	2	3	3	2									2	1	1
CO4	1			2			3						3	2	
CO5	2	3	3	2		2		2					2	3	
Avg	1.8	2.4	2.4	2		1.2	1	1					2	2	0.2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC402	MICROPROCESSORS AND MICROCONTROLLERS	SEMESTER			IV
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**3**
NIL	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:					
1.	To familiarise with 8086 and 8051 architectures.				
2.	To interface 8086 microprocessor and 8051 microcontrollers with peripherals by programming.				
3.	To gain basic knowledge of PIC microcontrollers.				
Unit I	**8086 MICROPROCESSOR ARCHITECTURE**	**9**	**0**	**0**	**9**
Overview of Microcomputer systems-8086 Architecture – Pin Assignments – Internal Architecture – Addressing modes-Instruction Formats- Directives and Operators-Assembly process.					
Unit II	**PROGRAMMING AND INTERFACING OF 8086**	**9**	**0**	**0**	**9**
Fundamental I/O considerations- Programmed I/O- Interrupt I/O- Basic 8086 Configurations- Minimum Mode-Maximum Mode-System Bus timing- I/O Interfaces-Peripheral Interfacing using 8255 PPI - 8279 Keyboard/Display controller - 8251 USART.					
Unit III	**8051 ARCHITECTURE**	**9**	**0**	**0**	**9**
8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization - Instruction set — Addressing modes					
Unit IV	**PROGRAMMING AND INTERFACING OF 8051**	**9**	**0**	**0**	**9**
Assembly language programming.8051Timers - Serial Port Programming - Interrupts Programming - LCD and Keyboard Interfacing - ADC, DAC and Sensor Interfacing - External Memory Interface - RTC Interfacing - Motor Control.					
Unit V	**PIC MICRO CONTROLLERS**	**9**	**0**	**0**	**9**
Main characteristics of PIC microcontrollers – PIC microcontroller families-Memory-Program Memory – RAM Data Memory - EEPROM Data Memory - Instruction set and timers in PIC					
Total (45L) = 45 periods					

Text Books:	
1.	Yu-Cheng Liu, Glenn A. Gibson," Microcomputer Systems, The 8086/8088 Family", Pearson, 2e, 2019.
2.	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, "The 8051 Microcontroller and Embedded Systems using Assembly and C", 2e, 2022.
Reference Books:	
1.	Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson education, 2011.
2.	Martin Bates ,"PIC Microcontrollers-An Introduction to Microelectronics", 3e, Elsevier,2011.
3.	Mathur Sunil,"Microprocessor 8086 : Architecture, Programming and Interfacing",PHI Learning Pvt. Ltd.,2011.
4.	Salvador Pinillos Gimenez," 8051 Microcontrollers Fundamental Concepts, Hardware, Software and Applications in Electronics", Springer,2019.
E-References:	
1.	Ashraf Almadhoun,"A Detailed Look Into PIC Microcontroller and Its Architecture",Amazon,2020.
2.	https://nptel.ac.in/courses/108105102
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Describe and analyse the architecture of 8086 microprocessor and 8051 architectures.	L1, L4
CO2	:	Develop assembly language programs and Interface peripherals with 8086.	L2, L3
CO3	:	Develop assembly language programs and Interface peripherals with 8051.	L2, L3
CO4	:	Determine application specific circuit for real-time applications.	L3
CO5	:	Associate appropriate PIC microcontroller for a given application.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1	2	2									2		1		
CO2	2	2	2	2									2	2	
CO3	2	2	2	2									2	2	
CO4	2	2	2	2									2	2	2
CO5	2	2		2									2	2	
Avg	2	2	1.2	1.6							0.4		1.8	1.6	0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC403	SIGNALS AND SYSTEMS	SEMESTER IV				
PREREQUISITES		CATEGORY	PC	Credit		3
NIL		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To introduce basics of signals and system.
2.	To understand and perform Fourier analysis on continuous and discrete time signal and sampling theorem.
3.	To introduce Laplace and Z transform in analysing signals and system

Unit I	INTRODUCTION TO SIGNALS AND SYSTEM	9	0	0	9

Classification of Signals: Even and Odd Signal - Energy and power signals - Continuous time (CT) and Discrete time (DT) signals - Continuous and Discrete amplitude signal - System properties and representation: linearity - Time-invariance – Causality – Stability - Realizability. - Linear Time-Invariant (LTI) systems: Impulse response and step response – Convolution – Correlation - System representation through differential equations and difference equations.

Unit II	FOURIER ANALYSIS OF CONTINUOUS TIME SIGNAL	9	0	0	9

Continuous Time Fourier Series (CTFS) - Properties of CTFS - Continuous Time Fourier Transform (CTFT) – CTFT of CT periodic signals - Properties of CTFT - Frequency response of systems characterized by differential equations.

Unit III	LAPLACE TRANSFORM AND CONTINUOUS-TIME LTI SYSTEMS	9	0	0	9

Laplace Transform - Laplace Transforms of some Common Signals - Region of Convergence -Properties of Laplace Transform- Inverse Laplace Transform - System Function - The Unilateral Laplace Transform -Solving differential equation of CT system.

Unit IV	SAMPLING THEOREM AND Z-TRANSFORMS	9	0	0	9

Representation of continuous time signals by its sample - Sampling theorem – Nyquist rate of sampling – Effects of under sampling (aliasing) – Sampling techniques - Data Reconstruction - Sampling of band pass signals - Z-transform - Relationship between z-transform and Fourier transform - Z-transform for discrete time signals - Region of Convergence – Properties of ROC – Properties of Z-transform - Poles and Zeros - Inverse Z-transform

Unit V	FOURIER ANALYSIS OF DISCRETE TIME SIGNALS	9	0	0	9

Discrete Time Fourier Series (DTFS) - Properties of CTFS – Discrete Time Fourier Transform (DTFT) – Properties of CTFT - Frequency Response of Discrete Time LTI Systems - Discrete Fourier Transform (DFT) - Realization structures – Direct form I - Direct form – II - Cascade and parallel forms.

Total (45L)= 45 periods

Text Books:

1.	A.Anand Kumar, ” Signals and Systems” , 3rd Edition, PHI, 2013.
2.	B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2009.

Reference Books:

1.	Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, “Signals and Systems”, 2nd edition, PHI Learning Private Limited, New Delhi, 2010.
2.	Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, 1998.
3.	Hsu.H.P, Rakesh Ranjan “Signals and Systems”,2nd Edition Schaum‘s Outlines, Tata McGraw Hill, 2010.
4.	Krishnaveni.V, Rajeswari.A, “Signals and Systems”, 1st Edition, Wiley India Pvt.. Ltd, 2012.

E-References:	
1.	https://www.youtube.com/watch?v=4GewDCPU5SQ&list=PLy3nfyfK6Yw6bQ-QXJdFrhzd37mgZzk0r
2.	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
3.	http://nptel.ac.in/courses/117104074/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand and Analyse different types of signals and systems.	L4
CO2	:	Represent continuous and discrete systems in time and frequency domain using different transforms.	L5
CO3	:	Able to perform Fourier analysis of signals.	L4
CO4	:	Sample and reconstruct a signal.	L2
CO5	:	Realize various structures for discrete time systems	L2

COURSE ARTICULATION MATRIX

CO//PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	-							2	2	2
CO2	3	2	2	3	3	2							2	2	2
CO3	3	2	2	3	3	2							2	2	1
CO4	3	2	1	3	3	2							2	2	2
CO5	3	2	2	3	3	-							1	2	2
Avg	3	2	2	3	3	1.2							1.8	2	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC404	CONTROL SYSTEMS		SEMESTER IV			
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
NIL		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Pre-Requiste:

1.	Laplace Transform, Partial Differential Equation

Course Objectives:

1.	To introduce the components and their representation of control systems.
2.	To learn various methods for an alyzing the time response, frequency response and stability of the systems.
3.	To introduce various methods for the state variable analysis.

Unit I	**MATHEMATICAL MODELS OF PHYSICAL SYSTEMS**	**9**	**0**	**0**	**9**

Basic Elements of Control System - Differential equations of physical systems – Open loop and Closed loop systems - Transfer function - Modelling of Electrical systems - Translational and rotational mechanical systems – Analogy - Block diagram reduction Techniques - Signal flow graph – Mason' Gain Formula.

Unit II	**TIME RESPONSE ANALYSIS**	**9**	**0**	**0**	**9**

Standard test signals - Time response analysis - Impulse and Step Response analysis of First and second order systems –Time domain specifications - P, PI, PD and PID controllers - Steady state errors and error constants - Generalized error co-efficient .

Unit III	**FREQUENCY RESPONSE ANALYSIS**	**9**	**0**	**0**	**9**

Sinusoidal TF and frequency Response - Frequency Domain specifications for second order system - Frequency response plots: Bode Plot - Polar Plot –Linear system design: Types of compensators - Lead, Lag and Lead Lag Compensators.

Unit IV	**STABILITY ANALYSIS**	**9**	**0**	**0**	**9**

Stability - Routh-Hurwitz Criterion - Nyquist Stability Criterion - Relative Stability - Root Locus Technique - Construction of Root Locus - Stability, Dominant Poles - Application of Root Locus.

Unit V	**STATE VARIABLE ANALYSIS**	**9**	**0**	**0**	**9**

Concept of state , state variable and state model - State space representation of linear Continuous and discrete Time systems – solutions of State equations – Transfer function from State Variable Representation – Concepts of Controllability and Observ ability

Total (45L)= 45 periods

Text Books:

1.	I.J Nagrath and M. Gopal, "Control System Engineering", 5th Edition, New Age International Edition, 2018.
2.	A.Nagoorkani, "Control Systems" 2nd Edition, RBA publications, 2009

Reference Books:

1.	Norman SNise,"Control Systems Engineering',Seventhedition,Wiley Publications, 2015
2.	Benjamin.C.Kuo, Automatic Control Systems, 7thEdition, PHI, 2009.
3.	K.Ogata,"ModernControlEngineering",PHI,5thEdition,2012.
4.	A.Anand Kumar, "Control Systems", Prentice Hall of India, 2012

E-References:

1.	https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x
2.	https://onlinecourses.nptel.ac.in/noc17_ee12
3.	https://onlinecourses.nptel.ac.in/noc22_ee31/preview

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Frame the transfer function of different physical systems	L2
CO2	:	Analyse the time domain specification and calculate the steady state error	L3
CO3	:	Illustrate the frequency response characteristics of open loop and closed loop system response.	L3
CO4	:	Analyse the stability of the system using Routh and root locus techniques.	L4
CO5	:	Test the controllability and observability of a physical system	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO2	PSO3
CO1	3	2	2	2	1								3		2
CO2	3	1	1	2	1								2		2
CO3	3	1	1	1	1								2		1
CO4	3	1	1	1	1								3	1	2
CO5	2	1	1	1	1								2		1
Avg	2.8	1.2	1.2	1.4	1								2.4	0.2	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC405	ANTENNA AND WAVE PROPAGATION	SEMESTER IV			
PREREQUISITES	**CATEGORY**	**PC**	**Credit**		**3**
		L	**T**	**P**	**TH**
NIL	**Hours/Week**	**3**	**0**	**0**	**3**

Course Objectives:

1.	To understand the fundamental principles of Antenna theory, and wave propagation with a lucid explanation of the basic concepts and equations.
2.	To understand the design and operation of various antenna types.
3.	To study the fundamental electromagnetic wave propagation indifferent layers of the atmosphere.

Unit I	**RADIATION FIELD SOFWIRE ANTENNAS**	**9**	**0**	**0**	**9**

Potential functions and electromagnetic field - Potential functions for sinusoidal oscillations - Fields associated with Hertzian dipole - Alternating current element - Power radiated and radiation resistance of current element – Radiation resistance of elementary dipole with linear current distribution - Current distribution on a thin wire antenna - Radiation from half – wave dipole or Effective length - Effective area.

Unit II	**ANTENNA ARRAYS**	**9**	**0**	**0**	**9**

Expression for electric field from two and three element arrays- Uniform linear array - Broadside array – End fire array - Method of pattern multiplication - Binomial array - Use of the method of images for antennas above ground –Folded dipole antenna – YagiUda antenna - Log periodic dipole array.

Unit III	**LOOP , HELICAL AND REFLECTOR ANTENNA**	**9**	**0**	**0**	**9**

Loop Antennas: small loop and general case - Radiation resistance of loops — Directivity of the circular loop — $\lambda/10$ diameter loop — λ/π diameter loop - Helical antenna: Helical geometry — monofilaraxial - mode helical antenna – Radiation from a traveling wave on a wire - Rhombic antenna: Analysis & Desig no f R hombic antennas–Reflector antennas: Flat sheet reflector-Corner reflector – Para boloidal reflector - Feed systems.

Unit IV	**APERTURE AND LENS ANTENNA**	**9**	**0**	**0**	**9**

Induction and equivalence theorems - Radiation from an elemental area of a plane wave (Huygen's Source) - Radiation from the open end of a coaxial line - Radiation from a rectangular aperture treated as an array of Huygen's sources—Slot antennas - Pattern of slot antennas in flat sheets - Babinet's principle and complementary antennas- Impedances of slot antennas - Method of feeding slot antennas - Field on the axis of an E - Plane sectoral horn – Radiation from circular aperture-Beam Width and Effective area - Di electric lens and metal plane lens antennas - Lumeberg lens - Spherical waves and Bi conical antenna.

Unit V	**WAVE PROPAGATION**	**9**	**0**	**0**	**9**

Sky wave propagation**:** Structure of the ionosphere - Effective dielectric constant of the ionized region - Mechanism of refraction - Refractive index - Critical frequency - Skip distance - Effect of earth's magnetic field - Energy loss in the ionosphere due to collisions-Maximum usable frequency - Fading and Diversity reception - Space wave propagation - Reflection from the ground for vertically and horizontally polarized waves - Reflection characteristics of the earth - Resultant of direct and reflected ray at the receiver - Duct propagation-Ground wave propagation: Attenuation characteristics for ground wave propagation - Calculation of field strength at a distance.

Total(45L)=45Periods

Text Books:

1.	E.C .Jordan and Balmain ," Electro Magnetic Waves and Radiating Systems",PHI,1968,Reprint2010.
2.	John D.Kraus and Ronalatory Marhefka,"Antennas", Tata McGraw – Hill Book Company,2010.

Reference Books:

1.	Terman ,F.E., "Radio Engineers Handbook" ,Tata McGraw - Hill, 1985.
2.	Constantine A. Balan is, "Antenna Theory Analysis and Design", John Wiley & Sons,2012.
3.	R.E. Collins, 'Antennas and Radio Propagation ",McGraw - Hill, 1987.
4.	Elliot, R.S," Antenna theory and design ",PHI, NewDelhi,1985.

E-References:	
1.	https://www.youtube.com/watch?v=LF9kebBTWXo&list=PLAULbhIvfai5yvvLIm-oIb89dGNp1BtM6
2.	https://www.youtube.com/watch?v=jA8aTA1Pg4s&list=PLCcWs0lpRgKcOu8LAX7GlZLIAHgyN1oVS
3.	https://link.springer.com/chapter/10.1007/978-1-4615-6459-1_28

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand and derive the behaviour of the antenna and its performance parameters.	L2
CO2	:	Design and analyse antenna arrays.	L4
CO3	:	Design and analyse Loop, Helical and Reflector antenna.	L4
CO4	:	Design and analyse aperture and lens antennas.	L4
CO5	:	Study radio wave propagation and its effects.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1								1	1	1
CO2	3	2	2	2	1								1	2	2
CO3	3	2	2	2	1								1	2	2
CO4	3	2	2	2	1								1	2	2
CO5	3	1	1	1	1										
Avg	3	2	1.6	1.6	1								0.8	1.4	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22MCIN03	DESIGN SPRINTS				SEMESTER IV			
PRE-REQUISITE:		**CATEGORY**	**EE**		**Credit**			**1**
		Hours/Week	**L**		**T**		**P**	**TH**
			0		**0**		**2**	**2**

Course Objectives:

1.	Develop key skill areas essential for a product designer from the perspective of design, its inherent complexity and supports them with tools & techniques to prototype rapidly.
2.	To enable the participants to visualize the experience for a user.
3.	To learn the roles & responsibilities of a designer in creating and shaping experiences for the user.
4.	The participants shall learn through the lenses of system thinking of how existing products work.
5.	Learn to select & apply various practice tools to aid them in rapid prototyping

UNIT I	**DESIGN FUNDAMENTALS**	**3**	**0**	**0**	**3**

Introduction to Visual Design, History and Modernism, Design Thinking methodology, seven elements of design, principles of design, principles of good design, designing a product and a service

UNIT II	**SYSTEM THINKING AND REVERSE ENGINEERING**	**3**	**0**	**0**	**3**

System Thinking for Engineering Problem Solving, Understanding Systems, Examples and Understandings, Complex Systems, Reverse Engineering Methodology, Identify building blocks/Components - Re-Engineering a complex system

UNIT III	**USER INTERFACE & USER EXPERIENCE**	**3**	**0**	**0**	**3**

Introduction to UI/UX, Human-Computer interface, user-centered Design Principles, User research techniques, UX Design workflow, Information Architecture, UI Components, need for UI prototyping, Wireframes

UNIT IV	**MECHANICAL PROTOTYPING**	**3**	**0**	**0**	**3**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Introduction - Working with Fusion 360 - 3D Modeling - 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNIT V	**ELECTRONIC & SOFTWARE PROTOTYPING**	**3**	**0**	**0**	**3**

Introduction to Lumped Circuits - Electronic Prototyping - Tinker CAD - Designing in KI CAD - PCB design - Source code management and version control - GitHub - GitHub Actions - GitBash - Continuous Integration - Platform as service - Heroku - Build Packs

Total (15L) = 15 Periods

Text Books:	
1.	Thinking in systems - Donella Meadows, 2015
2.	Rapid Prototyping And Engineering Applications: A Toolbox For Prototype Development - Frank W.Liou, 2007
3.	Rapid Prototyping Technology: Selection And Application - COOPER K. G, 2001
Reference Books:	
1.	https://thesystemsthinker.com/wp-content/uploads/2016/03/Introduction-to Systems-Thinking-IMS013Epk.pdf
2.	https://formlabs.com/blog/ultimate-guide-to-prototyping-tools-for-hardware-and product-design/
3.	https://docs.kicad-pcb.org/
4.	https://www.tinkercad.com/learn/circuits
5.	https://docs.github.com/en/free-pro- team@latest/actions/guides

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Understand the elements and principles of product and service design	Applying
CO2	Apply system thinking concepts in reverse engineering	Applying
CO3	Apply user research techniques to meet the UX needs of a customer and design a visual prototype	Applying
CO4	Develop prototyping models using the tools from mechanical prototyping models	Applying
CO5	Develop prototyping models using the tools from electrical and software prototyping methods	Applying

COURSE ARTICULATION MATRIX

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	0	1	0	0	0	0	0	2	0	0	0	0	0	2
CO2	2	3	0	0	0	0	0	0	2	0	0	0	0	0	2
CO3	3	0	1	0	0	0	0	1	2	0	0	0	0	0	2
CO4	0	0	3	2	3	0	0	0	2	0	0	0	0	0	2
CO5	2	0	2	0	1	0	0	0	2	0	0	0	0	0	2
Avg	**2**	**0.6**	**1.4**	**0.4**	**0.8**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**2**

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22CYMC01	ENVIRONMENTAL SCIENCE	SEMESTER	IV
PREREQUISTIES	CATEGORY	MC	Credit 0
NIL	Hours/Week	L T P TH	2 0 1 3

Course Objectives:

1.	To learn the concept of non-conventional energy systems.
2.	To explore the environmental impact assessment and to learn about the consequence of different types of pollutants.
3.	To have an ancient wisdom drawn from Vedas.
4.	To acquire activity-based knowledge to preserve environment.
5.	To learn about conservation of water and its optimization.

ENVIRONMENTAL AWARENESS — 30 0 0 30

Various types of traditional power Plant --Advantage and Disadvantage of conventional Power Definition of non-conventional energy sources Plants – Conventional vs. Non-conventional power generation. – types of non-conventional energy sources - India's current energy resources and their long-term viability – India's Energy requirement and management

Solar Energy Basics- Solar Thermal Energy- Solar Photovoltaic Energy- Benefits and Drawbacks -Effects on the environment and safety. Wind turbine power and energy- India's wind energy potential- Wind turbine types. Environmental benefits and impacts of offshore wind energy.

Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water Pollution-Sources and its remedy, Soil Pollution-Sources and its remedy, disposal of solid waste. Greenhouse gases – effect, acid rain. Noise pollution reduction. Aspects of pollution from various power plants.

ENVIRONMENTAL ACTIVITIES — 0 0 15 15

Group activity on water management – Group discussion on recycle of waste (4R's)- Slogan making contest – Poster making event – Expert lecture on environmental awareness – Imparting knowledge on reduction of electricity usage.

Identification and segregation of biodegradable and non-biodegradable waste – Campus cleaning activity – Plantation of trees in the college campus and local waste lands – Identification of varieties of plants and their usage – Shutting down the fans and ACs of the campus for an hour.

Total (30L+15P) = 45 Periods

Text Books:

1.	Elements of Environmental science and Engineering, P.Meenakshi, Prenitce — Hall of India, New Delhi, 2009.
2.	A Textbook of Environmental Chemistry and Pollution Control: (With Energy, Ecology, Ethics and Society), Revise Edition, Dr. S.S. Dara, D.D. Mishra Published by S. Chand & Company Ltd, 20 14.

Reference Books:

1.	Introduction to Environmental Engineering and Science, Gilbert M. Masters; Wendell P. Ela Publisher: Prentice-Ha India, 3rd Edition, 2008.
2.	Environmental Science, F;ldren D. Enger, Bredley F.Smith, WCD McGraw Hill 14"' Edition 2015.

E-Reference

1	www.onlinecourses.nptel.ac.in/
2	www.ePathshala.nic.in

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	To identify about the major renewable energy systems and will investigate the environmental impact of various energy sources as well as the consequences of various pollutants.	L2, L4
CO2	:	Predict the methods to conserve energy and ways to make optimal use of the energy for the future.	L3

COURSE ARTICULATION MATRIX

COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1	3			3	1	1				1	2		1
CO2		1	3			3	1	1				1	2		1
Avg		1	3			3	1	1				1	2		1
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22EN401	PLACEMENT AND SOFT SKILLS LABORATORY	SEMESTER IV			
PREREQUISITES	**CATEGORY**	**HS**	**Credit**		**2**
NIL	**Hours/Week**	**L**	**T**	**P**	**TH**
		0	**0**	**4**	**4**

1.	Basic knowledge in reading skill and writing skill
2.	Basic ability in listening skill and speaking skill

Course Objectives:

1.	To develop the students' confidence and help them to attend interviews successfully
2.	To express opinions, illustrate with examples and conclude in group discussions
3.	To acquire knowledge to write error free letters and prepare reports
4.	To enhance the employability and soft skills of students

Unit I	**WRITING SKILLS**	**12**	**+**	**0**

Letter seeking permission to go on industrial visit, Letter of invitation, Resume and cover letter, Job application, E-mail writing, Report writing, progress in project work

Unit II	**SPEAKING SKILLS**	**12**	**+**	**0**

Welcome address and vote of thanks, Analysing and presenting business articles, Power point presentation, Presenting the visuals effectively, Group discussion, Participating in group discussions, Understanding group dynamics, Brain-storming the topics

Unit III	**SOFT SKILLS**	**12**	**+**	**0**

Employability and career skills, Self-introduction, Introducing oneself to the audience, introducing the topic, Interview skills, Interview etiquette, Dress code, Body language, Attending job interviews

Unit IV	**VERBAL ABILITIES**	**12**	**+**	**0**

Error Spotting, Listening Comprehension, Reading comprehension, Rearranging Jumbled sentences, Vocabulary.

Unit V	**REASONING ABILITIES**	**12**	**+**	**0**

Series completion, Analogy, Classification, Coding-Decoding, Blood relations, Seating Arrangements, Directional Sense, Venn Diagram, Logical reasoning, Statements and Conclusions.

Total (60P) = 60 periods

List of Exercises:

1) Cover Letter and Resume
2) Letter Writing
3) Email Writing
4) Report Writing
5) Power point Presentation
6) Self-Introduction
7) Job Interview
8) Group Discussion
9) Welcome Address
10) Vote of Thanks
11) Presentation of Business Article
12) Jumbled Sentences
13) Error Spotting
14) Reading Comprehension
15) Series completion
16) Analogy
17) Coding-decoding
18) Blood relations
19) Seating arrangements
20) Logical reasoning

Reference Books:	
1.	Campus Recruitment Complete Reference, Praxis Groups (5th edition), Hyderabad, 2017.
2.	John Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi, 2004.
3.	R.S. Aggarwal. A Modern Approach to Verbal & Non-Verbal Reasoning. 2018 S Chand Publication, 2018
E-References:	
1.	https://prepinsta.com/
2.	https://www.indiabix.com/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	To participate in group discussion and interview confidently	L3
CO2	:	To develop adequate soft skills and career skills required for the workplace	L6
CO3	:	To make effective presentations on given topics	L6
CO4	:	To apply their verbal ability and reasoning ability in campus interviews	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				1					2	3		1			1
CO2				2					2	3		1			2
CO3				2					1	3		1			1
CO4				1					2	3		1			2
Avg				1.5					1.75	3		1			1.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC406	ANALOG CIRCUITS LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	PC	Credit		2
		L	T	P	TH
NIL	Hours/Week	0	0	4	4

Course Objectives:

1.	To understand the analysis and design of LC and RC oscillators , amplifiers and multi vibrators.
2	To apply operational amplifiers in Linear and Nonlinear Applications.
3	To uses imulation tools for circuit design.

EXPERIMENTS

1.	Design of RC Phase shift oscillator and We in Bridge oscillator.
2.	Design of Hartley and Colpitts oscillator.
3.	Design of Tuned Class C Amplifier.
4.	Design of As table ,Mono stable and Bi stable multi vibrators using BJ T.
5.	Simulation of As table Mono stable and Bi stable multi vibrators.
6.	Design of basic Circuits using Op - amp 741.
7.	Active Low pass, High pass and Band pass filter.
8.	As table, Mono stable multi vibrators using Op-Amp.
9.	Schmitt Trigger using op-amp.
10.	Phase shift and Wien bridge oscillator using op-amp.
11.	As table and Mono stable multi vibrators using NE 555 Timer.
12.	High voltage regulator using LM723.

Total(60P)=60 Periods

References:

1.	Analog Electronic circuits Laboratory Manual.2. David A .Bell," Electronic Devices and Circuits",5th Edition, Oxford University Press,
2.	B.Sasikala,S.PoornachandraRao,"Handbook of experiments in Electronics and Communication Engineering ",Vikas Publishing,2007.

E-References:

1.	http://www.srmuniv.ac.in/sites/default/files/2017/15EI205L-manual-full.pdf
2.	http://www.gopalancolleges.com/gcem/course-material/ece/manuals/sem-lll/analog-electronics-laboratory-manual-10ESL37.pdf
3	https://www.slideshare.net/vampec/ec-ii-lab-manual

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Design oscillators, multi vibrators and power amplifiers for the variety of engineering applications.	L6
CO2	:	Design Filters Using Op amp and Perform Experiment on Frequency Response.	L3, L4
CO3	:	Design and simulate multi vibrators using Simulation Tool.	L4
CO4	:	Design Oscillators and multi vibrators using operational amplifiers	L6
CO5	:	Understand the concept of high voltage regulators	L2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3							1	1	1	2	
CO2	2	3	3	3							1	1		2	
CO3	2	2			3								1		2
CO4	2	2		3	3									3	
CO5	2		2	2	3						1	1	2		1
Avg	2	2	1.6	2.2	1.8						0.6	0.6	2		1.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC407	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	PC	Credit		2
NIL	Hours/Week	L	T	P	TH
		0	0	4	4

Course Objectives:

1.	To introduce students with the architecture and operation of 8086 microprocessor and 8051 microcontroller.
2.	To familiarize the students with the programming and interfacing of 8086 microprocessor and 8051 microcontroller.
3.	To provide strong foundation for designing real world applications using 8086 microprocessor and 8051 microcontroller.

EXPERIMENTS

8086 Programs

1.	Kit Familiarization.
2.	Implementation of Basic Arithmetic and Logic operations.
3.	Implementation of Square, Square root and Cube Program.
4.	Implementation of Code conversion and Matrix operations.
5.	Implementation of String manipulation operations and Sorting and Searching.
6.	Peripheral Interfacing of keyboard and display.
7.	Implementation of Traffic light Control.
8.	Implementation of Serial and Parallel Communication.
9.	Design of programs for Digital clock and Stop watch.
10.	Implementation of Stepper Motor Control.

8051 Programs

11.	Implementation of basic arithmetic and Logical operations.
12.	Implementation of finding Square and Cube, 2's complement of a number.
13.	Implementation of programs on different addressing modes.
14.	A/D and D/A interfacing.
15.	Waveform generation using 8051.

Total (60P)= 60 Periods

References:

1.	" Microprocessors and Microcontrollers Lab Manual" prepared by ECE Department.
2.	https://www.studocu.com/in/document/anna-university/microprocessor-and-microcontroller/microprocessor-microcontroller-labaratory-manual-pdf/17250102

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Perform basic operations in 8086 microprocessor and 8051 microcontroller.	L2
CO2	:	Interface peripherals with 8086 microprocessor.	L3
CO3	:	Generate waveforms using Microcontroller.	L3
CO4	:	Develop assembly language programs for various applications using 8051 microcontroller	L3
CO5	:	Interface peripherals with 8051 microcontroller.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3											2	2	
CO2	2	3		2	2								2	3	
CO3	2	3		2	2								2	2	
CO4	2	3		2	2								2	3	2
CO5	2	3		2	2								2	2	
Avg	2	3		1.6	1.6								2	2.4	0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

SEMESTER V

22EC501	DIGITAL COMMUNICATION				SEMESTER V	
PREREQUISITES:		CATEGORY	PC	Credi		3
		Hours/Week	L	T	P	TH
			3	0	0	3
1.	Analog Communication					

Course Objectives:

1.	Understand the building blocks of digital communication system and to prepare mathematical background for communication signal analysis .
2.	Express pass-band data transmission and comparison of Digital modulation systems.
3.	Analyze the error performance of a digital communication system in the presence of noise and other interferences. Understand the concept of spread spectrum communication system.

Unit I	DETECTION AND ESTIMATION & SAMPLING PROCESS	9	0	0	9

Model of Digital Communication System - Gram-Schmidt orthogonalization procedure – Geometric interpretation of signals – Detection of known signals in noise - Probability of error - Correlation receiver - Matched filter receiver – Detection of signals with unknown phase in noise – Estimation: concepts and criteria - Sampling process: proof for sampling and reconstruction– PAM - Other forms of pulse modulation –TDM - Waveform coding techniques: PCM - DPCM - Delta modulation – Adaptive Delta Modulation.

Unit II	BASEBAND TRANSMISSION OF DIGITAL SIGNALS	9	0	0	9

Discrete PAM signals - Inter Symbol Interference - Nyquist's criterion for Distortion less Base band Binary Transmission - Correlative level coding - Duo binary and modified duo binary signalling – Eye patterns – Baseband M-ary PAM Systems – Adaptive Equalization for data transmission.

Unit III	PASSBAND TRANSMISSION OF DIGITAL SIGNALS	9	0	0	9

Digital Modulation Formats - Coherent Binary Modulation Techniques: Generation – Detection - Signal space diagram - Bit error probability - Power spectra and waveforms of BPSK, BFSK, QPSK and MSK schemes – Non Coherent Binary Modulation Techniques: BFSK, Differential phase shift keying – Comparison of binary and quaternary modulation techniques – Introduction to M – ary Modulation techniques – Synchronization: Carrier and symbol synchronization - Applications.

Unit IV	ERROR CONTROL CODING	9	0	0	9

Rationale for coding and types of codes - Discrete memory less channels – Linear block codes - Cyclic codes - Cyclic redundancy check codes - Convolutional codes – Maximum likelihood decoding of convolutional codes-Viterbi Algorithm - Trellis coded Modulation - Maximum length and Gold codes.

Unit V	SPREAD SPECTRUM MODULATION AND MULTIPLE ACCESS TECHNIQUES	9	0	0	9

Pseudo-Noise sequences – A notion of spread spectrum – Direct sequence spread spectrum with coherent binary phase shift keying – Signal space Dimensionality and processing gain –Probability of error – Frequency Hop Spread Spectrum (FHSS) - Applications --Multiple Access Techniques: TDMA , FDMA, CDMA and SDMA.

Total (45L)= 45 periods

Text Books:

1. Simon Haykins, "Digital Communications" John Wiley, 2017.
2. Theodore S.Rappaport , "Wireless Communications :Principles and Practice", 2nd Edition.", Pearson,2012.

Reference Books:	
1.	Taub & Schilling, "Principles of Digital Communication", 28th reprint , Tata McGraw-Hill, 2014.
2.	R.N.Mutagi,"Digital Communication", 2nd Edition, Oxford University Press, 2013
3.	Dennis Roddy, John Coolen,"Electronic Communications", 10th impression, Pearson Prentice Hall, 2013.
4.	John G.Proakis, "Digital Communication", 3rd Edition, Tata McGraw-Hill, 1995.
E-References:	
1.	http://www.nptelvideos.in/2012/11/communication-engineering.html
2.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-973-communication-system-design-spring-2006/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Analyze the sampling process and the performance of a baseband and pass band digital communication system in terms of error rate	L2
CO2	:	Able to analyse the system using eye patterns	L3
CO3	:	Select the modulation schemes for particular applications	L3
CO4	:	Perform the time and frequency domain analysis of the signals in a digital communication system and design error free communication.	L4
CO5	:	Understand the concept of secured communication and multiple access techniques	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1								2		2
CO2	2	1	1	2	1								1		2
CO3	1	1	1	1	1								1		1
CO4	2	1	1	1	1								2	2	2
CO5	2	1	1	1	1								2		1
Avg	1.8	1.2	1.2	1.4	1								1.6	0.4	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC502	DIGITAL SIGNAL PROCESSING	SEMESTER V

PREREQUISITES:	CATEGORY	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

1.	Signals and Systems

Course Objectives:

1.	To analyse the Discrete Fourier Transform, Fast Fourier Transform algorithms.
2.	To design and realize IIR FIR filters to understand finite word length effects on digital filters.
3.	To gain knowledge of DSP architecture, Programming and concepts of Multi rate signal processing.

Unit I	DISCRETE FOURIER TRANSFORM	9	0	0	9

Introduction to DFT–Properties of DFT-Circular convolution -FFT algorithms–Radix-2 FFT algorithms Decimation in Time and Decimation in Frequency algorithms.

Unit II	INFINITE IMPULSE RESPONSE FILTER DESIGN	9	0	0	9

Characteristics of Analog Butterworth filter-Chebyshev filter-Low pass filter, High pass filter, Band pass filter and Band stop filter-Transformation of analog filters in to equivalent digital filters using bilinear transformation method -Realization structure for IIR filters-Direct form-Cascade form-Parallel form.

Unit III	FINITE IMPULSE RESPONSE FILTER DESIGN	9	0	0	9

Linear phase response of FIR filter - FIR design using window method: Rectangular, Hamming, Hanning and Blackman Windows - Park-McClellan's method - Realization structures for FIR filters - Linear phase structures and Direct form structure-Comparison of FIR and IIR filters.

Unit IV	FINITE WORD LENGTH EFFECTS	9	0	0	9

Representation of numbers-Quantization by truncation and rounding– Derivation for quantization noise power–co-efficient quantization error – Product quantization error – Round off noise power - Limit cycle oscillations due to product round off and over flow errors –scaling to prevent overflow.

Unit V	DSP APPLICATION SAND DIGITALSIGNAL PROCESSOR	9	0	0	9

Introduction to Multi Rate signal processing: Decimation, Interpolation-Introduction to DSPTMS320C54X processor: Architecture- Instruction set-Addressing modes.

Total (45L)= 45 periods

Text Books:

1.	S.K.Mitra, "Digital Signal Processing, A Computer Based approach",4th Edition,McGraw-Hill,2013.
2.	John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", 5th Edition,Pearson Education, 2022.

Reference Books:

1.	Emmanuel C. I feacher, Barry W.Jervis,"Digital Signal Processing :A Practical Approach ",2nd Edition, Pearson Education, 2004.
2.	A.V. Oppenheim, R.W.Schaferand J.R. Buck,"Discrete-TimeSignalProcessing",3rd EditionPrenticeHall,
3.	L.R.Rabinerand B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
4.	J.R.Johnson, "Introduction to Digital Signal Processing", Prentice Hall,1992.

E-References:

1.	https://www.coursera.org/learn/dsp
2.	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/
3.	www.nptelvideos.in/2012/12/digital-signal-processing.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse the need for Discrete Fourier Transform, Fast Fourier Transform algorithms in digital signals & systems.	L4
CO2	Design and realize IIR filters	L6
CO3	Design and realize FIR filters	L6
CO4	Analyse finite Word length effect on filters.	L4
CO5	Apply the concepts of Multi rate signal processing and Gain the knowledge on DSP architecture and programming	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1								1	1	1
CO2	3	2	2	2	1		1						1	1	1
CO3	3	2	2	2	1		1						1	1	1
CO4	3	2	2	2	1		1						1	1	1
CO5	1	1	1	1	1								2	2	1
Avg	2	2	1.6	1.6	1		0.6						1.2	1.2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC503	EMBEDDED SYSTEMS	SEMESTER V

PREREQUISITES:	CATEGORY	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

1.	Microcontrollers

Course Objectives:

1.	To impart knowledge on embedded system architecture and embedded development strategies.
2.	To understand the bus communication in processors and peripheral interfacing.
3.	To understand basics of Real Time Operating Systems.

Unit I	INTRODUCTION TO EMBEDDED SYSTEMS	9	0	0	9

Introduction to Embedded Systems –Structural units in Embedded processor , selection of processor and memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target

Unit II	EMBEDDED NETWORKING	9	0	0	9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.

Unit III	EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT	9	0	0	9

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented

Unit IV	RTOS BASED EMBEDDED SYSTEM DESIGN	9	0	0	9

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

Unit V	EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT	9	0	0	9

RFID Systems - GPS Navigation System - Automotive Application - Smart card System Application-ATM machine –Digital

Total (45L)= 45 periods

Text Books:

1.	Peckol, “Embedded system Design”, John Wiley & Sons,2010
2.	Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013

Reference Books:

1.	Shibu. K.V, “Introduction to Embedded Systems”, 2e, Mcgraw Hill, 2017.
2.	Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, McGraw Hill, 2013
3.	Tammy Noergaard, ―Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4.	Rajib Mall “Real-Time systems Theory and Practice” Pearson Education, 2007.

E-References:

1.	https://lecturenotes.in/subject/225/embedded-system-es
2.	https://nptel.ac.in/courses/108102045/19
3.	https://www.coursera.org/learn/introduction-embedded-systems

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	Understand the basics of embedded systems	L2
CO2	Study about the bus communication and peripheral interfacing	L1

CO3	Know about the embedded product development and modeling	L2
CO4	Acquire knowledge on Real time operating system	L2
CO5	Design and Analyze the real-time applications of embedded-systems	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2		1	2	2								1		
CO2	2		2	2	2								2		2
CO3	2	1	3	3	2				2				2	1	2
CO4	2		3	2	3								1	1	1
CO5	2	2	3	3	3	2	2		2				2	2	2
Avg	2	0.6	2.4	2.4	2.4	0.4	0.4		0.8				1.6	0.8	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC504	PRINCIPLES OF MANAGEMENT	SEMESTER V				
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To enable the students to study the evolution of Management
2.	To study the functions and principles of management
3.	To learn the application of the principles in an organization.
4.	To emphasize the need for Data display recording and systems

Unit I	**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**	**9**	**0**	**0**	**9**

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

Unit II	**PLANNING**	**9**	**0**	**0**	**9**

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

Unit III	**ORGANISING**	**9**	**0**	**0**	**9**

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

Unit IV	**DIRECTING**	**9**	**0**	**0**	**9**

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

Unit V	**CONTROLLING**	**9**	**0**	**0**	**9**

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.

Total (45L)= 45 Periods

Text Books:

1.	JAF Stoner, Freeman R.E and Daniel R Gilbert “Management”, 6th Edition, Pearson Education, 2004.
2.	Stephen P. Robbins & Mary Coulter, “Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.

Reference Books:

1.	Harold Koontz & Heinz Weihrich, “Essentials of Management”, Tata McGraw Hill, 1998.
2.	Robert Kreitner & Mamata Mohapatra, “Management”, Biztantra, 2008.
3.	Stephen A. Robbins & David A. Decenzo& Mary Coulter, “Fundamentals of Management”, 7th Edition, Pearson Education, 2011.
4.	Tripathy PC & Reddy PN, “Principles of Management”, Tata Mcgraw Hill, 1999

E-References:	
1.	https://nptel.ac.in/courses/122108038/
2.	https://www.coursera.org/learn/fundamentals-of-management
3.	https://www.digimat.in/nptel/courses/video/110107150/L01.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling and have same basic knowledge on international aspect of management	L2
CO2	To have same basic knowledge on international aspect of management.	L1
CO3	To Gain Basic knowledge on international aspect of management.	L1
CO4	To help the students to develop cognizance of the importance of management principles.	L2
CO5	To enable them to analyze and understand the environment of the organization.	L2,L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	3								1	2	3
CO2	3	3	3	3	3								2	2	3
CO3	3	2	3	2	3								1	2	3
CO4	3	1	2	1	3								1	3	2
CO5	3	1	2	1	2								1	3	3
Avg	3	2	2.6	2	2.8								1.2	2.4	2.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22MCIN04	IDEATION SPRINTS		SEMESTER V			
PRE-REQUISITE:		Category	EE	Credit		1
		Hours/Week	L	T	P	TH
			0	0	2	2

Course Objectives:

1.	To offer a systematic and structured process to hack a solution using available tools & resources
2.	To identify the challenge/opportunity, derive insights from the customer/user interviews, & build a solution and validate the technical feasibility of the solution
3.	To build the PoC for proposed solution & pitch to user/customer for validation.

UNIT I	INNOVATION 101	0	0	6	6

Difference between a startup and a small business enterprise - Idea worth prototyping -Risk of innovations - Defining &validating hypothesis through Product Innovation Hypothesis (PIH) & Forge Innovation Rubric (FIR)

UNIT II	PROBLEM VALIDATION & CUSTOMER DISCOVERY	0	0	6	6

Tools and techniques of the managed innovation process (iTOOLS - innovation toolkit) -Customer-Centric Innovation: Customer-centric design thinking and validate the problem scenario, its significance, severity, and incidence - Discover & identify the right buyer beneficiary/Customer - rigorous Gap analysis of the existing solution - Adoption barriers of the solutions.

UNIT III	DESIGNING & CRAFTING VALUE PROPOSITION	0	0	6	6

Understand Customer Jobs, Pains & gains - Design Product/Service - Define & quantify Value Proposition -Build a compelling value proposition.

UNIT IV	MUP SOLUTION CONCEPT EXPLORATION & DESIGN GENERATION	0	0	6	6

Solution: Concept Generation, Concept Assessment, Solution, Capability, Usability, and Feasibility- MUP Design and Technology Block Diagrams- Bill of Materials Generation - BoM Optimization

UNIT V	PROOF OF CONCEPT DEVELOPMENT & DEMONSTRATION	0	0	6	6

Proof-of-Concept design - hack to build PoC with critical features -Test PoC for technical feasibility test deliver of Value proposition - Innovation Brief documentation (Proposal) - Demonstrate a PoC;

Total = 30 Periods

Text Books:

1.	Tim Brown, Change by Design:How design thinking transforms organizations and inspires innovation – HarperCollins e-books, 2009
2.	Alexander Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want (Strategyzer) - John Wiley & Sons, 2014
3.	Ulrich Karl and Eppinger Steven D, Product Design and Development - McGraw Hill, 5th edition, 2020
4.	Blank Steve, Four Steps to Epiphany: Successful strategies for products that win, KS Ranch, 5th edition, 2013

Reference Books:

1.	Everything you need about value proposition: https://blog.forgeforward.in/everything-you-need-to-know-about-value-proposition-7247493c940c
2.	Test your Value Proposition:http://businessmodelalchemist.com/2012/09/test-your-value-proposition-supercharge-lean-startup-and-custdev-principles.html
3.	Valuation Risk versus Validation Risk in Product Innovations:https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624
4.	User Guide for Product Innovation Rubric:https://blog.forgeforward.in/user-guide-for-product-innovation-rubric-857181b253dd
5.	Innovation Risk Diagnostic - Product Innovation Rubric:https://blog.forgeforward.in/product-innovation-rubric-

	adf5ebdfd356
6.	Evaluating Product Innovations - proof, potential, & progress:https://blog.forgeforward.in/evaluating-product-innovations-e8178e58b86e

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Apply a scientific method to understand the inherent risks of product innovation	Apply
CO2	Apply innovation tools & techniques to validate the problem scenario and to assess the market potential of product innovation;	Apply
CO3	Design solution concept based on the proposed value by exploring various alternate solutions to achieve value-price fit;	Design
CO4	Demonstrate technical skills by applying technology to build and demonstrate proof of concept for the solution proposed;	Develop
CO5	Develop skills to articulate the solution concept into a proposal for grants.	Develop

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
CO5															
Avg															

3 / 2 / 1 – indicates strength of correlation (3 – High, 2 – Medium, 1 – Low)

22EC505	COMMUNICATION SYSTEMS LABORATORY	SEMESTER V				
PREREQUISITES		CATEGORY	PC	Credit		2
		Hours/Week	L	T	P	TH
			0	0	4	4

Course objectives:

1.	To make the students to understand the basics of analog and digital modulation techniques
2.	To deal with the different pulse modulation schemes.
3.	To simulate different modulation scheme using suitable tool.

EXPERIMENTS

1.	Generation and detection of AM signal
2.	Generation and detection of FM signal
3.	Pulse Amplitude Modulation
4.	Pulse Width Modulation
5.	Pulse Position Modulation
6.	Sampling and reconstruction of signals
7.	Digital Modulation Techniques: ASK,PSK,FSK,QPSK
8.	Delta and Adaptive Delta modulation
9.	Pulse Code Modulation
10.	Time Division Multiplexing and De multiplexing
11.	Generation of various line codes.
12.	Simulation and performance analysis of analog and digital modulation techniques .

Total (60P)= 60 Periods

Text Books:

1.	S.Poorna Chandra, B.Sasikala, “Electronics Laboratory Primer”, S.Chand& Company Ltd, 2010.
2.	L.K. Maheshwari, M.M.S. Anand, “Laboratory Manual for Introductory Electronics Experiments”, New age International (P) Limited Publishers, 2010.
3.	Simon Haykin S., "Digital Communications Systems", 3rd Edition, John Wiley and Sons, 2013.

Reference Books:

1.	Simon Haykins, “Digital Communications” John Wiley, 2017.
2.	Taub & Schilling, “Principles of Digital Communication”, 28threprint , Tata McGraw-Hill, 2014.
3.	R.N.Mutagi,”Digital Communication”, 2nd Edition, Oxford University Press, 2013
4.	Dennis Roddy, John Coolen,”Electronic Communications”, 10th impression, Pearson Prentice Hall, 2013.

E-References:

1.	https://umairbfrend.files.wordpress.com/2015/01/analogue-digital-communication-manual_august-2015.pdf
2.	https://stannescet.ac.in/cms/staff/qbank/ECE/Lab_Manual/EC8561-_COMMUNICATION%20SYSTEM%20LABORATORY-2062944779-EC%208461%20communication%20systems%20manual.pdf

3.	www.vlab.co.in/ba-nptel-labs-electronics-and-communications

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Generate and analyse analog and digital modulated signals.	L4
CO2	:	Sample the given analog signal for various sampling frequency.	L4
CO3	:	Generate various line codes for digital signals.	L3
CO4	:	Multiplex and de multiplex digital signals	L3
CO5	:	Write codes for various analog and digital modulation schemes.	L3

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1	2							1	2	2	2
CO2	1	2	2	1	2							1	1	2	2
CO3	1	2	2	1	2							1	2	2	2
CO4	1	2	2	1	2							1	1	2	2
CO5	2	2	2	1	2							1	2	2	2
Avg	2.8	2	2	1	2							1	1.6	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC506	DIGITAL SIGNAL PROCESSING LABORATORY	SEMESTER V

PREREQUISITES	CATEGORY	PC	Credit		2
	Hours/Week	L	T	P	TH
1.Signals and Systems		0	0	4	4

Course objectives:

1.	To implement basic signals operations using a software tool.
2.	To design FFT algorithms, IIR and FIR filters.
3.	To verify the various basic signal processing technique.

EXPERIMENTS

1.	Generation of Signals
2.	Discrete-time convolution
3.	Circular convolution of two sequences
4.	Sampling and effect of aliasing
5.	Spectrum analysis using Discrete Fourier Transform
6.	Calculation of FFT of a signal using a) Decimation in time algorithm b) Decimation in frequency algorithm
7.	Design of FIR filters using a)Windowing technique b)Frequency sampling method
8.	Design of IIR digital filter using Bilinear transformation
9.	Design of IIR digital filter using Impulse invariant method
10.	Verification of BIBO stability of a system.

Total (60P)= 60 Periods

Text Books:

1.	Digital Signal Processing Using MATLAB, Vinay K.Ingle, John G.Proakis,Cent age learning, 3rd Edition,2012
2.	Sanjit K. Mitra,"Digital Signal Processing",3rd Edition, McGraw Hill Higher Education,2007.

Reference Books:

1.	Simon Haykins, "Digital Communications" John Wiley, 2017.
2.	Taub & Schilling, "Principles of Digital Communication", 28threprint , Tata McGraw-Hill, 2014.
3.	R.N.Mutagi,"Digital Communication", 2nd Edition, Oxford University Press, 2013
4.	Dennis Roddy , John Coolen , "Electronic Communications", 10th impression, Pearson Prentice Hall, 2013.

E-References:

1.	https://nptel.ac.in/courses/117102060/
2.	Studentsfocus.com/notes/anna_university/ECE/5SEM/EC6511%20%20DSP%20Lab/EC%206511%20DIGITAL%20SIGNAL%20PROCESSING%20LAB%20MANUAL_2013_regulation.pdf
3.	vlab.co.in/ba_nptel_labs.ph p? id =1

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Generate and analyse various signal processing algorithms.	L4
CO2	Implement FFT algorithms, Linear/Circular convolution.	L4
CO3	Design FIR filters.	L6
CO4	Design IIR filters.	L6
CO5	Verify and understand system stability.	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	3			1		1			1	1	1
CO2	3	3	1	1	3			1		1			1	1	1
CO3	3	3	2	2	3			1		1			1	1	1
CO4	3	3	2	2	3			1		1			1	1	1
CO5	3	3	2	2	3			1		1			1	1	1
Avg	3	3	1.6	1.6	3			1		1			1	1	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

SEMESTER VII

22EC701	VLSI DESIGN		SEMESTER VII			
PREREQUISITES:		**CATEGORY**	**P**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**
1.	Transmission lines and					

Course Objectives:

1.	To understand the concepts of MOS transistors operations and their AC and DC characteristics.
2.	To understand the fabrication process of CMOS technology and its layout design rules.
3.	To design Data path systems and Subsystems using Verilog HDL and Learn FPGA architectures

Unit I	**MOS TRANSISTOR THEORY**	**9**	**0**	**0**	**9**

NMOS, PMOS Enhancement transistor - Threshold voltage - Body effect – MOS device: Basic DC equations - Channel length modulation - Mobility variation - MOS models - Small signal AC characteristics Complementary CMOS inverter: DC characteristics - Noise Margin - Rise time - Fall time – Power dissipation Transmission gate – Stick diagram – Layout diagram.

Unit II	**CMOS TECHNOLOGY**	**9**	**0**	**0**	**9**

An overview of Silicon semiconductor technology - Basic CMOS technology: n-well - P well - Twin tub and SOI Process – CMOS process enhancements: Interconnects - Circuit elements: Resistors – Capacitors - Electrically Alterable ROMs - Bipolar transistors - Latch up and its prevention techniques.

Unit III	**DATA PATH SYSTEMS AND ARRAY OF SUBSYSTEMS**	**9**	**0**	**0**	**9**

Data path Subsystems: Addition/Subtraction - One/Zero Detectors – Comparators – Counters - Multiplication - Array Subsystems: SRAM – DRAM - Read-Only Memory.

Unit IV	**VERILOG HARDWARE DESCRIPTION LANGUAGE**	**9**	**0**	**0**	**9**

Basic Concepts: VLSI Design flow - Modules and ports - Switch level modelling - Gate level modelling – Data flow modelling – Behavioral modelling - Structural gate level description of decoder - Equality detector – Comparator - Priority encoder - D-flip flop - Half adder - Full adder - Ripple Carry Adder.

Unit V	**CMOS CHIP DESIGN**	**9**	**0**	**0**	**9**

ASIC design flow - CMOS chip design options: Full custom ASIC - Standard Cell based ASIC - Gate Array based ASIC - Channelled - Channel less and structured GA - Programmable logic structures; Programming of PALs - Programmable Interconnect - Reprogrammable GA - Need for CMOS testing.

Total (45L)= 45 periods

Text Books:

1.	Neil H. E. Weste & David Money Harris, "CMOS VLSI Design Circuits and System perspective ", 2nd Edition, Pearson Education, 2016
2.	Samir Palnitkar: "Verilog HDL" A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, 2012

Reference Books:

1.	Douglas.A.Puchnell, Kamran Eshraghian, "'Basics VLSI Design and Circuits", 3rd Edition, Prentice Hall India 2011.
2.	M.J.S .Smith, "Application - Specific Integrated Circuits", Pearson Education, 2009.
3.	V.G.Kirankumar, H.R.Nagesh, "Introduction to VLSI Design", Pearson Education, 2011
4.	Wayne Wolf, " Modern VLSI Design", Pearson Education, 2003.

E-References:	
1.	https://freevideolectures.com/Subject/VLSI-and-ASIC-Design 2. 3.
2.	https://www.tutorialspoint.com/vlsi_design/vlsi_design_useful_resources.html
3.	https://nptel.ac.in/courses/117101058

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the concept of MOS transistors, use analytical methods and circuit analysis models in analysis of CMOS circuits.	L3
CO2	Understand the CMOS process technology and design layout diagrams.	L2
CO3	Able to learn and design data path systems and array of subsystems.	L3
CO4	Model the digital system using Verilog Hardware Description Language and	L3
CO5	Learn FPGA architectures and need for CMOS testing.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	2														1
CO2	1														1
CO3	2														1
CO4	2	1		2	3								1	2	1
CO5			2	2										2	1
Avg	1.4	0.2	0.4	0.8	0.6								0.2	0.8	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC702	OPTICAL AND MICROWAVE ENGINEERING	SEMESTER VII

PREREQUISITES:	CATEGORY	PC	Credit	3
	Hours/Week	L	T	P	TH
		3	0	0	3

1.	Digital Electronics

Course Objectives:

1.	To understand and gain knowledge about various microwave components.
2.	To study the microwave generation and amplification using microwave solid-state devices.
3.	To study the microwave generation and amplification using microwave tubes.
4.	To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors.
5.	To understand the working of optic transmitters and receivers.

Unit I	MICROWAVE COMPONENTS	9	0	0	9

Review of low frequency parameters: Z, Y and ABCD Parameters - Introduction to S parameters -properties of S Matrix-Hybrid Circuits - Waveguide Tees - Magic Tees (Hybrid Tees) - Hybrid Rings (Rat-Race Circuits) -Waveguide Corners - Bends and Twists - Directional Couplers - Two-Hole Directional Couplers -S Matrix of a Directional Coupler - Hybrid Couplers - Circulators and Isolators.

Unit II	CMOS TECHNOLOGY	9	0	0	9

Introduction- Gunn Effect Diodes – GaAs Diode - Ridley-Watkins – Hilsum (RWH) Theory - Modes of Operation - Microwave Generation and Amplification - Avalanche transit - Time devices – Introduction - Read Diode -IMPATT Diodes - TRAPATT Diodes - BARITT Diodes - Parametric Devices

Unit III	MICROWAVE TUBES	9	0	0	9

Klystrons - Two cavity Klystron Amplifiers - Reflex Klystrons - Velocity Modulation - Power Output and Efficiency - Electronic Admittance - Helix Traveling Wave Tubes (TWTs) – Slow Wave structures - Amplification Process - Convection Current - Axial Electric Field - Wave Modes - Gain Consideration - Magnetron Oscillators - Cylindrical Magnetron - Coaxial Magnetron.

Unit IV	SIGNAL DEGRADATION IN OPTICAL FIBERS	9	0	0	9

Optical fiber structure and parameters – fiber types, Standard Single mode and multimode Fibers - Attenuation - Absorption losses - Scattering losses - Bending Losses - Core and Cladding losses - Signal Distortion in Fibers - Intermodal delay – Intra modal dispersion - Factors contributing to dispersion - Group Delay - Material Dispersion - Wave guide Dispersion - Basics of semiconductor physics – LED – Structures - Light source materials - Quantum efficiency and LED power - LASER diodes.

Unit V	FIBER OPTICAL RECEIVERS AND DIGITAL TRANSMISSION SYSTEM	9	0	0	9

Physical principles of photodiodes - PIN photo diode - Avalanche photo diodes – Photo detector noise - SNR-Detector response time - Double Hetero structure photodiodes - structure for In GaAS APDs -Temperature effect on avalanche gain - Fundamental receiver operation - Digital signal transmission - Error sources - Front end amplifier - Digital receiver performance - Receiver sensitivity - Optical Amplifiers – Types - Erbium Doped fiber amplifier.

Total (45L)= 45 periods

Text Books:

1.	Samuel Y.Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson education, 2008.
2.	Gerd Keiser, “Optical Fiber Communication”, 3rd& 4th Edition, McGraw –Hill International, 2012

Reference Books:

1.	R.E. Collin, “Foundations for Microwave Engineering”, 2nd Edition, IEEE Press, 2002.
2.	David M.Pozar, “Microwave Engineering”, 2nd Edition, John Wiley & Sons, 2003

3.	Govind P. Agrawal, "Fiber-Optic Communication Systems", John Wiley & Sons, reprint, 3rd Edition, 2012
4.	S.C.Gupta, “Textbook on Optical Fiber Communication and its applications”, 2nd Edition, PHI, 2012.
E-References:	
1.	https://nptel.ac.in/courses/108101112/
2.	http://nptel.ac.in/courses/113104012/
3.	http://nptel.ac.in/courses/115102026/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom’s Taxonomy Mapped
CO1	Explain the active and passive microwave components used in microwave communication.	L1
CO2	Have an in-depth knowledge of microwave generation and amplification.	L2
CO3	Calculate the degradation in the signal due to losses and dispersion.	L4
CO4	Ability to identify, understand and evaluate fiber transmission characteristics for real time link design.	L3
CO5	Explain the various optical sources and optical detectors and their use in the optical communication system.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO1	PSO2	PSO3
CO1		2	2	2							1		1	2	1
CO2		3	2	3							2		1	2	1
CO3		2	2	2									2	1	2
CO4		2	2	2							2		2	1	2
CO5		1	2	2							1		1	2	1
Avg		2	2	2.2							1.2		1.4	1.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC703	WIRELESS AND MOBILE COMMUNICATION	SEMESTER VII

PREREQUISITES		CATEGORY	PC	Credit		3
		Hours/Week	L	T	P	TH
1.	Digital Communication		3	0	0	3

Course Objectives:

1. To make the students understand the basics of wireless and mobile communication
2. To understand the basics and design if cellular system.
3. To have an insight into the various propagation models and the speech coders used in mobile communication

Unit I	INTRODUCTION AND MODERN WIRELESS COMMUNICATION SYSTEMS	9	0	0	9

Introduction to wireless communications - History and evolution – Mobile radio system around the world – Examples of common wireless communication systems - Trends in cellular radio and personal communications - Modern wireless communication systems: 2G Cellular networks – 3G wireless networks - 4G mobile web access - 5G faster wireless network - Wireless network standards

Unit II	THE CELLULAR CONCEPT: SYSTEM DESIGN FUNDAMENTALS AND MODULATION TECHNIQUES FOR MOBILE RADIO	9	0	0	9

Frequency reuse - Channel Assignment strategies - Handoff strategies - Interference and system capacity -Trunking and grade of service - Improving coverage and capacity in cellular systems - Modulation: Combined linear and Constant envelope modulation techniques: Mary PSK, M_ ary QAM, M _ ary FSK and OFDM.

Unit III	MOBILE RADIO PROPAGATION:LARGE SCALE PATH LOSS	9	0	0	9

Introduction to Radio wave propagation - Free-space propagation model - 3 basic propagation mechanisms and models: reflection - Ground reflection model – Diffraction - Knife-edge diffraction model -Scattering – radar cross section model - Practical Link budget design using path loss models - Outdoor propagation models - Indoor propagation models

Unit IV	MOBILE RADIO PROPAGATION:SMALL-SCALE FADING AND	9	0	0	9

Small-Scale fading: Small scale multipath propagation - Impulse response model of a multipath channel - Small-scale multipath measurements - Parameters of mobile multipath channels – Types of small-scale fading- Introduction to shape factors: Angular spread - Angular constriction - Azimuthal Direction of maximum fading.

Unit V	EQUALISATION,DIVERSITY AND CHANNEL CODING	9	0	0	9

Equalisation: Fundamentals – Training a generic adaptive equalizer – Equalizers in a communication receiver -Survey of equalization - Linear equalizers - Nonlinear equalization - Algorithms for adaptive equalization – Diversity: Practical Space Diversity Considerations - Polarization diversity -Frequency diversity -Time diversity - RAKE receiver – coding: Speech coding – Vocoders - LPC-Choosing Speech Codecs for Mobile communication - GSM codec - USDC codec

Total (45L) = 45 periods

Text Books:

1. Theodore S.Rappaport , “Wireless Communications: Principles and Practice”, 2nd Edition.”, Pearson,2012.
2. Simon Haykin, “Digital Communications” Student Edition, John Wiley & sons, 2008.

Reference Books:

1. A.Molisch,Wiley, “Wireless Communications”, 2nd Edition, 2010.
2. V.K. Garg, “Principles and Applications of GSM”, Pearson Edition.
3. V.K. Garg, “IS-95 CDMA and CDMA 2000”, Pearson Edition.
4. S. Haykins, “Communication Systems”, 5th Edition, John wiley, 2008.

E-References:	
1.	http://www.pdfsdownload.com/download-pdf-for-free/wireless+communication+rappaport
2.	https://www.oreilly.com/library/view/wireless-communications-principles/0130422320/
3.	https://en.wikipedia.org/wiki/Adaptive_equalizer

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Characterize a wireless channel and evolve the system design specifications and understand the difference between wireless compared to wired counterpart.	L2
CO2	:	Design a cellular system, with improved coverage and capacity with the cell structure based on the resource availability and traffic demands and able to calculate interference.	L3
CO3	:	Identify various propagation effects and calculate large scale path loss.	L3
CO4	:	Analyze small scale and multipath fading in mobile environment.	L2
CO5	:	Exploit multiple antenna techniques for capacity / performance gains and design equalizer.	L2

COURSE ARTICULATION MATRIX

Cos/Pos	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO2	PSO3
CO1		1	1	2	1								1	2	1
CO2	2	1	2	2	1								1	2	2
CO3	1	1	1	1	1								1	2	1
CO4	1	1	2	1	1								1	2	1
CO5	1	1	1	1	1								1	2	1
Avg	1	1	1.4	1.4	1								1	2	1.2
3/2/1 – indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC704	OPTICAL AND MICROWAVE ENGINEERING LABORATORY		SEMESTER VII			
PREREQUISITES		CATEGORY	PC	Credit		2
		Hours/Week	L	T	P	TH
1.	Communication systems Lab		0	0	4	4

Course Objectives:	
1.	To Understand the working principle of microwave components.
2.	To Practice microwave measurement procedures.
3.	To Understand the working principle of optical sources, detector, fibres and microwave components.
4.	To Develop and understand simple optical communication link.
5.	To Learn about the characteristics and measurements in optical fibre.
EXPERIMENTS:	
	OPTICAL COMMUNICATION
1.	Determination of Numerical aperture for Fibers and Measurement of Attenuation in fibers.
2.	Mode Characteristics of Fibers – SM Fibers.
3.	Coupling Fibers to Semi-Conductor Sources – Connectors & Splices.
4.	Establish Fiber optic analog and digital communication links.
5.	LED & Photo Diode Characteristics.
	MICROWAVE ENGINEERING
6.	VSWR Measurements.
7.	Determination of terminated impedance.
8.	Determination of guide wavelength and frequency.
9.	Radiation Pattern of Horn antenna.
10.	Microwave Power Measurement.
11.	Characteristics of Gunn diode Oscillator.
12.	Mode Characteristics Reflex Klystron.
13.	Dielectric constant measurements.
14.	Study of Isolator, circulator and Hybrid Tee.
	Total (60P)=60 Periods

References:	
1	Samuel Y.Liao, ―Microwave Devices and Circuits‖, Pearson education, 3rd Edition, 2008.
2	Gerd Keiser, ―Optical Fiber Communication‖ McGraw –Hill International, 3rd& 4th ed., 2012
E-References:	
1	http://nptel.ac.in/courses/113104012/
2	http://nptel.ac.in/courses/115102026/
3	http://nptel.ac.in/courses/113106062/21

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze the performance of simple optical link.	L4
CO2	Gain knowledge on working of LED and photo detector.	L2
CO3	Gain knowledge on testing microwave components.	L3
CO4	Analyze the radiation of pattern of antenna,	L3
CO5	Measure a microwave link's impedance, VSWR, and frequency.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	3	3			2				2		3	2	2
CO2	2	3	3	3			2				2		3	2	2
CO3	2	3	3	3			2				2		3	2	2
CO4	1	3	3	3			2				2		3	2	2
CO5	1	3	3	3			2				2		2	2	2
Avg	1.4	3	3	3			2				2		2.8	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22EC705	VLSI DESIGN AND EMBEDDED SYSTEMS LABORATORY	SEMESTER VII

PREREQUISITES		CATEGORY	PC	Credit		2
		Hours/Week	L	T	P	TH
1.	VLSI Design & Embedded Systems		0	0	4	4

COURSE OBJECTIVES:

1.	To design Digital system using Hardware Description Language.
2.	To practically train the programming concepts using Verilog HDL and implement in FPGA.
3.	Design the Building Blocks of Embedded Systems and simulation tools.

EXPERIMENTS:

	VLSI DESIGN
1.	Design and simulate Combinational circuits using Verilog HDL.
2.	Design and simulate Sequential circuits using Verilog HDL.
3.	Design Traffic light controller using Verilog HDL.
4.	Design Pipelined parallel adder to add 8 number of size 12 bits each in 2's complement.
5.	Design 8 bit signed multiplication algorithm.
6.	Study of FPGA Board.
7.	Implementation of ALU/MAC unit in FPGA.
8.	Implementation of Flip-Flops in FPGA.
	EMBEDDED SYSTEMS
9.	Embedded program for I/O interfacing using PIC controller.
10.	Design a stepper motor controller using LCD and keys in PIC controller.
11.	Generate 3-phase PWM signals and demonstrate the utility of PWM with high bright LED lights using RL 78.
12.	Measure room temperature and display the same in a LCD with keyboard interaction using RL 78
13.	Design an embedded system to measure the unknown signal frequency using timer/counter of RL78.
14.	Demonstrate the usage of watchdog timers and voltage detection facilities of RL78 in an application.
15.	Interface ADC with embedded system trainer kit.
16.	Basic experiments using ARM cortex.

Total (60P)=60 Periods

References:

1	J.Bhaskar, “Verilog HDL Primer” 2nd Edition, 2004.
2	**Alexander G. Dean**, “Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach”.

E-References:

1	https://freevideolectures.com/Subject/VLSI-and-ASIC-Design 2. 3.
2	https://www.tutorialspoint.com/vlsi_design/vlsi_design_useful_resources.html.
3	https://nptel.ac.in/courses/117101058.

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To demonstrate a clear understanding in VeriLog HDL	L6
CO2	Model a combinational circuit and sequential circuit using Verilog HDL.	L6
CO3	Import the logic modules into FPGA boards.	L5
CO4	Write, debug and compile embedded processors programs for a given Application.	L6
CO5	Implement interrupt control for a given embedded System.	L5

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	1	2	1		3	1				1			2	3	1
CO2	1	2	1		3	1				1			2	3	1
CO3	1	2	1		3	1				1			2	3	1
CO4	1	2	1		3	1				1			2	3	1
CO5	1	2	1		3	1				1			2	3	1
Avg	1	2	1		3	1				1			2	3	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

PROFESSIONAL ELECTIVES (PE)

S.No	Course Code	Course Title	Cat.	Hours/Week				Max. Marks		
				L	T	P	C	CA	FE	Total
25.	22ECPE601	Electronic Measurements	PE	3	0	0	3	40	60	100
26.	22ECPE602	Computer Architecture	PE	3	0	0	3	40	60	100
27.	22ECPE603	Digital Image Processing	PE	3	0	0	3	40	60	100
28.	22ECPE604	Machine Learning	PE	3	0	0	3	40	60	100
29.	22ECPE605	Modern Sensors and its Applications	PE	3	0	0	3	40	60	100
30.	22ECPE606	Radar Communication	PE	3	0	0	3	40	60	100
31.	22ECPE607	Internet of Things	PE	3	0	0	3	40	60	100
32.	22ECPE608	Computer Networks	PE	3	0	0	3	40	60	100
33.	22ECPE609	Software Defined Radio	PE	3	0	0	3	40	60	100
34.	22ECPE610	High Speed Networks	PE	3	0	0	3	40	60	100
35.	22ECPE611	Robotics	PE	3	0	0	3	40	60	100
36.	22ECPE612	Virtual Instrumentation	PE	3	0	0	3	40	60	100
37.	22ECPE613	Automotive Electronics	PE	3	0	0	3	40	60	100
38.	22ECPE614	Embedded C	PE	3	0	0	3	40	60	100
39.	22ECPE615	VLSI Physical Design	PE	3	0	0	3	40	60	100
40.	22ECPE616	RF & EMI/EMC Testing	PE	3	0	0	3	40	60	100
41.	22ECPE801	Multimedia Compression and Communication Techniques	PE	3	0	0	3	40	60	100
42.	22ECPE802	Wireless Sensor Networks	PE	3	0	0	3	40	60	100
43.	22ECPE803	Telecommunication and Switching Networks	PE	3	0	0	3	40	60	100
44.	22ECPE804	Deep Learning	PE	3	0	0	3	40	60	100
45.	22ECPE805	Network Security	PE	3	0	0	3	40	60	100
46.	22ECPE806	Satellite Communication	PE	3	0	0	3	40	60	100
47.	22ECPE807	Bio Medical Electronics	PE	3	0	0	3	40	60	100
48.	22ECPE808	Cognitive Radio	PE	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVES

22ECPE601	ELECTRONIC MEASUREMENTS		SEMESTER VI			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
1.	Electronic Devices		**3**	**0**	**0**	**3**

Course Objectives:

1.	To Know the basic measurement concepts, units, standards, various types of meters and errors.
2.	Learn to measure unknown value of components using bridges and understand the concept of various signal generator and analyzers.
3.	To gain knowledge on Different types transducers and their usage in the Data Acquisition system
4.	To emphasize the need for Data display recording and systems

Unit I	**BASIC MEASUREMENTS**	**9**	**0**	**0**	**9**

Introduction – Characteristics of measurement systems – Static and Dynamic – Errors in Measurements – Calibration and Standards - DC Ammeters and Voltmeters - AC Ammeters and Voltmeters – Multi range – Ohm meter: series Type, Shunt Type - Electronic Multi meter.

Unit II	**BRIDGE MEASUREMENT**	**9**	**0**	**0**	**9**

Introduction - DC Bridges and their Applications - Wheatstone Bridge - Kelvin Bridge - AC Bridges and their Applications - Maxwell's Bridge - Hay Bridge - Schering Bridge – We in Bridge - Wagner ground Connection.

Unit III	**SIGNAL GENERATOR & ANALYZERS**	**9**	**0**	**0**	**9**

Signal Generators: Sine wave generator, Frequency Synthesized Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators. - Sweep Frequency Generator - Pulse and square wave generator - Function Generators - Signal Analyzers: Wave Analyzers - Harmonic Distortion Analyzers - Spectrum Analyzers.

Unit IV	**TRANSDUCER & DATA ACQUISITION SYSTEMS**	**9**	**0**	**0**	**9**

Classification of Transducers – Variable Resistive transducers – Strain gauges, Thermistor, RTD - Variable Inductive transducers - LVDT, RVDT - Variable Capacitive Transducers - Photo electric transducers, Piezo electric transducers – Thermocouples - Thermistors – Smart / intelligent sensors, Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System.

Unit V	**DATA DISPLAY RECORDING AND SYSTEMS**	**9**	**0**	**0**	**9**

Dual trace CRO – Digital storage and Analog storage oscilloscope. Analog and Digital Recorders and printers. Virtual Instrumentation - Block diagram and architecture – Applications in various fields. Measurement systems applied to Micro and Nanotechnology

Total (45L)= 45 Periods

Text Books:

1.	Albert D.Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 5th Edition, PHI, 2011.
2.	A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2010.

Reference Books:

1.	John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", CRC Press. 2014
2.	RobertA.Witte,"ElectronicTestInstruments,AnalogandDigitalMeasurements",2nd Edition,PearsonEducation,2004.
3.	K.LalKishore,"Electronic MeasurementsandInstrumentations",PearsonEducation,2005.
4.	Deoblin E.O. "Measurement Systems - Application and Design", McGraw Hill, 4th Edition, 2005

E-References:

1.	https://nptel.ac.in/courses/108105153
2.	http://bcas.du.ac.in/wp-content/uploads/2020/04/Study-Material-Dr.-Avneesh-Mittal.pdf

3.	http://www.academia.edu/8140873/A_K.Sawhney-

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Discuss about the principles of various measurement techniques and identify its errors	L2
CO2	Have knowledge on designing and to find the unknown elements in the measuring bridges.	L3
CO3	To categorize different instruments used for signal generation and analysis.	L2
CO4	Analyze the transducers and its impact and to understand the function of Data acquisition systems.	L2
CO5	To have knowledge on Data display and recording Systems.	L1

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1		1								1		2
CO2	3		2	2	1								1	1	2
CO3	3	1		1	2								1	1	2
CO4	3		1	2									1		1
CO5	3	2	1		1								1	2	2
Avg	3	1	1	1	1								1	0.8	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE602	COMPUTER ARCHITECTURE	SEMESTER VI

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	T H
		3	0	0	3

Course Objectives:

1	To describe computer architecture concepts and mechanisms related to the design of modern processors, memories, and networks.
2	To understand various design alternatives and make a compelling quantitative and/or qualitative argument for why one design is superior to the other approaches.
3	To illustrate the fixed point and floating-point arithmetic of ALU operations.

Unit I	FUNDAMENTALS OF QUANTITATIVE DESIGN AND ANALYSIS	9	0	0	9

Introduction-Classes of Computers- Defining Computer Architecture- Trends in Technology- Trends in Power and Energy in Integrated Circuits-Trends in Cost - Dependability - Measuring, Reporting, and Summarizing Performance - Quantitative Principles of Computer Design - Putting It All Together: Performance, Price, and Power - Fallacies and Pitfalls.

Unit II	COMPUTER ARITHMETIC	9	0	0	9

Addition and subtraction of signed numbers - Design of fast adders - multiplication of positive numbers - signed operand multiplication, Booth algorithm - Fast multiplication - Bit pair recoding of the multiplier - Carry save addition - Integer division - Floating point numbers - Arithmetic operations on floating point numbers - Guard bits and truncation

Unit III	PROCESSING UNITS	9	0	0	9

Fundamental concepts – Execution of a complete Instruction – Multiple bus organization – Hardwired control – Micro programmed control - Pipelining – Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration – Superscalar operation – Performance considerations.

Unit IV	MEMORY SYSTEM	9	0	0	9

Basic concepts – semiconductor RAMs, ROMs – Speed, size and cost – Cache memories - Memory Hierarchy Design-Ten Advanced Optimizations of Cache Performance - Performance consideration – Virtual memory- Memory Management requirements – Secondary storage - CD-ROM - DVD_ROM - DVD drive - Hard drive

Unit V	DOMAIN-SPECIFIC ARCHITECTURES	9	0	0	9

Introduction - Guidelines for DSAs - Example Domain: Deep Neural Networks - The Neurons of DNNs-Training Versus Inference-Multilayer Perceptron - Convolutional Neural Network -Recurrent Neural Network – Batches – Quantization-Google's Tensor Processing Unit, an Inference Data Center Accelerator -TPU Architecture - TPU Instruction Set Architecture - TPU Micro architecture

Total(45L) =45 Periods

Text Books:

1.	John Hennessy, David Patterson ,"Computer Architecture A Quantitative Approach",6th Ed, Morgan Kaufmann Publishers,2019.
2.	Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization" 5th Ed, McGraw Hill, 2001.

Reference Books:

1.	William Stallings, "Computer Organization and Architecture – Designing for Performance", 10th Edition, Pearson, 2016.
2.	David A. Patterson and John L.Hennessy, "Computer Organization and Design, the hardware / software interface", 5th edition, Morgan Kaufmann, Elsevier, 2014.
3.	Caxton C. Foster, "Computer Architecture", 6th Edition, Van Nostrand Reinhold Company.
4.	Andrews .Tanenbaum , T odd Austin," Structured Computer Organization", 6th Edition, Pearson, 2013.

E-References:

1.	http://nptel.ac.in/courses/106102062/
2.	https://www.coursera.org/learn/comparch/home/week/1
3.	https://nptel.ac.in/courses/106106134

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize the trends followed in designing architecture.	L2
CO2	Illustrate the fixed point and floating-point arithmetic for ALU operation.	L1
CO3	Analyse the pipeline performance considering the hazards by computing clock cycles.	L4
CO4	Differentiate the types of memory and use suitable type for architecture development	L3
CO5	Understand domain-specific architectures like DNN and TPU for a new application	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2		2									2	1	2
CO2	2		3	2									1		
CO3	1		2										2		2
CO4	2	2	2	2	2								2		3
CO5		2	2		2								2	1	3
Avg	1	1.2	1.8	1.2	0.8								1.8	0.4	2
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22ECPE603	DIGITAL IMAGE PROCESSING	SEMESTER VI

PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
1	Signals and Systems		3	0	0	3

Course Objectives:

1	To become familiar with digital image fundamentals
2	To get exposed to simple image enhancement techniques in Spatial and Frequency domain
3	To learn concepts of degradation function and restoration techniques
4	To study the image segmentation and representation techniques.
5	To become familiar with image compression and recognition methods

Unit I	DIGITAL IMAGE FUNDAMENTALS	9	0	0	9

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

Unit II	IMAGE ENHANCEMENT	9	0	0	9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

Unit III	IMAGE RESTORATION	9	0	0	9

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

Unit IV	IMAGE SEGMENTATION	9	0	0	9

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

Unit V	IMAGE COMPRESSION AND RECOGNITION	9	0	0	9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

Total(45L) =45 Periods

Text Books:

1.	Rafael C. Gonzalez, Richard E. Woods, _Digital Image Processing‘, Pearson, Third Edition, 2010.Anil K. Jain, _Fundamentals of Digital Image Processing‘, Pearson, 2002.
2.	Anil K. Jain, _Fundamentals of Digital Image Processing‘, Pearson, 2002.

Reference Books:

1.	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, _Digital Image Processing using MATLAB‘, Pearson Education, Inc., 2011.
2.	Kenneth R. Castle man, _Digital Image Processing‘, Pearson, 2006.
3.	William K. Pratt, _Digital Image Processing‘, John Wiley, New York, 2002
4.	Milan Sonka et al _Image processing, analysis and machine vision‘, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

E-References:

1.	https://www.tutorialspoint.com/dip/index.html
2.	https://www.youtube.com/watch?v=zDuJZDBsfto
3.	https://www.udemy.com/topic/image-processing/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.	L2
CO2	Operate on images using the techniques of smoothing, sharpening and enhancement.	L3
CO3	Understand the restoration concepts and filtering techniques.	L2

CO4	Learn the basics of segmentation and features extraction	L2
CO5	Apply compression and recognition methods for color models.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	1	2	1	1						1		2	2	2
CO2	2	1	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	2	3	2	1						2		2	2	2
Avg	2	1.6	2.4	1.4	1						1.4		2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE604	MACHINE LEARNING	SEMESTER VI

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	T H
		3	0	0	3

Course Objectives:

1	To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
2	To explore the different supervised learning techniques including ensemble methods
3	To learn different aspects of unsupervised learning and reinforcement learning
4	To learn the role of probabilistic methods for machine learning
5	To understand the basic concepts of neural networks and deep learning .

Unit I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS	9	0	0	9

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

Unit II	SUPERVISED LEARNING	9	0	0	9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Over fitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines – Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

Unit III	UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING	9	0	0	9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction – Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

Unit IV	PROBABILISTIC METHODS FOR LEARNING	9	0	0	9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

Unit V	NEURAL NETWORK AND DEEP LEARNING	9	0	0	9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation- Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

Total(45L) =45 Periods

Text Books:

1.	Stephen Mars land, “Machine Learning: An Algorithmic Perspective”, Chapman & Hall/CRC, 2nd Edition, 2014.
2.	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.

Reference Books:

1.	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
2.	Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3.	Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4.	Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition, 1997.
5.	Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012

E-References:	
1.	https://machinelearningmastery.com/
2.	https://ai.google/education/
3.	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the mathematical foundation for solving ML problems.	L2
CO2	Apply various supervised learning technique to solve ML problem	L3
CO3	Apply various unsupervised and reinforcement learning technique to solve ML problems	L3
CO4	Understand various probabilistic methods of learning.	L3
CO5	Understand basic idea behind neural network and deep learning. p	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	1	2	1	1						1	1	2	2	2
CO2	2	1	2	1	1						1	1	2	2	2
CO3	2	2	3	2	1						3	2	2	2	2
CO4	2	2	2	1	1						3	2	2	2	2
CO5	2	2	3	2	1						3	2	2	2	2
Avg	2	1.6	2.4	1.4	1						2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE605	MODERN SENSORS AND ITS APPLICATIONS	SEMESTER VI			
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1	To know the various stimuli that are to be measured in real life instrumentation.
2	To select the right process or phenomena on which the sensor should depend on
3	Toa ware of the various sensors available for measurement and control applications.

Unit I	**PROBLEM SOLVING**	**9**	**0**	**0**	**9**

Introduction to sensors and transducers. Need for sensors in the modern world. Different fields of sensors based on the stimuli - various schematics for active and passive sensors. Static and dynamic characteristics of sensors - zero, I and II order sensors – Response to impulse, step, ramp and sinusoidal inputs. Environmental factors and reliability of sensors.

Unit II	**SENSORS FOR MECHANICAL SYSTEMS**	**9**	**0**	**0**	**9**

Sensors for mechanical systems or mechanical sensors - Displacement - acceleration and force - flow of fluids - level indicators - pressure in fluids - stress in solids. Typical sensors - wire and film strain gauges, anemometers, piezo electric and magneto strictive accelerometers, potentio metric sensors, LVDT

Unit III	**THERMAL AND OPTICAL SENSORS**	**9**	**0**	**0**	**9**

Thermal sensors: temperature – temperature difference – heat quantity. Thermometers for different situation – thermocouples thermistors – color pyrometry. Optical sensors: light intensity – wavelength and color – light dependent resistors, photodiode, photo transistor, CCD, CMOS sensors. Radiation detectors: radiation intensity, particle counter – Gieger Muller courter (gas based), Hallide radiation detectors.

Unit IV	**MAGNETIC AND ACOUSTIC SENSORS**	**9**	**0**	**0**	**9**

Magnetic sensors: magnetic field, magnetic flux density – magneto resistors, Hall sensors, super conduction squids. Acoustic or sonic sensors: Intensity of sound, frequency of sound in various media, various forms of microphones, piezo electric sensors.

Unit V	**APPLICATIONS OF ELECTRICAL AND HIGH FREQUENCY SENSORS**	**9**	**0**	**0**	**9**

Electrical sensors: conventional volt and ammeters, high current sensors, (current transformers), high voltage sensors, High power sensors. High frequency sensors like microwave frequency sensors, wavelength measuring sensors. MEMs and MEM based sensors.

Total(45L) =45 Periods

Text Books:	
1.	Doebelin, “Measurement Systems: Application and Design”, McGraw Hill Kogakusha Ltd,1983.
2.	Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim “Microsensors, MEMS and Smart Devices”, New York: Wiley, 2001.
Reference Books:	
1.	Henry Bolte, “Sensors – A Comprehensive Sensors”, John Wiley.
2.	Jocob Fraden,” Handbook of Modern Sensors, Physics, Designs, and Applications”, Springer,2014
3.	Manabendra Bhuyan,” Intelligent Instrumentation Principles and Applications”, CRC Press,2017
4.	Randy Frank,” Understanding Smart Sensors”, Second edition, Artech House,2000.
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee50/preview
2.	https://www.youtube.com/watch?v=1uPTyjxZzyo
3.	https://nptel.ac.in/courses/115107122

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Appreciate the operation of various measuring and control instruments which they encounter in their respective fields.	L2
CO2	Visualize the sensors and the measuring systems when they have to work in areas of interdisciplinary nature and also think of sensors and sensors systems when for a new situation they encounter in their career	L4
CO3	Identify and select the right process or phenomena on which the sensor should depend on.	L2
CO4	Know various stimuli that are to be measured in real life instrumentation.	L2
CO5	Apply all types sensor in various fields.	L3, L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	1	2											2		
CO2	2	2	1	1		2	1				3	1	3	2	
CO3	2	2	2	1			3				2		2		
CO4	3	2	3	2	3						1		1	2	
CO5	3	2	3		2	2	1				2	2	2		1
Avg	2.2	2	1.8	0.8	1	0.8	1				1.6	0.6	2	0.8	0.2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE606	RADAR COMMUNICATION	SEMESTER VI

PREREQUISITES	CATEGORY	PE	Credit	3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1	To introduce the students about various types of radar and its applications.
2	To enhance the knowledge on Doppler RADAR
3	To enhance the knowledge on detection of RADAR signals.
4	To enhance the knowledge on CFAR.
5	Develop an ability to gain knowledge on radar transmitters and receivers

Unit I	RADAR AND RADAR EQUATION	9	0	0	9

Introduction to Radar: Basic Radar –The simple form of the Radar Equation- Radar Block Diagram- Radar Frequencies – Applications of Radar – The Origins of Radar -The Radar Equation: Introduction- Detection of Signals in Noise- Receiver Noise and the Signal-to-Noise Ratio-Probability Density Functions- Probabilities of Detection and False Alarm.

Unit II	MTI AND PULSE DOPPLER RADAR	9	0	0	9

Introduction to 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 – Tracking with Radar –Mono pulse Tracking –Conical Scan and Sequential Lobing - Limitations to Tracking Accuracy - Low-Angle Tracking - Tracking in Range - Automatic Tracking with Surveillance Radars (ADT).

Unit III	THRESHOLD DETECTION OF RADAR TARGETS	9	0	0	9

Detection strategies for multiple measurements, Introduction to optimal detection: Hypothesis testing and Ney man-Pearson criterion, statistical models for noise and target RCS in radar, threshold detection of radar signals.

Unit IV	CONSTANT FALSE ALARM RATE DETECTORS	9	0	0	9

Overview of detection theory, false alarm impact and sensitivity, CFAR detectors, Cell averaging CFAR, robust CFARs, adaptive CFARs.

Unit V	RADAR TRANSMITTERS AND RECEIVERS	9	0	0	9

Introduction –Linear Beam Power Tubes - Solid State RF Power Sources - Magnetron - Crossed Field Amplifiers - Radar Receivers: The Radar Receiver - Receiver noise Figure - Super heterodyne Receiver - Duplexers and Receiver Protectors- Radar Displays.

Total(45L) =45 Periods

Text Books:

1.	Mark A.Richards, “Fundamentals of Radar Signal Processing”, Tata McGraw Hill, 1st Edition, 2005.
2.	Merrill I. Skolnik ," Introduction to Radar Systems", Tata McGraw-Hill (3rd Edition) 2008.

Reference Books:

1.	Mark A.Richards, James A.Scheer, William A.Holm,” Principles of Modern RADAR”, Yes dee Publishing Pvt Ltd, 1st Edition, 2012.
2.	Nathan son, F.E, “Radar Design Principles, second edition, McGraw-Hill, New York,1991.
3.	Steven M.Kay, “Fundamentals of Statistical Signal Processing”, Vol II Detection Theory, Prentice Hall Inc, 1998.
4.	Peyton Z. Peebles:, "Radar Principles", John wiley, 2004.

E-References:

1.	http://www.radioelectronics.com/info/data/semicond/semiconductor/semiconductor-materials-types-list.php
2.	http://911electronic.com/
3.	https://nptel.ac.in/courses/108105154

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the concepts of radar measurements, radar functions and range equation.	L2
CO2	Familiarize about MTI and pulse Doppler radar and detection of RADAR signals.	L2
CO3	Analyze the principle behind, detecting the signals of radar communication.	L4
CO4	Apply CFAR detector to improve the detection performance of Radar.	L3
CO5	Knowledge in RADAR systems and analyze the signal to noise ratio in the radar system.	L5

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1		2	3	3	2						2		2	2	2
CO2		2	3	3	2						2		2	2	2
CO3		2	2	3	2						2		2	2	2
CO4		2	3	2	2						2		2	2	2
CO5		2	3	3	2						2		2	2	2
Avg		2	2.8	2.8	2						2		2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE607	INTERNET OF THINGS	SEMESTER VI

PREREQUISITE	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1	To understand the vision of M2M to IOT.
2	To gain an understanding of IOT market perspective.
3	To acquire knowledge on IOT Technology Fundamentals and applications
4	To build small system using Raspberry Pi.

Unit I	M2M TO IOT – THE VISION	9	0	0	9

Introduction - From M2M to IOT- M2M towards IOT: M2M Communication - The global context - A use case example – Differing Characteristics.

Unit II	M2M TO IOT – A MARKET PERSPECTIVE	9	0	0	9

Introduction - Some Definitions - M2M Value Chains - IOT Value Chains - An emerging industrial structure for IOT- International driven global value chain and global information monopolies - M2M to IOT-An Architectural Overview – Building an architecture - Main design principles and needed capabilities - An IOT architecture outline - Standards considerations.

Unit III	IOT TECHNOLOGY FUNDAMENTALS	9	0	0	9

IOT Enabling technologies – IOT levels and deployment templates - Devices and gateways - Data management - Business processes in IOT - Everything as a Service (XaaS) - M2M and IOT Analytics.

Unit IV	BUILDING IOT WITH HARDWARE PLATFORMS	9	0	0	9

IOT Systems-Logical Design using Python –IOT Physical Devices and End Points- IOT Device - Raspberry Pi -Interfaces – Programming – Other IOT devices - IOT Reference Model - Real World Design Constraints.

Unit V	IOT USE CASES AND APPLICATIONS	9	0	0	9

Home automation-Automatic lighting-Home intrusion detection- Cities-Smart parking – Environment – We other monitoring system-Air pollution Monitoring-Forest Fire Detection- Agriculture- Smart irrigation. Commercial Building Automation – Introduction - Case study (Phase one) : Commercial building automation today - Case study (Phase two) - Commercial building automation in the future.

Total(45L) =45 Periods

Text Books:

1.	Jan Holler, Vlasios T siatsis, Catherine Mulligan, Stefan Aves and, Stamat is Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things-A hands-on approach", Universities Press, 2015

Reference Books:

1.	Olivier Hersent, davidBoswarthick, Omar Elloumi, 'The Internet of Things Applications to the smart grid and building automation', John Wiley & Sons, 2012.
2.	Francis da Costa, "Rethinking the Internet of Things : A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013
3.	HakimaChaouchi, 'The Internet of Things Connecting Objects', John Wiley & Sons, 2010.
4.	Fabrice Theoleyr, Ai-Chun Pang, 'Internet of Things and M2M Communications', River Publishers, 2013.

E-References:

1.	https://nptel.ac.in/courses/106105166
2.	https://onlineitguru.com/IoT-online-training.html
3.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the vision of IOT from a global context.	L2
CO2	Determine the Market perspective of IOT.	L1
CO3	Understand the IOT technology fundamentals.	L2
CO4	Build small system using Raspberry Pi.	L3
CO5	Analyse applications of IOT and case studies	L4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1		1			2										
CO2	2	2	2	2	2							1	1		
CO3	2	2	2	2	2							1	1		
CO4	2	2	2	2	2						2	2	2		
CO5	2	2	2	2	2						2		2		2
Avg	1.6	1.8	1.6	1.6	2						0.8	0.8	1.2		0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE608	COMPUTERNETWORKS	SEMESTER VI				
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**C**
Nil		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the basic concept in modern data communication and computer networking.
2.	To in traduce the students the functions of different layers and in-depth knowledge of data link layer.
3.	To make students to get familiarized with different protocols and network layer components.
4.	To introduce the basic functions of trans port layer and congestion in networks.
5.	To understand the concepts of various network Applications and Data security.

Unit I	**NETWORK FUNDAMENTALS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**

Components – networks – Topologies – The OSI reference model - layers and duties. TCP/IP reference model – layers and duties, Physical Layer: Transmission Media – Guided media & unguided media - EIA 232, SONET

Unit II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**

Logical link control Functions: - Framing, Flow control, Error control: CRC, LLC protocols -HDLC,P to P- Medium access layer: - Random access, Controlled access, Channelization - Wired LANs: Ethernet IEEE 802.3, IEEE 802.4, and IEEE 802.5. Internetworking, Interconnection issues, Interconnection devices: - Repeaters, Hubs, Routers/switches and Gateways.

Unit III	**NETWORK LAYER**	**9**	**0**	**0**	**9**

Switching-Circuit switching, packet switching, message switching. Internet protocols; IPV4, IPV6, ARP, RARP, ICMP, IGMP, VPN. Network Routing Algorithms - Unicast routing protocol: Distance Vector Routing – Link State Routing – Multicast Routing.

Unit IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**

Transport Services, Elements of Transport protocols, Connection management, – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control and Quality of services (QoS) – Integrated Services

Unit V	**APPLICATION LAYER**	**9**	**0**	**0**	**9**

Domain Name Space (DNS) – Electronic mail (SMTP, MIME, POP3, IMAP4) - Application protocols: WWW, HTTP, FTP and TELNET, Network management protocol: SNMP.

Total (45L)= 45 Periods

Text Books:

1.	Behrouz A. Foruzan, “Data communication and Networking”, TMH, 4th edition, 2014.
2.	James. F. Kurouse& W. Ross, “Computer Networking: A Top down Approach Featuring”, Pearson, 2020.

Reference Books:

1.	LarryL.Peterson&PeterS.Davie,“ComputerNetworks”,HarcourtAsiaPvt.Ltd.,SecondEdition,2000.
2.	AndrewS.Tanenbaum,“ComputerNetworks”,PHI,FourthEdition,2003.
3.	An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education,2002.
4.	AjitPal,“DataCommunicationandComputerNetworks”,PHI,2014.

E-References:

1.	https://nptel.ac.in/courses/106105183
2.	https://www.mbit.edu.in/wp-content/uploads/2020/05/Computer-Networks-5th-Edition.pdf
3.	https://www.tutorialspoint.com/data_communication_computer_network/index.htm

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Explain the basic concept in modern data communication and different level of layers in the protocol	L2
CO2	:	Analyse the functions and services of data link layer	L4
CO3	:	Categorize the functions and services of network layer	L2
CO4	:	Examine the basic functions of transport layer and congestion in networks	L2
CO5	:	Analyse the concepts of various network applications and data security	L4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1		1								2		1
CO2	2	1	2		1								2	1	1
CO3	2	1	1										3	1	2
CO4	3	2	1		2								2		2
CO5	2	1	1		1								1	1	1
Avg	2.2	1.2	1.2		1								2	0.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE609	SOFTWARE DEFINED RADIO	SEMESTER VI				
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
Nil			**3**	**0**	**0**	**3**

Course Objectives:

1.	To understand the evolving software defined radio techniques and their essential functionalities.
2.	To study the basic architecture and standard for software defined radio.
3.	To understand the evolving cognitive radio techniques and their functionalities.
4.	To study the basic architecture and standard for cognitive radio.
5.	To expose the student to evolving applications and next generation wireless network.

Unit I	**INTRODUCTION TO SOFTWARE-DEFINED RADIO**	**9**	**0**	**0**	**9**

Evolution of Software Defined Radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

Unit II	**SDR ARCHITECTURE**	**9**	**0**	**0**	**9**

Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

Unit III	**INTRODUCTION TO COGNITIVE RADIOS**	**9**	**0**	**0**	**9**

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

Unit IV	**COGNITIVE RADIO ARCHITECTURE**	**9**	**0**	**0**	**9**

Cognition cycle – orient, plan, decide and act phases, Organization, SDR as a platform for Cognitive Radio – Hardware and Software Architectures, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

Unit V	**NEXT GENERATION WIRELESS NETWORK**	**9**	**0**	**0**	**9**

The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.

Total (45L)= 45 Periods

Text Books:

1.	Joseph Mitola III,"Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000.
2.	Markus Dillinger, Kambiz Madani, Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003.

Reference Books:

1.	Kwang-Cheng Chen, Ramjee Prasad, ―Cognitive Radio Networks‖, John Wiley and Sons, 2009.
2.	Huseyin Arslan (Ed.), ―Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
3.	Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.
4.	Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006.

E-References:	
1.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%201%20notes.pdf
2.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%201%20notes.pdf
3.	https://www.dsengg.ac.in/ece/EC6802%20Wireless%20Network.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Gain knowledge on the design principles on software defined radio and cognitive radio	L2
CO2	An ability to make system-level decisions for software-defined radio technology and products	L3
CO3	Gain knowledge and understanding of software defined radio architecture.	L1
CO4	Apply the knowledge of advanced features of cognitive radio for real world applications	L3
CO5	Knowledge and development methods for wireless Network	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1		1	2				1					1		
CO2		1				2								2	
CO3	2			1									1		
CO4							2						2	1	1
CO5	2		1			1		2					1		
Avg	1	0.2	0.4	0.6		0.6	0.2	0.6					1	0.6	0.2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE610	HIGH SPEED NETWORKS	SEMESTER VI			
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
1. Computer Networks	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:

1. To understand the packet switching, ATM and Frame relay networks.
2. To know the techniques involved to support real-time traffic and congestion control.
3. To be familiar with different levels of quality of service to different applications.

Unit I	**INTRODUCTION TO HIGH SPEED NETWORKS**	**9**	**0**	**0**	**9**

The need for a protocol architecture – The TCP/IP protocol architecture – Internetworking – Packet switching networks – Frame Relay Networks – Asynchronous transfer mode: ATM Protocol Architecture, ATM logical Connections, ATM Cells, ATM Service Categories, AAL – High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fibre Channel – Wireless LANs: applications, requirements – Architecture of 802.11 .

Unit II	**CONGESTION AND TRAFFIC MANAGEMENT**	**9**	**0**	**0**	**9**

Queuing Analysis – Queuing Models – Single Server Queues – Effects of Congestion –Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

Unit III	**TCP AND ATM CONGESTION CONTROL**	**9**	**0**	**0**	**9**

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO back off – KARN's Algorithm – Window management – Performance of TCP over ATM – Traffic and Congestion control in ATM – Requirements – Attributes –Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.

Unit IV	**INTEGRATED AND DIFFERENTIATED SERVICES**	**9**	**0**	**0**	**9**

Integrated Services Architecture – Approach, Components, Services – Queuing Discipline: FQ, PS, BRFQ, GPS, WFQ – Random Early Detection – Differentiated Services.

Unit V	**PROTOCOLS FOR QOS SUPPORT**	**9**	**0**	**0**	**9**

RSVP – Goals and Characteristics, Data Flow, RSVP operations, Protocol Mechanisms – Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.

Total (45L)= 45 Periods

Text Books:

1. Warland, Pravin Varaiya, "High performance communication networks", Second Edition, Jean Harcourt Asia Pvt. Ltd, 2001.
2. William Stallings, "High speed networks and internets", Pearson Education, Second Edition, 2002.

Reference Books:

1. James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Pearson Education, Third Edition, 2011
2. IrvanPepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.
3. Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2004.
4. Kaven Pahlavan And Prashant Krishnamoorthy, "Principles Of Wireless Network", Prentice Hall Of India, 2010.

E-References:

1. http://freevideolectures.com/Course/2278/Data-Communication/30
2. http://nptel.ac.in/courses/106105082/30
3. https://nptel.ac.in/courses/106105183

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Compare ATM, Frame Relay and TCP/IP networks.	L4
CO2	Understand the concepts of queuing mechanism and congestion control techniques in packet switching and frame relay networks.	L2
CO3	Analyze the traffic management in TCP and ATM.	L4
CO4	Be familiar with the integrated and differentiated service architecture.	L1
CO5	Understand the protocols to support various levels of quality of service to different applications.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2		1	1	2	1					2		1	2	2
CO2	3		1	2	2	2							1	1	1
CO3	2		1	2	1	2							2	2	2
CO4	1		1	1	1	1							1	2	1
CO5	1		1	1	2	1					2		2	2	2
Avg	1.8		1	1.4	1.6	1.4					0.8		1.4	1.8	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE611	ROBOTICS	SEMESTER VI

PREREQUISITES	CATEGORY	PE	Credit	3

	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1. To understand the functions of the basic components of a Robot.
2. To study the use of various types of End of Effectors and Sensors
3. To impart knowledge in Robot Kinematics and Programming
4. To learn Robot safety issues and economics.

Unit I	FUNDAMENTALS OF ROBOT	9	0	0	9

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

Unit II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9	0	0	9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

Unit III	SENSORS AND MACHINE VISION	9	0	0	9

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Antilog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.

Unit IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9	0	0	9

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effectors commands and simple Programs.

Unit V	IMPLEMENTATION AND ROBOT ECONOMICS	9	0	0	9

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

Total (45L)= 45 Periods

Text Books:

1. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

Reference Books:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.
4. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008

E-References:	
1.	https://nptel.ac.in/courses/112105249
2.	https://nptel.ac.in/courses/112105236
3.	https://www.youtube.com/watch?v=7Bahzh3rniw

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	The students can able to apply the basic engineering knowledge for the design of robotics.	L1, L2
CO2	Apply the knowledge on robot drive systems and end effectors.	L2, L4
CO3	Have the knowledge on Sensors and meters	L2, L4
CO4	Able to apply the Robotic kinematic and VAL Programming	L4, L5
CO5	Implement the robotics on economics and safety.	L3, L6

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO3**
CO1	1	2	1	1	1								1		
CO2	2	1	2	2	1		1					1	2	1	
CO3	2	2	1	2	2		1					1	2	2	2
CO4	2	3	2	3	3	1	2	1				2	2	2	
CO5	3	3	2	3	3	1	2	2	1	1	3	3	3	2	3
Avg	2	2.2	1.6	2.2	2	0.4	1.2	0.6	0.2	0.2	0.6	1.4	2	1.4	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE612	VIRTUAL INSTRUMENTATION	SEMESTER VI

PRE-REQUISITE:	CATEGORY	PE	Credit		3
1. Analog Integrated Circuits.	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1. To introduce graphical programming environment
2. To teach fundamentals of virtual instrumentation programming
3. To develop simple applications using VI

Unit I	GRAPHICAL PROGRAMMING ENVIRONMENT	9	0	0	9

History of Virtual Instrumentation - Lab View and VI - Conventional and Graphical Programming - Future Perspective - Components of LabView - Owned and Free Labels - Tools and Other Palettes - Arranging Objects- Pop-up menus - Color Coding - Code Debugging - Context Sensitive Help - Types of VI's - Creating Sub-Vis - Concepts of graphical programming Lab-view software.

Unit II	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION PROGRAMMING	9	0	0	9

Modular programming - Controlling Program execution with structure - Composite data arrays and clusters - Visual displays types - Graphs and charts - Analog and digital - Shift registers and feedback nodes - Local and Global variables - Exploring string and File input and output operations.

Unit III	DATA ACQUISITION WITH LABVIEW	9	0	0	9

Concept of Virtual Instrumentation - PC based data acquisition - Typical on board DAQ card Resolution and sampling frequency - Multiplexing of analog inputs – Single ended and differential inputs - Different strategies for sampling of multi- channel analog inputs - Concept of universal DAQ card - Use of timer - counter and analog outputs on the universal DAQ card - NI-DAQ mx Tasks

Unit IV	CLUSTER OF INSTRUMENTS IN SYSTEM	9	0	0	9

Interfacing of external instruments to a PC RS232C - RS-422 - RS485 and USB standards - IEEE488 standard -ISO-OSI model for series bus-introduction to bus protocols of MOD bus and CAN bus.

Unit V	ANALYSIS TOOLS AND SIMPLE APPLICATION IN VI	9	0	0	9

Signal Processing and manipulation - Anti-aliasing Filter - Frequency_ Domain Signal analysis (DFT and FFT) - Power Spectrum - Windowing - Practical Hints for Frequency Domain Analysis - Signal Processing Functions - Time Domain Analysis - Frequency Domain Analysis – Filters: Control design and simulation - Simulation of a simple second order system.

Total (45L)= 45 Periods

Text Books:

1. Jovitha Jerome "Virtual Instrumentation using LabVIEW", PHI publication, 2010
2. Jeffrey Travis Jim Kring "LabVIEW for Everyone", 3rd Edition, Pearson education.

Reference Books:

1. Robert H. Bishop "Learning with Lab-View", PreticeeHall,2009
2. Sanjay Gupta "Virtual Instrumentation, LABVIEW", , TMH,NewDelhi,2003
3. Peter W Gofton,"Understanding Serial Communication", Sybes International, 2000
4. S.Gupta and J P Gupta , "PC Interfacing for Data Acquisition and Process Control" , Instrument Society of America,1994.

E-References:

1. http://www.ni.com/white-paper/4752/en/
2. http://sine.ni.com/tacs/app/fp/p/ap/ov/lang/en/pg/1/sn/n5:selfpacedonline/
3. https://www.virtualinstruments.com/training/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply structured programming concepts in developing VI programs and employ various debugging techniques.	L3
CO2	Create applications that uses plug in DAQ boards and built in analysis functions to process the data.	L3
CO3	Define and Describe acquisition methodologies.	L2
CO4	Design and analyze various applications using signal Processing tool kit	L4
CO5	Design and analyze various applications using control and simulation tool kit.	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3								1	2	1
CO2	3	2	2	3	2								2	2	2
CO3	3	2	2	2	3								1	2	2
CO4	3	1	2	1	2								1	3	2
CO5	3	2	2	1	2								1	3	3
Avg	3	2	2	2	2.4								1.2	2.4	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE613	AUTOMOTIVE ELECTRONICS		SEMESTER VI			
PRE-REQUISITE:		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1. The student will come to know the various stimuli that are to be measured in real life instrumentation.
2. He will be able to select the right process or phenomena on which the sensor should depend on
3. Aware of the various sensors available for measurement and control applications.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram – Alternators – requirements of starting system – Starter motors and starter circuits.

Unit II	**FUNDAMENTALS OF VIRTUAL INSTRUMENTATION PROGRAMMING**	**9**	**0**	**0**	**9**

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

Unit III	**SENSOR AND ACTUATORS**	**9**	**0**	**0**	**9**

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.

Unit IV	**ENGINE CONTROL SYSTEMS**	**9**	**0**	**0**	**9**

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

Unit V	**CHASSIS AND SAFETY SYSTEMS**	**9**	**0**	**0**	**9**

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.

Total (45L)= 45 Periods

Text Books:

1. Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2000.
2. William B. Ribbens, "Understanding Automotive Electronics", 5th edition, Newnes Publishing, 2000.

Reference Books:

1. Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2001.
2. "Fuel System and Emission controls", Check Chart Publication, 2000.
3. Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999.
4. S.Gupta and J P Gupta , "PC Interfacing for Data Acquisition and Process Control" , Instrument Society of America,1994.

E-References:

1. https://nptel.ac.in/courses/107106088
2. https://www.youtube.com/watch?v=2IosZDDqctU
3. https://www.renesas.com/in/en/application/automotive/chassis-safety

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Know the importance of emission standards in automobiles	L2
CO2	Understand the electronic fuel injection/ignition components and their function	L3

CO3	Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.	L3
CO4	Diagnose electronic engine control systems problems with appropriate diagnostic tools.	L3
CO5	Understand the safety measures in chassis and vehicle.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	3	3	2				3	3	3		2
CO2	3	3	2	3	3	3	2				3	3	3		2
CO3	3	3	3	3	3	3	2				3	3	3		2
CO4	3	3	2	3	3	3	2				2	3	3		2
CO5	3	3	2	3	3	3	2				3	3	3		2
Avg	3	3	2	3	3	3	2				2.8	3	3		2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE614	EMBEDDED C	SEMESTER VII

PREREQUISITE	CATEGORY	PE	Credit		3
1. C Programming	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1	To write embedded programs using the C programming language.
2	To understand and build skills in writing circuit and assembly-level code.
3	To impact knowledge on programming for real time problems.

Unit I	INTRODUCTION TO EMBEDDED SYSTEMS	9	0	0	9

Introduction- Best Practices for Embedded Systems-Difference between C and Embedded C-Processor to use-Programming Language- Operating system- Develop embedded software. 8051 microcontroller- Introduction-external interface- Reset requirements- Clock-Memory-I/O pins and timers- Interrupts-Serial Interface & Power Consumption.

Unit II	EMBEDDED PROGRAMMING	9	0	0	9

Introduction - Installing the Keil software and loading the project-Configuring the simulator- Building the target – Running the simulation – Dissecting the program – Aside: Building the hardware - Reading switches : Introduction – Basic techniques for reading from port pins – Example : Reading and writing bytes – bits- The need for pull-up resistors – Examples: Dealing with switch bounce – Reading switch inputs- counting goats

Unit III	REAL TIME PROGRAMMING	9	0	0	9

Object oriented programming with C – The Project Header (Main.h)- The port header (Port h) – Example: Restructuring the 'Hello Embedded World' example – Restructuring the goat-counting example-Further examples- Meeting real- time constraints – Creating 'hardware delays' using Timer 0 and Timer 1- Example: Generating a precise 50 ms delay- Creating a portable hardware delay- Creating loop timeouts and hardware timeouts

Unit IV	EMBEDDED OS	9	0	0	9

Creating an embedded operating system-Basis of a simple embedded OS- Introducing sEOS- -Using Timer 0 or Timer 1– Alternative system architectures – Important design constraints when using sEOS- Example-Milk pasteurization - Multi state systems and function sequences- Introduction – Implementing a multi-state system (timed) - Example: Traffic light sequencing and Animatronic dinosaur– Implementing a multi-state system (Input / Timed) - Example: Controller for a washing machine.

Unit V	INTERFACE AND CASE STUDY	9	0	0	9

Using serial Interface- Introduction – RS-232- basic RS-232 protocol – Asynchronous data transmission and baud rates – Flow control – The software architecture – Using the on-chip UART for RS-232 communications- Memory-Example-Serial menu architecture-Example-Data acquisition and Remote – control robot. Case Study : Intruder alarm system

Total(45L) =45 Periods

Text Books:

1.	Michael J.Pont," Embedded C", Pearson Education, 2008.
2.	Stephen Oualline, "Bare Metal C Embedded Programming for the Real World" , No Starch Press,2022

Reference Books:

1.	Mark Siegesmund, "Embedded C Programming Techniques and Applications of C and PIC MCUS", Elsevier Science, 2014.
2.	Michael Barr," Embedded C Coding Standard", Create Space Independent Publishing Platform, 2018.
3.	Michael Barr, Anthony Massa, "Programming Embedded Systems With C and GNU Development Tools", O'Reilly Media, 2006.
4.	LyLa B. Das, "Embedded Systems: An Integrated Approach", Pearson Education India, 2012.

E-References:

1.	https://www.cranesvarsity.com/courses/embedded-c-course/
2.	https://www.udemy.com/course/embedded-c-programming-for-embedded-systems/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand basics of embedded systems and 8051 microcontroller	L2
CO2	Develop basic embedded programs	L3
CO3	Develop advanced embedded programs	L3
CO4	Relate and write programs for embedded Operating System	L1
CO5	Analyse the case study problems	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1		1			2										
CO2	2	2	2	2	2							1	1		
CO3	2	2	2	2	2							1	1		
CO4	2	2	2	2	2						2	2	2		
CO5	2	2	2	2	2						2		2		2
Avg	1.6	1.8	1.6	1.6	2						0.8	0.8	1.2		0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE615	VLSI PHYSICAL DESIGN	SEMESTER VI

PRE-REQUISITE:	CATEGORY	PE	Credit		3
1. VLSI design 1. VLSI design	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	Understand the concepts of Physical Design Process such as partitioning, Floor planning, Placement and Routing.
2.	Discuss the concepts of design optimization algorithms and their application to physical design automation.
3.	Understand the concepts of simulation and synthesis in VLSI Design Automation Formulate CAD design problems using algorithmic methods.

Unit I	INTRODUCTION TO VLSI DESIGN AUTOMATION TOOLS	9	0	0	9

VLSI design automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.

Unit II	LAYOUT COMPACTION, PLACEMENT AND PARTITIONING	9	0	0	9

Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.

Unit III	FLOOR PLANNING AND ROUTING	9	0	0	9

Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.

Unit IV	SIMULATION AND LOGIC SYNTHESIS AND VERIFICATION	9	0	0	9

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.

Unit V	HIGH-LEVEL SYNTHESIS	9	0	0	9

High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

Total (45L)= 45 Periods

Text Books:

1.	S.H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley (India), 2006.
2.	N.A.Sherwani, “Algorithms for VLSI Physical Design Automation”, Kluwer, 2012.

Reference Books:

1.	S.M. Sait, H. Youssef, “VLSI Physical Design Automation”, Cambridge India, 2010.
2.	M.Sarrafzadeh, “Introduction to VLSI Physical Design”, McGraw Hill (IE), 1996.
3.	Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits”, McGraw Hill, 2017
4.	Andrew B. Kahng and Jens Lienig “VLSI Physical Design: From Graph Partitioning to Timing Closure”, Springer, 2011

E-References:

1.	https://nptel.ac.in/courses/106105161
2.	https://www.vlsi-expert.com/p/physical-design.html
3.	https://www.academia.edu/36687882/VLSI_Design_smd154_Physical_design_back_end

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Know to place the blocks and to partition the blocks while designing the layout for IC.	L2
CO2	Solve the performance issues in circuit layout.	L3
CO3	Analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing	L4
CO4	Decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing	L3
CO5	Students are able to analyze circuits using both analytical and CAD tools.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	1	1	1									1	1	
CO2	2	2	1	1									1		
CO3	2	2	1	1									1		
CO4	1	1	1	1		1							1	1	
CO5	3	3	1	1	3	1							1	2	3
Avg	1.8	1.8	1	1	0.6	0.4							1	0.8	0.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE616	RF&EMI/EMC TESTING		SEMESTER VI			
PRE-REQUISITE		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
1.	Physics for electromagnetism		3	0	0	3

Course Objectives:	
1.	To know the RF equipment's needed for testing.
2.	To explain the concepts of EMI and EMC in electrical circuits and their characteristics.
3.	To introduce the importance of measuring equipment's.
4.	To impart the knowledge on grounding and shielding measures and design aspects.
5.	To expose basic concepts of standards and regulations

Unit I	RF EQUIPMENT FOR MEASUREMENT AND ANTENNA MEASUREMENT	9	0	0	9

Spectrum Analyzer- Principle, Measurement procedure, Network Analyzer- Principle, Measurement procedure, Calibration. Antenna Measurement**:** Reflection coefficient, Return loss of different antennas, Measurement with Spectrum and Network Analyzer, Gain Measurement, Radiation pattern measurement in both Indoor and Anechoic chamber, Test ranges.

Unit II	EMC FUNDAMENTALS	9	0	0	9

Definition of EMI and EMC, Sources and Simulators, Propagation Methods, Basic Aspects of EMI in System Environment, cross talk or near field coupling, EM coupling in Far field, EM topology and grounding, Filtering, Shielding.

Unit III	EMI FROM APPARATUS, CIRCUITS AND OPEN AREA TEST SITES	9	0	0	9

Electromagnetic emissions, noise from relays and switches, nonlinearities in circuits, passive intermodulation, transients in power supply lines, electromagnetic interference. Open area test sites and measurements, open-area test site, normalized site attenuation, antenna factor measurement.

Unit IV	RADIATED AND CONDUCTED INTERFERENCE MEASUREMENT	9	0	0	9

Anechoic chamber, TEM cell, giga-Hertz TEM Cell, comparison of test facilities, characterization of conduction currents /voltages, conducted EM noise on power lines, conducted EMI from equipment, immunity to conducted EMI, detectors and measurements.

Unit V	EMC STANDARDS	9	0	0	9

Overview of EMC Standards, Radiated and Conducted Emission (RE/CE) Standards, Radiated and Conducted Immunity (RI/CI) Standards, Electrostatic Discharge (ESD) Standards.

Total (45L)= 45 Periods

Text Books:	
1.	IET Electrical Measurement Series, "Microwave Measurements" 3rd Edition.
2.	Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons, 2009.
Reference Books:	
1.	V.P. Kodali, Engineering Electromagnetic Compatibility, 2/e, Wiley-IEEE Press, 2001.
2.	Dipak L. Sengupta and Valdis V. Liepa,"Applied Electromagnetics and Electromagnetic Compatibility", John Wiley & Sons.
3.	C. R. Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, 2013.
4.	EMI/EMC Tesing, Society of Applied Microwave Electronics Engineering and Research
E-References:	
1.	http://edocs.soco.agilent.com
2.	https://archive.nptel.ac.in/courses/108/106/108106138/
3.	https://courseware.cutm.ac.in/courses/electromagnetic-compatibility/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basics of RF measurement and Experience testing of RF components.	L4
CO2	Find the source of Electromagnetic interference.	L4
CO3	Predict the proper grounding, Shield and safety equipment's.	L3
CO4	Analyze the test conditions for the EUT.	L4
CO5	Explain the measurements with help of testing procedures and explain the standards for EMI/EMC.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1		2	3	3	3						2		3	2	3
CO2		2	3	3	2						2		3	2	3
CO3		2	3	2	3						2		2	2	2
CO4		2	2	3	3						2		2	2	2
CO5		2	3	3	3						2		3	2	3
Avg		2	2.8	2.8	2.8						2		2.6	2	2.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE801	MULTIMEDIA COMPRESSION AND COMMUNICATION TECHNIQUES	SEMESTER VIII

PRE-REQUISITE	CATEGORY	PE	Credit	3
1.Basic mathematical analysis skills and digital modulation techniques.	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	Highlight the features of data redundancy and various compression techniques involved.
2.	To understand the various challenges involved in text and audio compression.
3.	To impart knowledge on various image and video compression techniques.

Unit I	INTRODUCTION AND TEXT COMPRESSION	9	0	0	9

Introduction: Overview of information theory - Redundancy – Compression Techniques: Loss less compression - Lossy Compression – Measures of performance – Text compression: Shannon Fano coding – Huffman coding – Arithmetic coding – Dictionary techniques – LZW family algorithms – Entropy measures of performance – Quality measures.

Unit II	AUDIO COMPRESSION	9	0	0	9

Introduction: Spectral masking, Temporal masking, and Psychoacoustic model - Basic sub bands coding - Application to speech coding: G.722 - Application to audio coding: MPEG audio - Progressive encoding for audio – Silence compression - Speech compression techniques– Vocoders.

Unit III	IMAGE COMPRESSION AND VIDEO COMPRESSION	9	0	0	9

Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262 - ITU-T Recommendation H.263.

Unit IV	MULTIMEDIA COMMUNICATIONS	9	0	0	9

Introduction – Multimedia networks: Telephone – Data – Broadcast television – ISDN – Broadband multiservice networks – Multimedia applications: Interpersonal communications – Interactive applications over the internet – Entertainment applications – Application and networking terminology: Media – Communication modes – Network – Multipoint conferencing – Network QoS – Application QoS.

Unit V	STANDARDS FOR MULTIMEDIA COMMUNICATIONS	9	0	0	9

Introduction – Reference models: TCP/IP- Protocol basics – Standards relating to interpersonal communications: Circuit mode networks - Packet switched networks - Electronic mail - Standards relating to interactive applications over the internet: Information browsing- Electronic commerce - Intermediate systems - Java and JavaScript – Standards for entertainment applications: Movie/Video on demand - Interactive television.

Total (45L) = 45 Periods

Text Books:

1.	SayoodKhaleed, - "Introduction to data compression", Morgan Kauffman, London, 2006.
2.	Fred Halshall - "Multimedia communication - Applications, Networks, Protocols and Standards", Pearson Education, 2007.

Reference Books:

1.	Watkinson J, "Compression in video and audio", Focal press, London,1995.
2.	Mark Nelson, — "Data compression book", BPB Publishers, New Delhi, 1998.
3.	Jan Vozer, —Video compression for multimedia‖, AP 83rofess, New York, 1995
4.	Peter D. Johnson Jr., Greg A. Harris, D.C. Hankerson, "Introduction to Information Theory and Data Compression", 2nd Edition, Chapman and Hall/CRC, February 26, 2003.

E-References:

1.	http://freevideolectures.com/Course/2278/Data-Communication/30
2.	http://nptel.ac.in/courses/106105082/30

3.	https://www.google.co.in/books/edition/Multimedia_Communications_Applications_N/g_lECYMqrVwC?hl=en&gbpv=1&dq=Fred+Halsall,+%E2%80%95Multimedia+communication-+Applications,+Networks,+Protocols+and+Standards%E2%80%96,+Pearson+education,+2007+pdf+download&printsec=frontcover

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To understand different coding techniques and apply various algorithms for compression.	L2
CO2	To understand the quality and performance of various text and audio compression algorithms.	L2
CO3	Apply various text and video compression algorithms for practical applications.	L3
CO4	Apply the compression concepts in multimedia communication.	L3
CO5	Able to configure multimedia communication network.	L4

COURSE ARTICULATION MATRIX

Os/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	3	2								3	1	2
CO2	3	2	1	3	1								3	1	2
CO3	3	2	1	2	2								3	2	1
CO4	2	2	2	3	1								3	1	1
CO5	2	2	1	3	1								3	2	2
Avg	2.4	1.8	1.2	2.8	1.4								3	1.4	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE802	WIRELESS SENSOR NETWORKS	SEMESTER VIII

PRE-REQUISITE	CATEGORY	PE	Credit	3
1. Wireless networks	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	Learn fundamental of Ad hoc network and architecture
2.	Understand the MAC and routing protocols.
3.	Have an in-depth knowledge on QoS, security and sensor network platforms

Unit I	ROUTING PROTOCOLS	9	0	0	9

Elements of Ad hoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Ad hoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).

Unit II	ARCHITECTURES OF WSN	9	0	0	9

WSN application examples, Types of applications, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Single-Node Architecture: Hardware Components, Energy Consumption of Sensor Nodes, Operating systems and execution environments

Network Architecture: Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, gateway concepts.

Unit III	MAC PROTOCOLS AND ROUTING PROTOCOLS	9	0	0	9

Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262 - ITU-T Recommendation H.263.

Unit IV	QUALITY OF SERVICE AND ADVANCED APPLICATION SUPPORT	9	0	0	9

Quality of Service: Coverage and deployment, Reliable data transport, Single packet delivery, Block delivery, Congestion control and rate control - Advanced application support: Advanced in-network processing, Security and Application-specific support.

Unit V	SENSOR NETWORK PLATFORMS AND TOOLS	9	0	0	9

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – Tiny OS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.

Total (45L) = 45 Periods

Text Books:

1.	C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008
2.	Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.

Reference Books:

1.	Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.
2.	Charles E. Perkins, ―Ad Hoc Networking‖, Addison Wesley, 2000.
3.	William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004
4.	I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, Computer Networks, Elsevier, 2002, 394 - 422.

E-References:

1.	https://nptel.ac.in/courses/106105183
2.	https://nptel.ac.in/courses/106105183

3.	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Know the basics of Ad hoc networks and Wireless Sensor Networks	L2
CO2	Have a knowledge on architecture of Wireless Sensor Networks	L3
CO3	Apply the knowledge to identify MAC and routing protocols	L3
CO4	Understand the transport layer and security issues possible in Ad hoc and sensor networks	L2
CO5	Be familiar with the OS used in Wireless Sensor Networks and build basic modules	L1

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	3	3	2				3	3	3		2
CO2	3	3	2	3	3	3	2				3	3	3		2
CO3	3	3	3	3	3	3	2				3	3	3		2
CO4	3	3	2	3	3	3	2				2	3	3		2
CO5	3	3	2	3	3	3	2				3	3	3		2
Avg	3	3	2	3	3	3	2				2.8	3	3		2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE803	TELECOMMUNICATION AND SWITCHING NETWORKS	SEMESTER VIII

PRE-REQUISITE	CATEGORY	PE	Credit		
1. Digital communication	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1. To understand the fundamentals and application of telecommunication networks.
2. To understand and design Modern digital telecommunication switching and networks.
3. To understand recent topics like switching systems, time division switching systems, ISDN, voice data integration and importance of telephone traffic analysis and telephone networks.

Unit I	MULTIPLEXING	9	0	0	9

Transmission Systems, FDM Multiplexing and modulation, The Introduction to digits, Digital Transmission and Multiplexing: Pulse Transmission, Asynchronous and synchronous transmission, Line Coding, Binary N-Zero Substitution, Digital Biphase, Differential Encoding, error performance Time Division Multiplexing, Time Division Multiplex Loops and Rings.

Unit II	DIGITAL SWITCHING	9	0	0	9

Switching Functions, Space Division Switching, Time Division Switching, two-dimensional Switching: STS Switching, TST Switching, No.4 ESS Toll Switch, Digital Cross-Connect Systems, Digital Switching in an Analog Environment. Elements of SSN07 signalling.

Unit III	NETWORK SYNCHRONIZATION CONTROL AND MANAGEMENT	9	0	0	9

Timing: Timing Recovery, Phase-Locked Loop, Clock Instability, Elastic Store, Jitter Measurements, Systematic Jitter. Timing Inaccuracies: Slips, Asynchronous Multiplexing, Network Synchronization, U.S. Network Synchronization, Network Control, Network Management.

Unit IV	DIGITAL SUBSCRIBER ACCESS	9	0	0	9

ISDN: Basic Rate Access Architecture, ISDN U Interface, ISDN D Channel Protocol. High-Data-Rate Digital Subscriber Loops: Asymmetric Digital Subscriber Line, VDSL, Digital Loop Carrier Systems: Universal Digital Loop Carrier Systems, Integrated Digital Loop Carrier Systems, Next-Generation Digital Loop Carrier, Fiber in the Loop, Hybrid Fiber Coax Systems, and Voice band Modems: PCM Modems, Local Microwave Distribution Service, Digital Satellite Services.

Unit V	TRAFFIC ANALYSIS	9	0	0	9

Traffic Characterization: Arrival Distributions, Holding Time Distributions, Loss Systems, Network Blocking Probabilities: End-to-End Blocking Probabilities, Overflow Traffic, Delay Systems: Exponential service Times, Constant Service Times, Finite Queues.

Total (45L) = 45 Periods

Text Books:

1. J. Bellamy, “Digital Telephony”, John Wiley, 2003, 3rd Edition.
2. JE Flood, “Telecommunications Switching, Traffic and Networks”, Pearson.

Reference Books:

1. R.A.Thomson, “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 Inter science, 1994.
4. Syed. R. Ali ―Digital switching systems‖, McGraw Hill New York 1998

E-References:

1. https://www.telecommunications-tutorials.com/
2. https://cosmolearning.org/video-lectures/sonetsdh-11113/
3. https://ieeexplore.ieee.org/document/6770122

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the concepts of Frequency and Time division multiplexing	L2
CO2	Design the Space division switching and Time division switching	L3
CO3	Understand the concepts of network organization of telephone networks	L2
CO4	To compare telephone network, data network and integrated service digital network.	L2
CO5	Analyze traffic in telephone networks	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	2													2	1
CO2	2	1											2	2	1
CO3	2		1			1							2	2	1
CO4	2		1											2	1
CO5	2	1		1									2	2	1
Avg	2	0.4	0.4	0.2		0.2							1.2	2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE804	DEEP LEARNING	SEMESTER VIII

PRE-REQUISITE	CATEGORY	PE	Credit	3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	Understanding the basics concepts of deep learning
2.	Emphasizing knowledge on various deep learning algorithms
3.	Understanding of CNN and RNN to model for real world applications
4.	Understanding the various challenges involved in designing deep learning algorithms for varied applications.

Unit I	INTRODUCTON TO DEEP LEARNING	9	0	0	9

Introduction to Deep Learning: Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

Unit II	FEEDFORWARD NETWORKS	9	0	0	9

Feed forward Networks: Multilayer Perceptron, Gradient Descent, Back propagation, Empirical Risk Minimization, regularization, auto encoders.

Unit III	CONVOLUTIONAL NETWORKS	9	0	0	9

Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function - Structured Outputs - Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- Le Net, Alex Net

Unit IV	RECURRENT NEURAL NETWORKS	9	0	0	9

Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks - The Long Short-Term Memory and Other Gated RNNs.

Unit V	DEEP GENERATIVE MODELS AND APPLICATIONS	9	0	0	9

Deep Generative Models: Boltzmann Machines - Restricted Boltzmann Machines - Introduction to MCMC and Gibbs Sampling-gradient computations in RBMs - Deep Belief Networks- Deep Boltzmann Machines - Applications: Large-Scale Deep Learning - Computer - Speech Recognition - Natural Language Processing - Other Applications.

Total (45L) = 45 Periods

Text Books:

1.	Ian Good fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
2.	Bengio, Yoshua. "Learning deep architectures for AI." Boston Delft 2009

Reference Books:

1.	N.D.Lewis, "Deep Learning Made Easy with R: A Gentle Introduction for Data Science", January 2016.
2.	Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly publications.
3.	Tariq Rashid, "Make your own neural network " Amazon Digital Services
4.	Anirudh Koul, "Practical Deep Learning for Cloud, Mobile, and Edge", O'Reilly Media, 2019.

E-References:

1.	https://machinelearningmastery.com/
2.	https://ai.google/education/
3.	https://in.coursera.org/learn/Deep-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand basic idea behind deep learning.	L1
CO2	Develop concept of feed forward network and encoders	L3

CO3	Apply concept of CNN in a real time application.	L3
CO4	Apply concept of RNN for an application	L3
CO5	Develop Deep Generative models	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1	1	2	2	2
CO2	2	1	2	1	1						1	1	2	2	2
CO3	2	2	3	2	1						3	2	2	2	2
CO4	2	2	2	1	1						3	2	2	2	2
CO5	2	2	3	2	1						3	2	2	2	2
Avg	2	1.6	2.4	1.4	1						2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE805	NETWORK SECURITY				SEMESTER VIII
PRE-REQUISITE		CATEGORY	PE	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1. To understand Cryptography Theories, Algorithms and Systems.
2. To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.

Unit I	INTRODUCTON	9	0	0	9

Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies - Model of network security – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography).- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.

Unit II	SYMMETRIC CRYPTOGRAPHY	9	0	0	9

Mathematics of symmetric key cryptography: Algebraic structures - Modular arithmetic-Euclid‘s algorithm- Congruence and matrices - Groups, Rings, Fields- Finite fields- SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis - Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard - RC4 – Key distribution.

Unit III	PUBLIC KEY CRYPTOGRAPHY	9	0	0	9

Mathematics of asymmetric key cryptography: Primes – Primality Testing – Factorization – Euler‘s totient function, Fermat‘s and Euler‘s Theorem - Chinese Remainder Theorem – Exponentiation and logarithm - ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange - ElGamal cryptosystem – Elliptic curve arithmetic-Elliptic curve cryptography.

Unit IV	MESSAGE AUTHENTICATION AND INTEGRITY	9	0	0	9

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA –Digital signature and authentication protocols – DSS- Entity Authentication: Biometrics, Passwords, Challenge Response protocols- Authentication applications - Kerberos, X.509.

Unit V	SECURITY PRACTICE AND SYSTEM SECURITY	9	0	0	9

Electronic Mail security – PGP, S/MIME – IP security – Web Security - SYSTEM SECURITY: Intruders – Malicious software – viruses – Firewalls.

Total (45L) = 45 Periods

Text Books:

1. William Stallings, “Cryptography and Network Security: Principles and Practice”, PHI 3rd Edition, 2006.
2. BehrouzA.Foruzan, “Cryptography and Network Security”, Tata McGraw Hill 2007

Reference Books:

1. C K Shyamala, N Harini and Dr. T R Padmanabhan, “Cryptography and Network Security”, Wiley India Pvt.Ltd
2. Charlie Kaufman, Radia Perlman, and Mike Speciner, “Network Security: PRIVATE Communication in a PUBLIC World”, Prentice Hall, ISBN 0-13-046019-2
3. Cyber Security and Network Security Sabyasachi Pramanik , Debabrata Samanta, M. Vinay , Abhijit Guha Wiley Publication
4. Arthur Salmon, “ Applied Network Security”, Packt Publishing, 2017.

E-References:

1. https://geekflare.com/learn-network-security/
2. https://www.checkpoint.com/cyber-hub/network-security/what-is-network-security/
3. https://www.udemy.com/courses/it-and-software/network-and-security/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the fundamentals of networks security, security architecture, threats and vulnerabilities	L2
CO2	Apply the different cryptographic operations of symmetric cryptographic algorithms	L3
CO3	Apply the different cryptographic operations of public key cryptography	L3
CO4	Apply the various Authentication schemes to simulate different applications.	L3
CO5	Understand various Security practices and System security standards	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1	1	2	2	2
CO2	2	1	2	1	1						1	1	2	2	2
CO3	2	2	3	2	1						3	2	2	2	2
CO4	2	2	2	1	1						3	2	2	2	2
CO5	2	2	3	2	1						3	2	2	2	2
Avg	2	1.6	2.4	1.4	1						2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE806	SATELLITE COMMUNICATION	SEMESTER VIII

PREREQUISITES	CATEGORY	PE	Credit	3

	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	The goal of the course is to introduce students to the fundamentals of satellite communication
2.	To provide them with a sound understanding of how a satellite communication system successfully transfers information from one earth station to another.
3.	To expose them to examples of applications and tradeoffs that typically occur in engineering system design, and to ask them to apply the knowledge in design problems.

Unit I	OVERVIEW OF SATELLITE SYSTEMS, ORBITS AND LAUNCHING METHODS	9	0	0	9

Introduction – Frequency Allocations for Satellite Services – INTELSAT – U.S.Domsats – Polar Orbiting Satellites- Kepler's First Law – Kepler's Second Law – Kepler's Third Law – Definitions of Terms for Earth -orbiting Satellites – Orbital Elements – Apogee and Perigee Heights – Orbital Perturbations - Local Mean Solar Time and Sun - Synchronous Orbits.

Unit II	GEOSTATIONARY ORBIT & SPACE SEGMENT	9	0	0	9

Introduction – Antenna Look Angels – The Polar Mount Antenna – Limits of Visibility – Near Geostationary Orbits – Earth Eclipse of Satellite – Sun Transit Outage – Launching Orbits - Power Supply – Attitude Control – Station Keeping – Thermal Control – TT&C Subsystem – Transponders - Antenna Subsystem – Morelos and Satmex5 – Anik-Satellites – Advanced Tiros - N Spacecraft.

Unit III	EARTH SEGMENT & SPACE LINK	9	0	0	9

Receive Only Home TV Systems – Master Antenna TV System – Community Antenna TV System – Transmit Receive Earth Stations - Equivalent Isotropic Radiated Power – Transmission Losses : Free-Space Transmission – Feeder Losses – Antenna Misalignment Losses – Fixed Atmospheric and Ionospheric Losses – Link Power Budget Equation – Carrier-to-Noise Ratio – Uplink – Down link - Effects of rain – Combined Uplink and Downlink C/N Ratio – Inter modulation Noise.

Unit IV	SATELLITE ACCESS	9	0	0	9

Single Access – Preassigned FDMA - Demand-Assigned FDMA - SPADE System - Bandwidth-limited and Power-limited TWT amplifier operation - TDMA -On-board signal Processing for TDMA / FDMA operation - Satellite switched TDMA - Code Division Multiple Access.

Unit V	DBS & SATELLITE MOBILE AND SPECIALIZED SERVICES	9	0	0	9

Direct Broadcast Satellite (DBS) Television - Orbital Spacing - Power Rating and Number of Transponders -Frequencies and Polarization -Transponder capacity - Bit rates for digital Television -The Home Receiver Outdoor Unit(ODU)-The Home Receiver Indoor Unit(IDU) – HDTV - Satellite Mobile Services – VSATs – GPS –Orbcomm.

Total (45L)= 45 periods

Text Books:

1.	Dennis Roddy, "Satellite Communications", Tata McGraw-Hill Education Private Limited, fourth edition, 2009
2.	Barry George Evans, "Satellite communication systems", 3rd Edition, IETPublications 1999

Reference Books:

1.	Timothy Pratt – Charles Bostian& Jeremy Allmuti, Satellite Communications, John Willy & Sons (Asia) Pvt. Ltd, second edition 2014
2.	Wilbur L. Pritchars Henri G.SuyderHond Robert A.Nelson, Satellite Communication Systems Engineering, Pearson Education Ltd., Second edition 2003..
3.	M.Richharia, Satellite Communication Systems (Design Principles), Macmillan Press Ltd. Second Edition 2003.
4.	Satellite communication engineering By Michael O. Kolawole, CRC Press, 2002.

E-References:

1.	http://nptel.ac.in/courses/117105131/
2.	http://nptel.ac.in/courses/106105082/33
3.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-851-satellite-engineering-fall-2003/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Describe the motion of satellite in the orbit and understand orbital effects in communications system performance	L2
CO2	:	Calculate the received carrier power at the input of earth station receiver or satellite transponder.	L3
CO3	:	Compute the noise power and carrier to noise ratio at the input of earth station or satellite transponder	L3
CO4	:	Calculate losses and design both up-link and down link	L3
CO5	:	design domestic satellite system using small earth station	L2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3
CO1		2	2	2	1								1	2	1
CO2	2	1	1	2	1								1	2	2
CO3	2	1	1	1	1								1	2	1
CO4	2	1	1	1	1								2	2	1
CO5	1	1	1	1	1								2	1	1
Avg	1.4	1.2	1.2	1.4	1								1.4	1.8	1.2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE807	BIO MEDICAL ELECTRONICS	SEMESTER VIII

PREREQUISITES	CATEGORY	PE	Credit	3
Analog Electronics	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	To gain knowledge about the various physiological parameters both electrical and non-electrical, the methods of recording and also the method of transmitting these parameters.
2.	To study about various assist devices used in hospitals.

Unit I	ELECTRO-PHYSIOLOGY AND BIOPOTENTIAL RECORDING	9	0	0	9

The origin of Bio-potentials – Bio potential electrodes types - Bio amplifiers, ECG, EEG, EMG lead systems and recording methods, typical waveforms and signal characteristics.

Unit II	BIO-CHEMICAL AND NON-ELECTRICAL PARAMETER MEASUREMENT	9	0	0	9

Measurement of pH, PO2 and PCO2, colorimeter - Blood flow meter - Cardiac output - Respiratory rate measurement - Blood pressure measurement - Heart rate measurement - Pulse rate measurement - Blood cell counters.

Unit III	MEDICAL IMAGING SYSTEM	9	0	0	9

Radiography - Computer tomography – Mammography – Magnetic Resonance Imaging – Positron Emission Tomography - Ultrasonography - Thermography,

Unit IV	ASSIST DEVICES AND BIO-TELEMETRY	9	0	0	9

Cardiac pacemakers - DC Defibrillator – Hemodialyzer, Heart Lung Machine, Telemetry: principles, Frequency selection, Biotelemetry - Radio pill

Unit V	RECENT TRENDS IN MEDICAL INSTRUMENTATION	9	0	0	9

Endoscopy unit - Applications of Laser in medicine - Cryogenic application - Introduction to Telemedicine, Electrical safety in medical environment

Total (45L)= 45 Periods

Text Books:	
1.	Khandpur, R.S., Handbook of Biomedical Instrumentation, TATA McGraw- Hill, New Delhi, 2014
2.	John G. Webster, Medical Instrumentation Application and Design, John Wiley and Sons, 4th edn., 2009
Reference Books:	
1.	Joseph J.Carr and John M.Brown, Introduction to Biomedical equipment Technology, Pearson
2.	Education, 2013.
3.	Leslie Cromwell, Fred J. Weibell, "Erich A. Pfeiffer, Biomedical Instrumentation and Measurements", Pearson Education India, 2nd Edition, 2015.
4.	Edward J. Bukstein, Medical electronics, Ungar Publications, 2002
E-References:	
1.	https://nptel.ac.in/courses/108108180
2.	https://biomedikal.in/2009/12/lecture-notes-on-biomedical-instrumentation/
3.	https://www.digimat.in/nptel/courses/video/108105101/L40.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire and analyze the various bio signals and vital parameters.	L4
CO2	Measure biochemical and other physiological information.	L3
CO3	To understand the use of radiation for diagnostic and therapy	L2
CO4	Explain the function and application of various diagnostic and therapeutic equipment.	L2
CO5	Explain about the recent developments in the field of biomedical engineering and analyze the safety aspects of medical equipment.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1								3		2
CO2	3	2	2	1	2								3	1	2
CO3	3	1	3	1	1								3	1	2
CO4	3	2	2	1									3	2	1
CO5	3	2	3	1	1								3	2	2
Avg	3	1.8	2.4	1.2	1.2								3	1.2	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECPE808	COGNITIVE RADIO		SEMESTER VIII			
PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives

1	To enable the student to understand the requirements in designing software defined radios and cognitive radio and its functionalities
2	To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
3	To analyse the spectrum management functions using cognitive radio systems and cognitive radio networks.

Unit I	**INTRODUCTION TO COGNITIVE RADIOS**	9	0	0	9

Marking radio self-aware, the cognition cycle, organization of congnition tasks, structuring knowledge for cognition tasks, Enabling location and environment awareness in cognitive radios –concepts, architecture, design considerations.

Unit II	**SDR ARCHITECTURE**	9	0	0	9

Software Defined Radio: Evolution - essential functions of the Software Defined Radio - architecture goals - quantifying degrees of programmability - top level component topology - computational properties of functional components - interface topologies among plug and play modules - architecture partitions - merits and demerits of SDR - problems faced by SDR.

Unit III	**COGNITIVE RADIO ARCHITECTURE**	9	0	0	9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture

Unit IV	**COGNITIVE RADIO NETWORK SECURITY**	9	0	0	9

Overview of IEEE 802.22 standard for broadband wireless access in TV bands -Primary user emulation attacks - security vulnerabilities in IEEE 802.22 - security threats to the radio software.

Unit V	**MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO**	9	0	0	9

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

Total (45 L) = 45 Periods

Text Books:

1	Alexander M. Wyglinski, MaziarNekovee, and Thomas Hou Y, "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

Reference Books:

1	Arslan H, "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", University of South Florida, USA, Springer, 2007.
2	Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, "Cognitive Radio Networks - From Theory to Practice", Springer Series: Analog Circuits and Signal Processing, 2009.
3	Mitola J, "Cognitive Radio: An Integrated Agent Architecture for software defined radio", Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
4	E. Biglieri, A.J. Goldsmith., L.J. Greenstein, N.B. Mandayam, H.V. Poor, "Principles of Cognitive Radio", Cambridge University Press, 2013.

E-Reference:

1	http://www.wirelessinnovation.org/Cognitive_Radio_Architecture
2	http://www.xgtechnology.com/innovations/cognitive-radio-networks/
3	http://www.radio-electronics.com/info/rf-technology-design/cognitive-radio-cr/technologytutorial.php

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the concepts and design of cognitive radios.	L2
CO2	Study about the SDR architecture and analysis.	L1
CO3	Analyse the various cognitive radio network architectures.	L4
CO4	Analyse the various security threats to the radio software in cognitive radio network.	L4
CO5	To analyse the performance of MAC and network layer design for cognitive radio.	L3

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COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		2	2	2	1		2		1		1	1	2		1
CO2		2	2	1	2		1		1		1	1	2	1	1
CO3		1	3	1	1		1		1		1	1	2	1	1
CO4		2	2	1			2		1		1	1	2	2	1
CO5		2	3	1	1		1		1		1	1	2	2	1
Avg		1.8	2.4	1.2	1.2		1.4		1		1	1	2	1.2	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

Open Elective (OE)										
1	22ECOE01	Fundamentals of Electron Devices	OE	3	0	0	3	40	60	100
2	22ECOE02	Principles of Modern Communication Systems	OE	3	0	0	3	40	60	100
3	22ECOE03	Microcontrollers and its applications	OE	3	0	0	3	40	60	100
4	22ECOE04	Computer Networks	OE	3	0	0	3	40	60	100
5	22ECOE05	Basics of Embedded Systems	OE	3	0	0	3	40	60	100
6	22ECOE06	Basics of Internet of Things	OE	3	0	0	3	40	60	100
7	22ECOE07	Artificial Intelligence and Machine Learning	OE	3	0	0	3	40	60	100

OPEN ELECTIVES

22ECOE01	FUNDAMENTALS OF ELECTRON DEVICES	OPEN ELECTIVE

PREREQUISITES	CATEGORY	OE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1. To understand the fundamentals of electron devices and apply the knowledge of these devices in electronic circuits.
2. To design and analyse single stage and multistage amplifier circuits.
3. To understand and classify different kinds of power and feedback amplifiers.

Unit I	SEMICONDUCTOR DIODE	9	0	0	9

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.

Unit II	BIPOLAR JUNCTION TRANSISTORS	9	0	0	9

NPN -PNP -Operations-Early effect-Current equations — Input and Output characteristics of CE, CB, CC – Hybrid -p model – h-parameter model, Multi Emitter Transistor.

Unit III	FIELD EFFECT TRANSISTORS	9	0	0	9

JFETs — Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance- MOSFET- Characteristics-Threshold voltage, D-MOSFET, E-MOSFET- Characteristics — Comparison of MOSFET with JFET.

Unit IV	SPECIAL SEMICONDUCTOR DEVICES	9	0	0	9

Metal-Semiconductor Junction- MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode, LASER diode.

Unit V	POWER DEVICES AND DISPLAY DEVICES	9	0	0	9

UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS, LED, LCD, Photo transistor, Opto Coupler, Solar cell, CCD.

Total (45L) = 45 periods

Text Books:

1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
2. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, “Electronic Devices and circuits”, Fourth Edition, Tata McGraw- Hill, 2016.

Reference Books:

1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, “Solid State Electronic Devices”, 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, “A Textbook of Electronic Devices and Circuits”, 2nd Edition, S.Chand Publications, 2008.
4. David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Oxford University Press, 2008.

E-References:

1. https://archive.nptel.ac.in/courses/108/108/108108122/
2. https://www.youtube.com/watch?v=qqQ8wO-lNmI
3. https://slideplayer.com/slide/12438044/

Course Outcomes: Upon completion of this course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Analyze the characteristics of semiconductor diodes.	L2
CO2	Describe the problems of Transistor circuits using model parameters.	L2, L4
CO3	Analyze the knowledge of various types of FET.	L2, L4
CO4	Gain a knowledge on special semiconductor devices	L2
CO5	Understand the knowledge on Power and Display devices.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	3	1										1		
CO2	2	3	1	2									2		
CO3	2	3	1	3									3		
CO4	1	2	1				1				1	3	3		1
CO5	1	3	1	1	1		1				2	3	3	1	2
Avg	1.6	2.8	1	1.2	0.2		0.4				0.6	1.2	2.4	0.2	0.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE02	PRINCIPLES OF MODERN COMMUNICATION SYSTEMS	OPEN ELECTIVE			
PREREQUISITES		CATEGORY	OE	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To have the knowledge of the basic concepts of AM, FM and PM.
2.	To gain knowledge about different pulse modulation and digital modulation techniques.
3.	To gain knowledge about technical information on satellite communication and wireless communication

Unit I	FUNDAMENTALS OF ANALOG COMMUNICATION	9	0	0	9

Modulation: Introduction - Amplitude modulation: Modulator and demodulator with waveforms - Angle Modulation: Frequency modulation: Modulator and demodulator with waveforms - Phase modulation - Equivalence between PM and FM - FM transmitters and receivers (Block diagram approach only) - Comparison of various Analog Communication System (AM – FM – PM).

Unit II	BASICS OF DIGITAL COMMUNICATION AND PULSE MODULATION	9	0	0	9

Pulse Amplitude Modulation (PAM) – Pulse Width Modulation (PWM) – Pulse code Modulation (PCM)–Differential Pulse Code Modulation - Pulse Position modulation: Generation and detection - Comparison of various Pulse Communication System (PAM – PWM – PCM - PPM).

Unit III	DIGITAL MODULATION TECHNIQUES	9	0	0	9

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) - Minimum Shift Keying (MSK) –Binary Phase Shift Keying (BPSK) – QPSK –M- ary PSK- Comparison of various Digital Communication System (ASK – FSK – PSK).

Unit IV	SATELLITE COMMUNICATION	9	0	0	9

History of Satellites- Kepler's laws - Satellite Orbits-Geo synchrous Satellites - Satellite Classification - Footprints - Satellite system link models: Uplink model and down link model - Multiple Access Techniques: TDMA - FDMA-CDMA-SDMA - Comparison of Multiple Access Schemes - various satellite services.

Unit V	CELLULAR MOBILE COMMUNICATION	9	0	0	9

Cellular concept - Frequency reuse-Channel Assignment Strategy - Hand off mechanism - Basic propagation models: Reflection - diffraction and scattering - Bluetooth-WLAN-Global System for Mobile Communications (GSM) –GPRS.

Total (45L)= 45 Periods

Text Books:

1.	Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007
2.	Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2010

Reference Books:

1.	Dennis Roddy, John Coolen, "Electronic Communications", Prentice Hall of India, 4th Edition.,2016
2.	H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007.
3.	B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007.
4.	AnokhSingh , "Principles of Communication Engineering" ,S.CHAND Publication, 2002

E-References:	
1.	http://www.nptelvideos.in/2012/11/communication-engineering.html
2.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-973-communication-system-design-spring-2006/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the need for modulation and how analog modulation takes place	L2
CO2	Understand the features of digital communication and pulse modulation.	L2
CO3	Analyse various digital modulation schemes.	L4
CO4	Have the knowledge about satellite communication.	L1
CO5	Have the basics of wireless and mobile communication.	L1

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1								3	2	2
CO2	2	2	1	1	1								2	1	2
CO3	1	3	2	2	1								3	1	2
CO4	2	2	1	1	1								3	2	2
CO5	1	2	2	1	1								3	2	2
Avg	1.6	2.2	1.4	1.4	1								2.8	1.6	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE03	MICROCONTROLLER AND ITS APPLICATIONS	OPEN ELECTIVE			
PREREQUISITES		**CATEGORY**	**OE**	**Credit**	**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To learn microcontroller basics and get exposure to 8051 architectures
2.	To embed and program with 8051 microcontrollers
3.	To introduce the advanced features in microcontrollers and its applications

Unit I	**INTRODUCTION TO 8051 MICROCONTROLLER**	**9**	**0**	**0**	**9**

Introduction to the concepts of microprocessors, microcontrollers, RISC, CISC, Harvard and Von Neumann architectures. Selection of microcontrollers, variants of MCS-51 family and their features. Applications of microcontrollers. 8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization.

Unit II	**ASSEMBLY LANGUAGE PROGRAMMING**	**9**	**0**	**0**	**9**

Features of machine language, assembly language, middle-level and high-level languages. 8051 Addressing modes. Instruction set: Classification, syntax and function of instructions, example programs.

Unit III	**I/O PORT AND INTERRUPTS PROGRAMMING**	**9**	**0**	**0**	**9**

Features of I/O ports. Byte size I/O, bit addressability and configuring I/O ports, interface I/O devices such as LED, buzzer, push-button switch, relay, example programs with assembly. Polling & interrupt methods, executing an interrupt, different types, IE and IP registers, enabling, disabling and priority setting, example programs in assembly.

Unit IV	**PIC MICROCONTROLLERS**	**9**	**0**	**0**	**9**

Main characteristics of PIC microcontrollers – PIC microcontroller families-12-bit instruction word-14-bit instruction word-16-bit instruction word-Inside a PIC microcontroller.

Unit V	**APPLICATIONS**	**9**	**0**	**0**	**9**

Multiplexed seven-segment display, LCD module, ADC 0804, wave form generation using DAC 0808, DC motor-PWM for speed control, Stepper motor, appropriate program.

Total (45L)= 45 Periods

Text Books:

1.	A.Mazidi , J.C. Mazidi&R.D.McKinlay," The 8051 Microcontroller & Embedded systems using assembly and C" (2ndEdition)
2.	Lucio Di Jasio et.al., "PIC Microcontrollers: Know It All", Elsevier Science,2007

Reference Books:

1.	Microcontrollers & applications, Ramani Kalpathi, & Ganesh Raja
2.	Embedded C - Michael .J.Pont - Pearson Education -2002
3.	I. Scott MacKenzie, Raphael C.-W. Phan "The 8051 Microcontroller" , Pearson/Prentice Hall Publishers, 2008.
4.	M. Mahalakshmi, "8051 Microcontroller Architecture, Programming and Application", Laxmi Publications , 2008.

E-References:

1.	https://nptel.ac.in/courses/108105102

2.	https://www.youtube.com/playlist?list=PLm_MSClsnwm9hEIDpFfDnOEu-6kVnF4ug
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basics of microcontroller and 8051 architectures.	L2
CO2	Develop programs for control applications using assembly language	L3
CO3	Illustrate the use of interrupts and service routines	L1, L3
CO4	Understand the PIC microcontroller architecture.	L2
CO5	Design microcontroller based-applications for simple real-world applications	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2		2		2							3		2
CO2	1	2				2									1
CO3	2	2		3		1							2		3
CO4	1	3		2		2							2		1
CO5	2	3		1		2							2		2
Avg	1.4	2.4		1.6		1.8							1.8		1.8
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22ECOE04	COMPUTERNETWORKS	OPEN ELECTIVE			
PREREQUISITES		**CATEGORY**	**OE**	**Credit**	**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	To introduce the basic concept in modern data communication and computer networking.
2.	To introduce the students the functions of different layers and in - depth knowledge of data link layer.
3.	To make students to get familiarized with different protocols and network layer components.
4.	To introduce the basic functions of transport layer and congestion in networks.
5.	To understand the concepts of various network Applications and Data security.

Unit I	**NETWORK FUNDAMENTALS AND PHYSICAL LAYER**	**9**	**0**	**0**	**9**

Components – networks – Topologies – The OSI reference model - layers and duties. TCP/IP reference model – layers and duties, Physical Layer: Transmission Media – Guided media & unguided media - EIA 232, SONET

Unit II	**DATA LINK LAYER**	**9**	**0**	**0**	**9**

Logical link control Functions: - Framing, Flow control, Error control: CRC, LLC protocols -HDLC, P to P- Medium access layer: - Random access, Controlled access, Channelization - Wired LANs: Ethernet IEEE 802.3, IEEE 802.4, and IEEE 802.5. Internetworking, Interconnection issues, Interconnection devices: - Repeaters, Hubs, Routers/switches and Gateways.

Unit III	**NETWORK LAYER**	**9**	**0**	**0**	**9**

Switching-Circuit switching, packet switching, message switching. Internet protocols; IPV4, IPV6, ARP, RARP, VPN. Network Routing Algorithms - Unicast routing protocol: Distance Vector Routing – Link State Routing.

Unit IV	**TRANSPORT LAYER**	**9**	**0**	**0**	**9**

Transport Services, Elements of Transport protocols, Connection management, – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control and Quality of services (QoS) – Integrated Services

Unit V	**APPLICATION LAYER**	**9**	**0**	**0**	**9**

Domain Name Space (DNS) – Electronic mail (SMTP, MIME, POP3, IMAP4) - Application protocols: WWW, HTTP, FTP and TELNET, Network management protocol: SNMP.

Total (45L)= 45 Periods

Text Books:

1.	Behrouz A. Foruzan, “Data communication and Networking”, TMH, 4th edition, 2014.
2.	James. F. Kurouse& W. Ross, “Computer Networking: A Top down Approach Featuring”, Pearson, 2020.

Reference Books:

1.	LarryL.Peterson&PeterS.Davie,“ComputerNetworks”,HarcourtAsiaPvt.Ltd.,SecondEdition.
2.	AndrewS.Tanenbaum,“ComputerNetworks”,PHI,FourthEdition,2003.
3.	An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education
4.	AjitPal,“DataCommunicationandComputerNetworks”,PHI,2014.

E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://www.mbit.edu.in/wp-content/uploads/2020/05/Computer-Networks-5th-Edition.pdf
3.	https://www.tutorialspoint.com/data_communication_computer_network/index.htm

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Explain the basic concept in modern data communication and different level of layers in the protocol	L2
CO2	:	Analyse the functions and services of data link layer	L4
CO3	:	Categorize the functions and services of network layer	L2
CO4	:	Examine the basic functions of transport layer and congestion in networks	L2
CO5	:	Analyse the concepts of various network applications and data security	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1		1								2		1
CO2	2	1	2		1								2	1	1
CO3	2	1	1										3	1	2
CO4	3	2	1		2								2		2
CO5	2	1	1		1								1	1	1
Avg	2.2	1.2	1.2		1								2	0.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE05	BASICS OF EMBEDDED SYSTEMS	OPEN ELECTIVE			
PREREQUISITES		**CATEGORY**	**OE**	**Credit**	**3**
		Hours/Week	**L**	**T**	**P**	**TH**
1.	Microprocessor and microcontroller		**3**	**0**	**0**	**3**

Course Objectives:

1.	To impart knowledge on embedded system architecture and embedded development Strategies
2.	To understand the bus Communication in processors and peripheral interfacing
3.	To understand basics of Real Time Operating System

Unit I	**BASICS OF EMBEDDED SYSTEMS**	**9**	**0**	**0**	**9**

Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Examples - Programming Languages - Recent Trends in Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning - Development Environment.

Unit II	**MEMORY MANAGEMENT AND INTERRUPTS**	**9**	**0**	**0**	**9**

Memory Access Procedure - Types of Memory - Memory Management Methods - DMA – Memory Interfacing - Polling Vs Interrupts - Types of Interrupts - Interrupt Latency - Interrupt Priority – Programmable Interrupt Controllers - Interrupt Service Routines.

Unit III	**COMMUNICATION INTERFACES**	**9**	**0**	**0**	**9**

Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth

Unit IV	**REAL TIME OPERATING SYSTEMS**	**9**	**0**	**0**	**9**

Real-Time Concepts - Task Management - Task Scheduling - Classification of Scheduling Algorithms - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing - Priority Inheritance Protocol - Priority Ceiling Protocol - Inter Task Communication - Mutex - Semaphores - Message Queues - Timers - Commercial RTOS.

Unit V	**VALIDATION AND DEBUGGING**	**9**	**0**	**0**	**9**

Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer – Background Debug Mode - InCircuit Emulator CASE STUDY: RFID Systems - GPS Navigation System – Development of Protocol Converter.

Total (45L)= 45 Periods

Text Books:

1.	Sriram VIyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2.	Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.

Reference Books:

1.	Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003
2.	Heath, "Embedded Systems Design‖", Newnes an Imprint of Elsevier, Massachusetts, 2003.
3.	Tammy Noergaard, "Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4.	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013

E-References:

1.	https://lecturenotes.in/subject/225/embedded-system-es
2.	https://nptel.ac.in/courses/108102045/19
3.	https://www.coursera.org/learn/introduction-embedded-systems.

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Outline the concepts of embedded systems	L1
CO2	Understand the concept of memory management system and interrupts.	L2
CO3	Know the importance of interfaces.	L2
CO4	Understand real time operating system concepts.	L2
CO5	To realize the applications of validation and debugging.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	3	3	2				3	3	3		2
CO2	3	3	2	3	3	3	2				3	3	3		2
CO3	3	3	3	3	3	3	2				3	3	3		2
CO4	3	3	2	3	3	3	2				2	3	3		2
CO5	3	3	2	3	3	3	2				3	3	3		2
Avg	3	3	2	3	3	3	2				2.8	3	3		2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE06	BASICS OF INTERNET OF THINGS	OPEN ELECTIVE				
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
1.	Microprocessor and microcontroller		**3**	**0**	**0**	**3**

Course Objectives:						
1.	To understand the vision of M2M to IOT.					
2.	To gain an understanding of IOT market perspective.					
3.	To acquire knowledge on Io T Technology Fundamentals and applications					
4.	To build small system using Raspberry Pi.					
Unit I	**M2M TO IOT – THE VISION**		**9**	**0**	**0**	**9**
Introduction - From M2M to Io T- M2M towards Io T: M2M Communication - The global context - A use case example – Differing Characteristics.						
Unit II	**M2M TO IOT – A MARKET PERSPECTIVE**		**9**	**0**	**0**	**9**
Introduction - Some Definitions - M2M Value Chains – Io T Value Chains - An emerging industrial structure for Io T- International driven global value chain and global information monopolies - M2M to Io T-An Architectural Overview – Building an architecture - Main design principles and needed capabilities - An Io T architecture outline - Standards considerations.						
Unit III	**IOT TECHNOLOGY FUNDAMENTALS**		**9**	**0**	**0**	**9**
Io T Enabling technologies – Io T levels and deployment templates - Devices and gateways - Data management - Business processes in Io T - Everything as a Service (XaaS) - M2M and Io T Analytics.						
Unit IV	**BUILDING IOT WITH HARDWARE PLATFORMS**		**9**	**0**	**0**	**9**
Io T Systems-Logical Design using Python –Io T Physical Devices and End Points- Io T Device - Raspberry Pi - Interfaces – Programming – Other Io T devices – Io T Reference Model - Real World Design Constraints.						
Unit V	**IOT USE CASES AND APPLICATIONS**		**9**	**0**	**0**	**9**
Home automation-Automatic lighting-Home intrusion detection- Cities-Smart parking – Environment - Weather monitoring system-Air pollution Monitoring-Forest Fire Detection- Agriculture- Smart irrigation. Commercial Building Automation – Introduction - Case study (Phase one) : Commercial building automation today - Case study (Phase two) - Commercial building automation in the future.						
Total (45L)= 45 Periods						

Text Books:	
1.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things-A hands-on approach", Universities Press, 2015
Reference Books:	
1.	Olivier Hersent, davidBoswarthick, Omar Elloumi, 'The Internet of Things Applications to the smart grid building automation', John Wiley & Sons, 2012
2.	Francis daCosta, "Rethinking the Internet of Things : A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
3.	HakimaChaouchi, 'The Internet of Things Connecting Objects', John Wiley & Sons, 2010.
4.	FabriceTheoleyr, Ai-Chun Pang, 'Internet of Things and M2M Communications', River Publishers, 2013.

E-References:	
1.	https://nptel.ac.in/courses/106105166
2.	https://onlineitguru.com/IoT-online-training.html
3.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Understand the vision of Io T from a global context.	L2
CO2	:	Determine the Market perspective of Io T.	L1
CO3	:	Understand the Io T technology fundamentals.	L2
CO4	:	Build small system using Raspberry Pi.	L3
CO5	:	Analyse applications of Io T and case studies	L4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		1			2										
CO2	2	2	2	2	2							1	1		
CO3	2	2	2	2	2							1	1		
CO4	2	2	2	2	2						2	2	2		
CO5	2	2	2	2	2						2		2		2
Avg	1.6	1.8	1.6	1.6	2						0.8	0.8	1.2		0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECOE07	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	OPEN ELECTIVE				
PREREQUISITES		**CATEGORY**	**OE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
1.	Microprocessor and microcontroller		**3**	**0**	**0**	**3**

Course Objectives:	
1.	Study about uninformed and Heuristic search techniques.
2.	To Learn techniques for reasoning under uncertainty
3.	Introduce Machine Learning and supervised learning algorithms
4.	Study about ensemble and unsupervised learning algorithms.
5.	Learn the basics of deep learning using neural networks.

Unit I	**PROBLEM SOLVING**	**9**	**0**	**0**	**9**
Introduction - From M2M to IoT- M2M towards IoT: M2M Communication - The global context - A use case example – Differing Characteristics.					
Unit II	**PROBABILISTIC REASONING**	**9**	**0**	**0**	**9**
Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.					
Unit III	**SUPERVISED LEARNING**	**9**	**0**	**0**	**9**
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree.					
Unit IV	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**	**9**	**0**	**0**	**9**
I Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN					
Unit V	**NEURAL NETWORKS**	**9**	**0**	**0**	**9**
Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) –batch normalization, regularization, dropout.					
Total (45L)= 45 Periods					

Text Books:	
1.	Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021
2.	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006

Reference Books:	
1.	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
2.	Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3.	Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4.	Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.

E-References:	
1.	https://machinelearningmastery.com/
2.	https://ai.google/education/
3.	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Use appropriate search algorithms for problem solving	L2
CO2	Apply reasoning under uncertainty	L3
CO3	Build supervised learning models	L3
CO4	Build ensembling and unsupervised models	L3
CO5	Build deep learning neural network models	L3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1	1	2	2	2
CO2	2	1	2	1	1						1	1	2	2	2
CO3	2	2	3	2	1						3	2	2	2	2
CO4	2	2	2	1	1						3	2	2	2	2
CO5	2	2	3	2	1						3	2	2	2	2
Avg	2	1.6	2.4	1.4	1						2.2	1.6	2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: VLSI DESIGN

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH101	VLSI technology	PEC	3	0	0	3
2.	22ECH102	Analog CMOS IC design	PEC	3	0	0	3
3.	22ECH103	Device modelling	PEC	3	0	0	3
4.	22ECH104	Network on chip	PEC	3	0	0	3
5.	22ECH105	DSP integrated circuits	PEC	3	0	0	3
6.	22ECH106	VLSI signal processing	PEC	3	0	0	3
7.	22ECH107	Mixed signal VLSI design	PEC	3	0	0	3
8.	22ECH108	VLSI for wireless communication	PEC	3	0	0	3
9.	22ECH109	VLSI for IOT systems	PEC	3	0	0	3
10.	22ECH110	VLSI for CAD Design	PEC	3	0	0	3

VERTICAL 2: NETWORKING

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH201	High performance networks	PEC	3	0	0	3
2.	22ECH202	Optical communication networks	PEC	3	0	0	3
3.	22ECH203	Network security and management	PEC	3	0	0	3
4.	22ECH204	Artificial neural networks	PEC	3	0	0	3
5.	22ECH205	5G networking	PEC	3	0	0	3
6.	22ECH206	Wireless Adhoc and sensor networks	PEC	3	0	0	3
7.	22ECH207	Software defined networks	PEC	3	0	0	3
8.	22ECH208	Embedded system for networking	PEC	3	0	0	3
9.	22ECH209	Cognitive radio networking	PEC	3	0	0	3
10.	22ECH210	Next generation networks	PEC	3	0	0	3

VERTICAL 3: COMMUNICATION

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH301	Statistical Theory of Communication	PEC	3	0	0	3
2.	22ECH302	Information Theory and Coding	PEC	3	0	0	3
3.	22ECH303	mm Wave Communication	PEC	3	0	0	3
4.	22ECH304	Spread Spectrum Communication	PEC	3	0	0	3
5.	22ECH305	MIMO Communication	PEC	3	0	0	3
6.	22ECH306	Smart Antennas	PEC	3	0	0	3
7.	22ECH307	RF IC and Microwave MEMs	PEC	3	0	0	3
8.	22ECH308	Cognitive Radio	PEC	3	0	0	3
9.	22ECH309	Satellite Positioning and Navigation Systems	PEC	3	0	0	3
10.	22ECH310	Remote Sensing	PEC	3	0	0	3

VERTICAL 4: SIGNAL PROCESSING

S. No.	Course Code	Course Title	Category	Hrs/Wk& Credits			
				L	T	P	C
1.	22ECH401	Advanced digital signal processing	PEC	3	0	0	3
2.	22ECH402	Speech processing	PEC	3	0	0	3
3.	22ECH403	Software defined radio	PEC	3	0	0	3
4.	22ECH404	Wavelet signal processing	PEC	3	0	0	3
5.	22ECH405	Pattern recognition and machine learning	PEC	3	0	0	3
6.	22ECH406	Adaptive/array signal processing	PEC	3	0	0	3
7.	22ECH407	Multimedia processing	PEC	3	0	0	3
8.	22ECH408	Biomedical signal and image processing	PEC	3	0	0	3
9.	22ECH409	VLSI signal processing	PEC	3	0	0	3
10.	22ECH410	Radar signal processing	PEC	3	0	0	3

22ECH101	VLSI TECHNOLOGY		Semester			
PREREQUISITES		Category	PEC	Credit		3
VLSI Design		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the concepts of wafer preparation, epitaxy and oxidation.
2	To study the use of various deposition and diffusion.
3	To impart knowledge in ion implementation and VLSI process integration.

Unit I	**CRYSTAL GROWTH, WAFER PREPARATION, EPITAXY AND OXIDATION**	**9**	**0**	**0**	**9**

Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing consideration, Vapor phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Growth Mechanism and kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopants at interface, Oxidation of Poly Silicon, Oxidation induced Defects.

Unit II	**LITHOGRAPHY AND RELATIVE PLASMA ETCHING**	**9**	**0**	**0**	**9**

Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, relative Plasma Etching techniques and Equipments.

Unit III	**DEPOSITION AND DIFFUSION**	**9**	**0**	**0**	**9**

Deposition process, Polysilicon, Silicon Dioxide- Silicon Nitride- plasma assisted Deposition, Models of Diffusion in Solids, Flick's one dimensional Diffusion Equation – Atomic Diffusion Mechanism –Measurement techniques.

Unit IV	**ION IMPLEMENTATION AND METALLIZATION**	**9**	**0**	**0**	**9**

Range theory- Implant equipment. Annealing-Shallow junction – High energy implantation – Metallization Applications-Metallization choices- Physical vapor deposition – Patterning.

Unit V	**VLSI PROCESS INTEGRATION AND PACKAGING OF VLSI DEVICES**	**9**	**0**	**0**	**9**

NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology – Bipolar IC Technology – IC Fabrication. Package types– banking design consideration – VLSI assembly technology – Package fabrication technology.

Total (45 L) = 45 Periods

Text Books:

1	Sze, S.M., "VLSI Technology", Second Edition, McGraw-Hill, New York, 1998.
2	Mukherjee, Amar., "Introduction to NMOS and CMOS VLSI System Design", Prentice Hall India, New Delhi, 2000.

Reference Books:

1	Plummer, James D., Deal, Michael D. and Griffin, Peter B., "Silicon VLSI Technology: Fundamentals Practice and Modeling", Prentice Hall India, New Delhi, 2000.
2	Hubert Kaeslin., "Digital Integrated Circuit Design From VLSI Architectures to CMOS Fabrication" Cambridge, 2008.
3	Douglas A.Pucknell, "Basic VLSI Design", Third Edition, Mc Graw Hill Book Co., 2015.
4	Sorab K.Ghandhi., "VLSI Fabrication Principles: Silicon and Gallium Arsenide", 2nd Edition, John Wiley & Sons, 1994.

E-Reference:

1	https://nptel.ac.in/courses/117106093
2	https://freevideolectures.com/course/3183/vlsi-technology-i
3	http://www.infocobuild.com/education/audio-video-courses/electronics/VLSITechnology-IIT-Madras/lecture-09.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Summarize the approach for wafer preparation, Epitaxy and Oxidation	L2
CO2	Distinguish the various methods for lithography and plasma etching	L4
CO3	Illustrate the various Deposition and diffusion process	L4
CO4	Infer the process of ion implantation and metallization	L2
CO5	Realize the various IC technology and Package types	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3		2	1	1						1	1	1	2	
CO2	3		2	1	1						2	1	2	2	
CO3	3		2	1	2		2				2	1	2	3	
CO4	3	1	2	1	2		2				1	2	2	3	
CO5	3	2	2	3	3	1	2	2	1	1	3	3	3	3	3
Avg	3	1.5	2	1.4	1.8	1	2	2	1	1	1.8	1.6	2	2.6	3

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH102	ANALOG CMOS IC DESIGN		Semester			
PREREQUISITES		Category	PEC	Credit		3
VLSI Design		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To design the fundamentals of analog circuits and MOS device models.
2	To design high frequency amplifiers and analyse Operational amplifiers.
3	To analyse two stage amplifiers and design current sources and sinks.

Unit I	**SINGLE STAGE AMPLIFIERS**	9	0	0	9

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower, differential amplifier with active load, Cascode and Folded Cascode configurations with active load, design of Differential and Cascode Amplifiers – to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures.

Unit II	**HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS**	9	0	0	9

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, statistical characteristics of noise, noise in Single Stage amplifiers.

Unit III	**FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS**	9	0	0	9

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.

Unit IV	**STABILITY AND FREQUENCY COMPENSATION OF TWO STAGE AMPLIFIER**	9	0	0	9

Analysis Of Two Stage Op Amp – Two Stage Op Amp Single Stage CMOS CS as Second Stage And Using Cascode Second Stage, Multipole Systems, Phase Margin, Frequency Compensation, And Compensation Of Two Stage Op Amps, Slewing In Two Stage Op Amps, Other Compensation Techniques.

Unit V	**BANDGAP REFERENCES**	9	0	0	9

Current sinks and sources, current mirrors, Wilson current source, Widlar current source, cascode current source, design of high swing cascode sink, current amplifiers, supply independent biasing, temperature independent references, PTAT and CTAT current generation, constant-gm biasing.

Total (45 L) = 45 Periods

Text Books:

1	BehzadRazavi, “Design Of AnalogCmos Integrated Circuits”, Tata Mcgraw Hill, 2001.
2	Willey M.C. Sansen, “Analog Design Essentials”, Springer, 2006.

Reference Books:

1	Grebene, “Bipolar And MosAnalog Integrated Circuit Design”, John Wiley & Sons,Inc.,2003.
2	Phillip E.Allen, Douglas R .Holberg, “CmosAnalog Circuit Design”, Oxford University Press, 2nd Edition, 2002

3	Recorded Lecture Available at 6. Jacob Baker “CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.
4	Uyemura John P Uyemura "CMOS Logic Circuit Design", Kluwer Academic Publishers, 1999.
E-Reference:	
1	http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
2	https://onlinecourses.nptel.ac.in/noc22_ee37/
3	https://archive.nptel.ac.in/courses/117/106/117106030/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Design amplifiers to meet user specifications	L3
CO2	Analyze the frequency and noise performance of amplifiers	L4
CO3	Design and analyze feedback amplifiers and one stage op amps	L3
CO4	Design and analyze two stage op amps	L3
CO5	Design and analyze current mirrors and current sinks with MOS devices.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
CO1	2	2	1	1	1		1				1		1	2	1
CO2	2	2	1	1	1		1				1		1	2	1
CO3	2	3	2	1	2		1				2	1	1	2	1
CO4	2	3	2	1	2		2	1	2		2	2	1	2	1
CO5	2	3	1	1	2		2	1	2		3	2	1	2	1
Avg	2	2.6	1.4	1	1.6		1.4	1	2		1.8	1.67	1	2	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH103	DEVICE MODELING	Semester	

PREREQUISITES	Category	PEC	Credit		3
Electronic Devices and Circuits	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To study the MOS capacitors and to model MOS Transistors
2	To understand the various CMOS design parameters and their impact on performance of the device
3	To study the device level characteristics of BJT transistors

Unit I	MOS CAPACITORS	9	0	0	3

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown

Unit II	MOSFET DEVICES	9	0	0	3

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields

Unit III	CMOS DEVICE DESIGN	9	0	0	3

MOSFET Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements

Unit IV	CMOS PERFORMANCE FACTORS	9	0	0	3

Basic CMOS Circuit Elements, CMOS Inverters, CMOS NAND and NOR Gates, Inverter and NAND Layouts, Parasitic Elements, Source–Drain Resistance, Parasitic Capacitances, Gate Resistance, Interconnect R and C, Sensitivity of CMOS Delay to Device Parameters, Propagation Delay and Delay Equation, Delay Sensitivity to Channel Width, Length, and Gate Oxide Thickness, Sensitivity of Delay to Power-Supply Voltage and Threshold Voltage, Sensitivity of Delay to Parasitic Resistance and Capacitance, Delay of Two-Way NAND and Body Effect, Performance Factors of Advanced CMOS Devices, MOSFETs in RF Circuits, Effect of Transport Parameters on CMOS Performance, Low-Temperature CMOS

Unit V	BIPOLAR DEVICES	9	0	0	3

n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current–Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Falloff at High Currents, Nonideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time-Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor, Relation Between BVCEO and BVCBO.

Total (45L+0T)= 45 Periods

Text Books:

1	Behzad Razavi, “Fundamentals of Microelectronics” Wiley Student Edition, 2nd Edition, 2013.
2	J P Collinge, C A Collinge, “Physics of Semiconductor devices” Springer 2002 Edition.
Reference Books:	
1	Donald A. Neamen , “Semiconductor Physics and Devices”, University of New Mexico, 4th Edition, 2012.
2	Yuan Taur and Tak H. Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2nd Edition, 2009.
3	A.S. Sedra and K.C. Smith, “Microelectronic Circuits”, 7th edition, Oxford University Press, 2015.
4	Ben G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices” ,7th edition, Pearson, 2014.
E-References:	
1.	http://www.nptelvideos.com/course.php?id=527
2.	https://www.digimat.in/nptel/courses/video/108105188/L28.html
3.	https://freevideolectures.com/course/4072/nptel-microelectronics

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Design MOSFET and BJT devices to desired specifications.	L2
CO2	Model MOSFET and BJT devices to desired specifications.	L3
CO3	Analyze the CMOS Parameters and performance.	L4
CO4	Apply the mathematical techniques for device simulations	L3
CO5	Analyze concepts about Bipolar Devices.	L4

COURSE ARTICULATION MATRIX															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2	2	2	1									2	2	1
CO 2	2	1	1	1									2	2	1
CO 3	2	2	2	1		1							2	2	2
CO 4	2	2	1	1									2	2	2
CO 5	2	2	2	1		1							2	2	2
Avg	2	1.8	1.6	1		1							2	2	1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH104	NETWORKS ON CHIP		Semester			
PREREQUISITES		**Category**	**PEC**	**Credit**		**3**
1.Computer Networks		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the concept of network - on - chip
2	To learn router architecture designs
3	To study fault tolerance and three dimensional integration of network - on - chip

Unit I	**INTRODUCTION TO NOC**	**9**	**0**	**0**	**3**
Introduction to NoC – OSI layer rules in NoC - Interconnection Networks in Network-on-ChipNetwork Topologies - Switching Techniques - Routing Strategies - Flow Control Protocol Quality-of-Service Support					
Unit II	**ARCHITECTURE DESIGN**	**9**	**0**	**0**	**3**
Switching Techniques and Packet Format - Asynchronous FIFO Design -GALS Style of Communication - Wormhole Router Architecture Design - VC Router Architecture Design - Adaptive Router Architecture Design.					
Unit III	**ROUTING ALGORITHM**	**9**	**0**	**0**	**3**
Packet routing-Qos, congestion control and flow control – router design – network link design – Efficient and Deadlock-Free Tree-Based Multicast Routing Methods - Path-Based Multicast Routing for 2D and 3D Mesh Networks- Fault-Tolerant Routing Algorithms - Reliable and Adaptive Routing Algorithms					
Unit IV	**TEST AND FAULT TOLERANCE OF NOC**	**9**	**0**	**0**	**3**
Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-on Chips-Test and Fault Tolerance for Networks-on-Chip Infrastructures-Monitoring Services for Networks-on-Chips.					
Unit V	**THREE-DIMENSIONAL INTEGRATION OF NETWORK-ON-CHIP**	**9**	**0**	**0**	**3**
Three-Dimensional Networks-on-Chips Architectures. – A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures - Resource Allocation for QoS On-Chip Communication – Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-on-Chip					
					Total (45L+0T)= 45 Periods

Text Books:

1	Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, Chita R.Das" Networks-on - Chip " Architectures Holistic Design Exploration", Springer. 2009.
2	Fayezgebali, Haythamelmiligi, HqhahedWatheq E1-Kharashi "Networks-on-Chips theory and practice CRC press, 2009.

Reference Books:

1	Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-on-Chip Architectures" 2013
2	Palesi, Maurizio, Daneshtalab, Masoud "Routing Algorithms in Networks-on-Chip" 2014

3	SantanuKundu, SantanuChattopadhyay "Network-on-Chip: The Next Generation of System on-Chip Integration", CRC Press, 2014.
4	Sheng Ma, Libo, Mingche, Shi, Zhiying, "Networks-on-chip", Morgan Kaufmann, 2014.
E-References:	
1.	https://archive.nptel.ac.in/courses/106/103/106103183/
2.	https://www.digimat.in/nptel/courses/video/108106149/L93.html
3.	https://slideplayer.com/slide/7253925/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Compare different architecture design	L2
CO2	Discuss different routing algorithms	L2
CO3	Explain three dimensional networks - on-chip architectures	L3
CO4	Analyze test and fault tolerance of Communications in NOC	L4
CO5	Apply the 3D Integration procedures in NOC	L3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	2	1							2		1	2	
CO2	2	3	2	2									2	3	2
CO3	1	3	1	2									2	3	
CO4	2	3	2	2									2	3	2
CO5	1	3	2	2									2	3	2
Avg	1.4	2.8	1.8	1.8									1.8	2.8	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH105	DSP INTEGRATED CIRCUITS	Semester	

PREREQUISITES	Category	PEC	Credit		3
1.Digital Signal Processing	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To familiarize the concept of DSP and DSP algorithms.
2	To introduce the Multirate systems and finite wordlength effects
3	To know about the basic DSP processor architectures and the synthesis of the processing elements

Unit I	INTRODUCTION TO DSP INTEGRATED CIRCUITS	9	0	0	3

Introduction to Digital signal processing, Sampling of analog signals, Selection of sample frequency, Signal- processing systems, Frequency response, Transfer functions, Signal flow graphs, Filter structures, Adaptive DSP algorithms, DFT-The Discrete Fourier Transform, FFT Algorithm, Image coding, Discrete cosine transforms, Standard digital signal processors, Application specific ICs for DSP, DSP systems, DSP system design, Integrated circuit design.

Unit II	DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS	9	0	0	3

FIR filters, FIR filter structures, FIR chips, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Mapping of analog filter structures, Multi rate systems, Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multi rate filters. Finite word length effects - Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise.

Unit III	DSP ARCHITECTURES	9	0	0	3

DSP system architectures, Standard DSP architecture-Harvard and Modified Harvard architecture. Ideal DSP architectures, Multiprocessors and multi computers, Systolic and Wave front arrays, Shared memory architectures.

Unit IV	SYNTHESIS OF DSP ARCHITECTURES	9	0	0	3

Synthesis: Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs. Combinational & sequential networks- Storage elements – clocking of synchronous systems, Asynchronous systems -FSM

Unit V	ARITHMETIC UNIT AND PROCESSING ELEMENTS	9	0	0	3

Conventional number system, Redundant Number system, Residue Number System, Bit-parallel and Bit-Serial arithmetic, Digit Serial arithmetic, CORDIC Algorithm, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator. Case Study: DCT and FFT processor

Total (45L+0T)= 45 Periods

Text Books:

1	Lars Wanhammer, “DSP Integrated Circuits”, Academic press, New York, 1999.
2	John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2002.

Reference Books:

1	Keshab Parhi, “VLSI Digital Signal Processing Systems design & Implementation”, John Wiley & Sons, 1999.
2	B.Venkatramani, M.Bhaskar, “Digital Signal Processors”, Tata McGraw-Hill, 2002.

3	Avtar Singh and S. Srinivasan, "Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx", cengage Learning India Private Limited, Delhi 2012
4	S.K. Mitra, "Digital Signal Processing, A Computer Based approach", 4th Edition, McGraw-Hill, 2010.
E-References:	
1	http://www.nptelvideos.com/lecture.php?id=7678
2	https://www.digimat.in/cgi-bin/search.cgi
3	https://www.allaboutcircuits.com/video-tutorials/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Get to know about the Digital Signal Processing concepts and its algorithms	L1
CO2	Get an idea about finite word length effects in digital filters	L2
CO3	Concept behind multi rate systems is understood.	L2
CO4	Get familiar with the DSP processor architectures	L2
CO5	Perform the synthesis of processing elements	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO 12	PSO1	PSO2	PSO3
CO1	1		2	1									2	2	2
CO2	2		1	1									1	2	1
CO3	3		1	1									2		1
CO4	1		1	1									2	2	1
CO5	2	2	2	1									1	2	1
Avg	1.8	2	1.4	1									1.6	2	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH106	VLSI SIGNAL PROCESSING		Semester			
PREREQUISITES		Category	PEC	Credit		3
VLSI Design		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To introduce fundamentals of VLSI signal processing and expose them to examples of applications.
2	To design and optimize VLSI architectures for basic DSP algorithms.
3	To impart knowledge in asynchronous pipelining.

Unit I	PIPELINING AND PARALLEL PROCESSING OF DIGITAL FILTERS	9	0	0	3

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

Unit II	ALGORITHMIC STRENGTH REDUCTION TECHNIQUE I	9	0	0	3

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 architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.

Unit III	ALGORITHIMIC STRENGTH REDUCTION -II	9	0	0	3

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with powerof-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

Unit IV	BIT-LEVEL ARITHMETIC ARCHITECTURES	9	0	0	3

Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon‟s bit-serial multipliers using Horner‟s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner‟s rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.

Unit V	NUMERICAL STRENGTH REDUCTION, WAVE AND ASYNCHRONOUS PIPELINING	9	0	0	3

Numerical strength reduction – subexpression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.

Total (45 L) = 45 Periods

Text Books:

1	Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2010.
2	U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004

Reference Books:

1	Magdy A. Bayoumi, Magdy A. Bayoumi, E. Swartzlander, "VLSI Signal Processing Technology",Kluwer Academic Publishers.October 1994.
2	Isamail, Mohammed and Fiez, Terri, "Analog VLSI Signal and Information Processing", McGraw-Hill, New York, 1994.
3	S.Y. Kuang, H.J. White House, T.Kailath., "VLSI and Modern Signal Processing", Prentice Hall, 1995.
4	Jose E. France, YannisTsividls, "Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing", Prentice Hall, 1994.
5	Richard. J. Higgins, "Digital Signal Processing in VLSI", Prentice Hall, 1990.

e-Reference:

1	https://nptel.ac.in/courses/108105157

2	https://slideplayer.com/slide/8932417/
3	https://www.youtube.com/watch?v=gIgNlhuqxWo

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand VLSI design methodology for signal processing systems.	L2
CO2	Perform the pipelining and parallel processing in FIR systems to achieve high speed and low power.	L2,L4
CO3	Apply the algorithmic strength reduction using various techniques.	L2,L4
CO4	Modify the existing or new DSP architectures suitable for VLSI.	L4,L5
CO5	Implement the strength reduction and asynchronous pipelining.	L3,46

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	1	1								2		
CO2	3	1	2	2	1		2					2	2	1	
CO3	3	2	1	2	2	2	1					2	2	2	2
CO4	2	2	2	3	3	1	2	1				2	2	2	1
CO5	3	3	2	3	3	1	2	2	2	1	3	3	3	2	3
Avg	2.8	2	1.6	2.2	2	1.3	1.75	1.5	2	1	3	2.25	2.2	1.75	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH107	MIXED SIGNAL VLSI DESIGN	Semester			
PREREQUISITES	Category	PEC	Credit		3
VLSI Design	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To analyze the characteristics of IC based CMOS filters.
2	To design various data converter architecture circuits.
3	To design oscillators and phase lock loop circuit.

Unit I	INTRODUCTION	9	0	0	9

Introduction to Active Filters & Switched capacitor filters: Switched capacitor filters: Switched capacitor resistors - amplifiers – comparators - sample & hold circuits – Integrator- Biquad

Unit II	INTEGRATOR BASED CMOS FILTERS	9	0	0	9

Integrator Building Blocks- low pass filter, Active RC integrators, MOSFET-C Integrators, gm- C integrators, Discrete time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function.

Unit III	DATA CONVERTER ARCHITECTURES	9	0	0	9

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures- Flash, Two-step flash ADC, Pipeline ADC, Integrating ADC‘s, Successive Approximation ADC.

Unit IV	DATA CONVERTER MODELING AND SNR	9	0	0	9

Sampling and Aliasing: A modeling approach, Impulse sampling, The sample and Hold, Quantization noise. Data converter SNR: An overview, Clock Jitter, Improving SNR using Averaging, Decimating filter for ADCs, Interpolating filter for DACs, Band pass and High pass sinc filters - Using feedback to improve SNR.

Unit V	OSCILLATORS AND PLL	9	0	0	9

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops.

Total (45 L) = 45 Periods

Text Books:

1	CMOS Mixed Signal Circuit Design by R.Jacob Baker, Wiley India, IEEE Press, reprint 2008.
2	CMOS Circuit Design, Layout and Simulation by R.Jacob Baker, Wiley India, IEEE Press, Second Edition, reprint 2009.

Reference Books:

1	Design of Analog CMOS Integrated Circuits by Behzad Razavi, McGraw Hill, 33rd Re- print, 2016.
2	M.L.Bushnell & V.D.Agarwal, “Essentials of Electronic Testing for Digital, Memory and Mixed signal VLSI Circuits”,Kluwer Academic Publishers, 2004
3	*N*.K Jha and S.G Gupta ,”Testing of Digital Systems”, Cambridge University Press, 2003.

4	Laung-Terng Wang,Cheng-Wen Wu,Xiaoqing Wen,VLSI "Test Principles and Architectures", Morgan Kaufmann Publishers, 2006
E-Reference:	
1	http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
2	https://onlinecourses.nptel.ac.in/noc22_ee37/
3	https://archive.nptel.ac.in/courses/117/106/117106030/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Apply the concepts for mixed signal MOS circuit.	L2
CO2	Analyze the characteristics of IC based CMOS filters.	L2
CO3	Design of various data converter architecture circuits.	L3
CO4	Analyze the signal to noise ratio and modeling of mixed signals.	L3
CO5	Design of oscillators and phase lock loop circuit.	L4

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	1	2	1						1		1	2	1
CO2	3	2	2	2	1						1		2	2	1
CO3	3	3	3	2	1				2		1		2	2	1
CO4	2	2	2	3	2		2		2		2	1	2	2	1
CO5	2	2	2	3	2		2		2		2	2	2	2	2
Avg	2.4	2.2	2	2.4	1.4		2		2		1.4	1.5	1.8	2	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH108	VLSI FOR WIRELESS COMMUNICATION				
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Wireless Communication and VLSI Design	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives

1	To understand the concepts of basic wireless communication concepts.
2	To design low noise amplifiers, mixers and various types of mixers designed for wireless communication.
3	To design PLL and VCO and to understand the concepts of back end of the transmitters and front end of the receiver in wireless communication.

Unit I	**WIRELESS COMMUNICATION CONCEPTS**	**9**	**0**	**0**	**9**

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

Unit II	**RECEIVER ARCHITECTURE AND LOW NOISE AMPLIFIERS**	**9**	**0**	**0**	**3**

Receiver front end – Filter design – Non-idealities and Design parameters – Noise figure and Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching and Core amplifier.

Unit III	**MIXERS**	**9**	**0**	**0**	**9**

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer - Switching Mixer – Distortion, Conversion Gain and Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer - Sampling Mixer - Conversion Gain, Distortion, Intrinsic and Extrinsic Noise in Single ended sampling Mixer.

Unit IV	**FREQUENCY SYNTHESIZERS**	**9**	**0**	**0**	**9**

PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters and design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

Unit V	**TRANSMITTER ARCHITECTURES AND POWER AMPLIFIERS**	**9**	**0**	**0**	**9**

Transmitter back end design – Quadrature Local Oscillator generator – Power amplifier design.

Total (45 L) = 45 Periods

Text Books:

1	Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002
2	B.Razavi ,”RF Microelectronics” , Prentice-Hall communication engineering and emerging technologies series, 2012.

Reference Books:

1	Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999
2	Emad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI wireless design – Circuits & Systems”, Kluwer Academic Publishers, 2000.
3	Crols and M. Steyaert, “CMOS Wireless Transceiver Design,” Boston, Kluwer Academic Pub., 1997
4	Thomas H.Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Cambridge University Press ,2003.

e-Reference:	
1	https://nptel.ac.in/courses/117104099/
2	http://www.nptelvideos.in/2012/12/wireless-communication.html
3	http://videos.gitam.edu/nptel/ece.html

Course Outcomes: Upon completion of this course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the fading concepts	L2
CO2	Design Low Noise amplifier and low noise amplifiers.	L3
CO3	Design mixers with noise	L3
CO4	Evaluate the performance of Frequency synthesizers.	L5
CO5	Design and analyze Power amplifiers.	L3

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	2	2	1	2	2	1	1				2	2	2		2
CO2	1	2	2	2	1	1	2				1	2	1		2
CO3	2	1	2	1	1	2	1				2	1	2		1
CO4	1	1	2	2	1	1	2				1	1	1		2
CO5	2	1	2	1	2	2	1				2	2	1		1
Avg	1.6	1.4	1.8	1.6	1.4	1.4	1.4				1.6	1.6	1.4		1.6
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH109	VLSI FOR IOT SYSTEMS		Semester			
PREREQUISITES		Category	PEC	Credit		3
VLSI Design &IOT		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To analyze the components of IOT and IC technology for IOT.
2	To acquire the electronic system design for IOT.
3	To impart the knowledge on System design for IOT and applications.

Unit I	**INTRODUCTION**	9	0	0	9

Concept of connected world - Need, Legacy systems for connected world-features and limitations, Key features of loT architecture, Merits and Demerits of loT technology. Applications driven by loT technology – examples.

Unit II	**COMPONENTS OF IOT**	9	0	0	9

Review of classic embedded system architecture, Basic building blocks of an IoT system - Artificial Intelligence, Connectivity. Sensors and Computing nodes. Sensors used in loT systems - Characteristics and requirements. Types of sensors propertiesfor loT systems, Compute nodes of loT Connectivity technologies in loT - Software in loT systems - features and properties

Unit III	**IC TECHNOLOGY FOR IOT**	9	0	0	9

SoC architecture for lot Devices - Application Processors, Microcontrollers, Smart Analog, Memory architecture for loT - Non Volatile Memories (NVM). Embedded Non-Volatile Memories, Anti-Fuse One Time Programmable (OTP) memories, Power Management - Low Dropout Regulator, DC-to-DC Converters, Voltage References, Power Management Units (PMUS) in IC's and Systems, Role of Field Programmability in IoT systems.

Unit IV	**ELECTRONIC SYSTEM DESIGN FOR IOT**	9	0	0	9

Electronic System Design for loT Requirements, Computing blocks in IoT systems - MCU's, DSPS and FPGA, System Power Supply Design for IoT systems, Mixed Signal challenges in hardware systems, Form Factor- Guidelines and prevailing standards, Component models & System Design - Feasibility and challenges, System Level Integration, Operating conditions of loT devices and impact on Electronic System Design, Hardware Security issues, EMI/EMC, SI/P) and Reliability Analysis in IOT systems.

Unit V	**APPLICATIONS**	9	0	0	9

Automated Design of Reconfigurable Microarchitectures for Accelerators Under Wide-Voltage Scaling - Approximate Adder Circuits Using Clocked CMOS Adiabatic Logic (CCAL) for IoT Applications -Battery Management Technique to Reduce Standby Energy Consumption in Ultra-Low Power IoT and Sensory Applications

Total (45 L) = 45 Periods

Text Books:

1	Alloto. "Enabling the Internet of Things- From Integrated Circuits to Integrated Systems", Springer Publications, First Edition, 2017.
2	Pieter Harpe, Kofi A. A Makinwa, Andrea Baschirotto, "Hybrid ADCs, Smart Sensors for the loT, and Sub-1V & Advanced Node Analog Circuit Design". Springer International Publishing AG, 2017

Reference Books:	
1	Rashid Khan, KajariGhoshdastidar, AjithVasudevan, "Learning lot with Particle Photon and Electron". Packt Publishi Limited (Verlag), 2016.
2	Shubakar Kalya, Muralidhar Kulkarni, Shivaprakasha, Advances in VLSI, Signal Processing, Power Electronics, IoT, Communication and Embedded Systems, Springer, 2021.
3	Ibrahim (Abe) M. Elfadel (Editor), Mohammed Ismail (Editor), TheIoT Physical Layer: Design and Implementation, Springer, 2018.
4	JyotiKandpal, Opportunity and Challenges for VLSI in IoT Application, DOI:10.4018/978-1-6684-3855-8.ch0105Bosco H Leung "VLSI for Wireless Communication", PearsonEducation, 2002
E-Reference:	
1	http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
2	https://onlinecourses.nptel.ac.in/noc22_ee37/
3	https://archive.nptel.ac.in/courses/117/106/117106030/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the basic concepts of IOT	L2
CO2	Infer the components of IOT	L2
CO3	Understand the IC technology for IOT	L2
CO4	Acquire the electronic system design for IOT	L3
CO5	Infer the applications of IOT	L2

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	1							1		1	2	
CO2	1	1	1	1							2		1	2	
CO3	1	1	1	1	2		1				2		1	2	
CO4	1	1	1	1	2	1	1	1			2	2	1	2	2
CO5	1	1	1	1	2	1	1	1	1		2	2	1	2	2
Avg	1	1	1	1	2	1	1	1	1		1.8	2	1	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH110	CAD FOR VLSI DESIGN		Semester			
PREREQUISITES		Category	PEC	Credit		3
VLSI Design		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To introduce the VLSI design methodologies, data structures and algorithms required for VLSI design.
2	To study algorithms for partitioning, placement, floor planning and routing.
3	To study algorithms for modelling, simulation and synthesis.

Unit I	**INTRODUCTION**	9	0	0	9

Introduction to VLSI Design Methodologies – VLSI Design Cycle – New Trends in VLSI Design Cycle – Physical Design Cycle – New Trends in Physical Design Cycle – Design Styles – Review of VLSI Design Automation Tools

Unit II	**DATA STRUCTURES AND BASIC ALGORITHMS**	9	0	0	9

Introduction to Data Structures and Algorithms – Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable Problems – General Purpose Methods for Combinatorial Optimization.

Unit III	**ALGORITHMS FOR PARTITIONING AND PLACEMENT**	9	0	0	9

Layout Compaction – Problem Formulation – Algorithms for Constraint Graph Compaction – Partitioning – Placement – Placement Algorithms.

Unit IV	**ALGORITHMS FOR FLOORPLANNING AND ROUTING**	9	0	0	9

Floorplanning – Problem Formulation – Floorplanning Algorithms – Routing – Area Routing – Global Routing – Detailed Routing.

Unit V	**MODELLING, SIMULATION AND SYNTHESIS**	9	0	0	9

Simulation – Gate Level Modeling and Simulation – Logic Synthesis and Verification – Binary Decision Diagrams – High Level Synthesis

Total (45 L) = 45 Periods

Text Books:

1	Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Second Edition, Wiley-India, 2017.
2	Naveed a. Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, Springer, 2017.

Reference Books:

1	Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition
2	N.a. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
3	Andrew B Kahng and Jens Lienig, "VLSI Physical Design: From Graph Partitioning to Timing Closure”.
4	Rolf Drechsler, "Evolutionary Algorithms for VLSI CAD".

E-Reference:	
1	https://archive.nptel.ac.in/courses/106/106/106106088/
2	https://gndec.ac.in/~librarian/web%20courses/IIT-MADRAS/CAD%20for%20VLSI%20DESIGN%20I/index1.html
3	https://archive.nptel.ac.in/courses/117/101/117101058/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use various VLSI design methodologies	L2
CO2	Understand different data structures and algorithms required for VLSI design.	L3
CO3	Develop algorithms for partitioning and placement.	L3
CO4	Develop algorithms for floorplanning and routing.	L3
CO5	Design algorithms for modelling, simulation and synthesis.	L4

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	1	1								1	2	1
CO2	1	1	1	1	1	1					1		1	2	1
CO3	1	1	1	1	1	1					1		1	2	1
CO4	1	1	1	1	1	1					2	1	1	2	1
CO5	1	1	1	1	1						2	1	1	2	1
Avg	1.2	1.2	1	1	1	1					1.5	1	1	2	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH201	HIGH PERFORMANCE NETWORKS		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To Compare and contrast high throughput and low latency networking devices
2	To introduce the layered communication architectures of high performance network.
3	To apply various layer protocols and solve security issues

UNIT I	INTRODUCTION	9	0	0	9

Review of OSI, TCP/IP, Multiplexing, Modes of communication, Switching, Routing, SONET-DWDM-DSL-ISDN-BISDN, ATM-Features, Addressing signaling & Routing, Header structure, ATM adaptation layer, Management control, Interworking with ATM.

UNIT II	MULTIMEDIA NETWORKING APPLICATIONS	9	0	0	9

Streaming stored audio and video-Best effort service -protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism integrated services, RSVP, differentiated services.

UNIT III	ADVANCED NETWORKS CONCEPTS	9	0	0	9

Architecture and performance, binary block codes, orthogonal, Biorthogonal, VPN-remote access VPN, site-to-site VPN, tunneling to PPP, security in VPN, MPLS-operation, routing, tunneling and use of FEC, traffic engineering, MPLS based VPN, overlay networks, P2P connections

UNIT IV	TRAFFIC MODELLING	9	0	0	9

Little's theorem, Need for modeling, Poisson modeling and its failure, non-poisson models, Network performance evaluation, Non-Markovian –Pollaczek-Khinchin formula and M/G/1, M/D/1, self-similar models and Batch-arrival model, Networks of Queues- Burke's theorem and Jackson theorem.

UNIT V	NETWORK SECURITY AND MANAGEMENT	9	0	0	9

Network Architecture, SNMP basics, SNMP naming and OIDs, MIBs, SNMPv1 data types, SNMP operations, Authentication applications- Kerberos, X.509 authentication service, Electronic mail security-Pretty Good Privacy, IP Security-IP security overview, Firewalls- Firewall design principles.

Total (45L) = 45 Periods

Text Books:

1	Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014
2	SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013

Reference Books:

1	Software Defined Networking with OpenFlow by SiamakAzodolmolky, Packt Publishing, 2013
2	Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.

3	Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76
4	Vivek Tiwari, ―SDN and Open Flow for Beginners‖, Amazon Digital Services, Inc., 2013.
E-Reference	
1	https://onlinecourses.nptel.ac.in/noc23_cs35/preview
2	https://www.youtube.com/watch?v=d70RV20bJaY

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Recognize and differentiate concepts of ATM, SONET and ISDN.	L2
CO2	Understand various multimedia networking applications and services.	L2
CO3	Apply advanced networks concepts	L3
CO4	Perform traffic based on the various models and theorems	L3
CO5	Solve various networks security issues and understand management concepts	L1, L3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1		2		2									3		2
CO2		2		2									3		3
CO3	2	2	2	2								2	2		1
CO4	2	2	2	2								2	1		1
CO5	2	2	3	2								2	2		2
Avg	1.2	2	1.4	2								1.2	2.2		1.8

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22ECH202	OPTICAL COMMUNICATION NETWORKS	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
2	To learn the various optical source materials, LED structures, quantum efficiency and Laser diodes and its uses.
3	To understand the fiber optical network components, variety of networking aspects, SONET/SDH and operational principles WDM.

UNIT I	OPTICAL FIBER COMMUNICATIONS	9	0	0	9

Historical development, The general system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, Photonic crystal fibers.

UNIT II	TRANSMISSION CHARACTERISTICS	9	0	0	9

Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices: Fusion Splices, Mechanical splices, Fiber connectors: Cylindrical ferrule connectors, Duplex and Multiple fiber connectors, Fiber couplers: three and four port couplers, star couplers, Optical Isolators and Circulators.

UNIT III	OPTICAL SOURCES	9	0	0	9

Optical sources: Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant Frequencies. Photodetectors: Physical principles of Photodiodes, Photo detector noise, Detector response time. Optical Receiver: Optical Receiver Operation: Error sources. Front End Amplifiers, Receiver sensitivity, Quantum Limit.

UNIT IV	OPTICAL NETWORK ARCHITECTURES	9	0	0	9

Introduction to Optical Networks; WDM networks, SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks- Topologies for Broadcast Networks, Media Access Control Protocols, Wavelength Routing Architecture. WOBAN and OTDM networks. Introduction to ASON.

UNIT V	PACKET SWITCHING AND ACCESS NETWORKS	9	0	0	9

Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronisation, Broadcast OTDM networks, Switch-based networks; Access Networks – Network Architecture overview, OTDM networks; Optical Access Network Architectures; Future Access Networks

Total (45L) = 45 Periods

Text Books:

1	Gerd Keiser, Optical Fiber Communication, 5th Edition, Mc Graw Hill Education (India) Private Limited, 2015.ISBN:l-25-900687-5.
2	Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks : A Practical Perspective”, Harcourt Asia Pte Ltd., Second Edition 2004.

Reference Books:

1	Optical Communication systems by John Gowar, 2nd Edition
2	Optical fiber Communications by John M. Senior, 3rd Edition
3	Biswanath Mukherjee, “Optical Communication Networks”, Mc-GrawHill ©1997, First Edition
4	C. Siva Ram Moorthy and Mohan Gurusamy, “WDM Optical Networks : Concept, Design and Algorithms”, Prentice Hall of India, Ist Edition, 2002.
E-Reference	
1	Optical Communications - Course (nptel.ac.in)
2	https://opg.optica.org/jocn/home.cfm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Recall the principles of operation of various optical fiber communication systems.	L1
CO2	Analyze the transmission characteristics of optical fiber and use	L3
CO3	Recognize the type of optical sources	L1
CO4	Understand different types of optical network architectures and their applications	L2
CO5	Relate aspects of algorithms to connectivity and packet switching and queuing.	L3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1		2		2									3		2
CO2	2	2	2	2								2	2		1
CO3	2	2	2	2								2	2		1
CO4	2	2	2	2								2	1		1
CO5	2	2	2	2								2	2		1
Avg	1.6	2	1.6	2								1.6	2.2		1.2

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22ECH203	NETWORK SECURITY AND MANAGEMENT	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Understand the need and concept of security
2	To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.
3	To understand Cryptography Theories, Algorithms and Systems

Unit I	INTRODUCTION AND NUMBER THEORY	9	0	0	9

Introduction to Information Security, Computer Security & Network Security. Need For Security. Security – Goals, Attacks, Security Services and Mechanisms, and Techniques. Number Theory and Mathematics for Symmetric Cryptography- Finite Arithmetic, Congruence Arithmetic-Linear Congruence and Quadratic Congruence – Basics for Asymmetric-Key Cryptography. Classical Symmetric-Key Ciphers –Substitution Ciphers, Transposition Ciphers

Unit II	SYMMETRIC AND ASYMMETRIC CRYPTOSYSTEMS	9	0	0	9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

Unit III	AUTHENTICATION, DIGITAL SIGNATURES AND CERTIFICATES	9	0	0	9

Message Integrity & Message Authentication - Message Authentication Code (MAC), Cryptographic Hash Functions – Birthday Attacks, Digital Signatures - Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – Public Key Distribution – RSA schemes, Digital Certificates - PKI Certificates, PKI Life Cycle Management.

Unit IV	SECURITY AT LAYERS	9	0	0	9

Network Layer Security - IPSec, Transport Layer Security- SSL/TLS, SSH, Application Layer Security –PGP, S/MIME, Firewall - Concepts, Architecture, Packet Filtering, Proxy Services and Bastion Hosts.

Unit V	NETWORK MANAGEMENT AND SNMP PROTOCOL MODEL	9	0	0	9

Network and System management, Network management system platform; Current SNMP Broadband and TMN management, Network management standards. SNMPV1, SNMPV2 system architecture, SNMPV2, structure of management information. SNMPV2 – MIB – SNMPV2 protocol, SNMPV3-Architecture, Application, MIB, security user based security model, access control RMON.

Total (45L)= 45 Periods

Text Books:

1	Behrouz A.Forouzan, “Cryptography and Network Security”, Special Edition, Tata McGraw Hill, 2007
2	Mani Subramanian, “Network Management – Principles & Practice” – 2nd Edition Prentice Hall, 2012.

Reference Books:

1	William Stallings “Cryptography and Network Security: Principles and Practice”, 3rd Edition, Pearson Education, 2002.
2	Bruce Scheneier, “Applied Cryptography”, John Wiley & Sons, 1994.

3	Charlie Kaufmann, Radia Perlman, Mike Speciner, "Network Security", Second Edition,
4	David M. Durton, “Elementary Number Theory”, Tata Mcgraw Hill, Sixth Edition, 2009.
E-References:	
1	https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2	https://nptel.ac.in/courses/106105031
3	https://www.udemy.com/courses/it-and-software/network-and-security/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Apply a structed approach to identify the need, interest and functionality of the networks.	L3
CO2	Able to identify the security issues in the network and resolve it.	L1
CO3	Analyze the vulnerabilities in any computing system and hence we able to design a security solution	L4
CO4	Evaluate security mechanisms using rigorous approaches by key ciphers and Hash functions.	L5
CO5	Demonstrate various security applications, firewall, web security, Email security and malicious software, etc.,	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1	1	2	2	2
CO2	2	1	2	1	1						1	1	2	2	2
CO3	2	2	3	2	1						3	2	2	2	2
CO4	2	2	2	1	1						3	2	2	2	2
CO5	2	2	3	2	1						3	2	2	2	2
Avg	2	1.6	2.4	1.4	1						2.2	1.6	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH204	ARTIFICIAL NEURAL NETWORKS		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the biological neural network and to model equivalent neuron models.
2	To understand the architecture, learning algorithms
3	To know the issues of various feed forward and feedback neural networks.
4	To explore the Neuro dynamic models for various problems

UNIT I	Introduction	9	0	0	9

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning.

UNIT II	Perceptrons	9	0	0	9

Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment. Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection

UNIT III	Back Propagation	9	0	0	9

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

UNIT IV	Self-Organization Maps (SOM)	9	0	0	9

Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification

UNIT V	Neuro Dynamics and Hopfield Models	9	0	0	9

Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, restricted boltzmen machine.

Total (45L) = 45 Periods

Text Books:

1	Artificial Neural Networks - B. Vegnanarayana Prentice Hall of India P Ltd 2005
2	Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Reference Books:

1	Neural Networks in Computer Inteligance, Li Min Fu TMH 2003
2	Neural Networks a Comprehensive Foundations, Simon S Haykin, PHI Ed.

3	Neural Networks -James A Freeman David M S Kapura Pearson Ed., 2004.
4	Joao Luis Garcia Rosa, Artificial Neural Networks Models and Applications, IntechOpen,2016
E-Reference	
1	https://in.coursera.org/learn/neural-networks-deep-learninghttps://in.coursera.org/learn/neural-networks-deep-learning
2	https://nptel.ac.in/courses/117105084
3	https://in.coursera.org/learn/machine-learning

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the similarity of biological networks and Neural networks	L2
CO2	Perform the training of neural networks using various learning rules.	L3
CO3	Apply the concepts of forward and backward propagations.	L3
CO4	Recognize mapping models and self-organizing map	L1
CO5	Understand and construct the Hopfield models.	L2, L3

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1		2		2									3		2
CO2	2	2	3	2								2	2		3
CO3	2	2	2	2								2	2		1
CO4	2	2	2	2								2			
CO5		2	3	2								2	2		2
Avg	1.2	2	2	2								1.6	1.8		1.8

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH205	5G COMMUNICATION NETWORKS	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To describe the evolution of mobile communication leading to the introduction of 5G
2	To identify the spectrum requirement
3	To explain the key innovations in radio and network

Unit I	INTRODUCTION TO 5G	9	0	0	9

3G and 4G(LTE) overview- Introduction to 5G – Use Cases – Evolving LTE to 5G Capability- 5G NR and 5G core network (5GCN) – 5G Standardization – 3GPP and IMT2020 – Spectrum for 5G – 5G deployment – Options, Challenges and Applications

Unit II	5G WIRELESS PROPAGATION CHANNELS AND SPECTRUM	9	0	0	9

Channel modeling requirements, propagation scenarios and challenges in the 5G modelling, Channel Models for mm Wave MIMO Systems. Spectrum for 4G – Spectrum Challenges in 5G- 5G Spectrum technologies- Value of spectrum for 5G.

Unit III	TRANSMISSION AND DESIGN TECHNIQUES FOR 5G	9	0	0	9

Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), nonorthogonal multiple accesses (NOMA).

Unit IV	DEVICE-TO-DEVICE (D2D) COMMUNICATIONS	9	0	0	9

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multihop and multi-operator D2D communications.

Unit V	MILLIMETER WAVE COMMUNICATIONS	9	0	0	9

Millimeter-wave Communications – spectrum regulations, deployment scenarios, beamforming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM).

Total (45L)= 45 Periods

Text Books:

1	Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks” , Cambridge University Press
2	Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell

Reference Books:

1	Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
2	Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.

3	Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.
4	Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press.
E-References:	
1	https://nptel.ac.in/courses/112104181/
2	https://www.qualcomm.com
3	https://5glab.de

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts and design of cognitive radios.	L2
CO2	Study about the SDR architecture and analysis.	L1
CO3	Analyse the various cognitive radio network architectures and network security.	L4
CO4	To analyse the performance of MAC and network layer design for cognitive radio.	L4
CO5	Able to improve the quality of video conferencing, improve the immersive learning experience and able to use AR and VR to design modules	L3

COURSE ARTICULATION MATRIX															
Cos/Pos	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO3
CO1	2	3	2	1	1								3		
CO2	3	2	2	1	1								3	2	1
CO3	2	2	2	3	1								3	2	
CO4	1	1	2	1	2								2	3	
CO5	1	1	2	2	2								2	3	1
Avg	1.8	1.8	2	1.6	1.4								2.6	2	0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH206	WIRELESS ADHOC AND SENSOR NETWORKS	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the basics of Ad-hoc & Sensor Networks.
2	To learn various fundamental and emerging protocols of all layers.
3	To understand the nature and applications of Ad-hoc and sensor networks.

Unit I	MAC & TCP IN AD HOC NETWORKS	9	0	0	9

Fundamentals of WLANs – IEEE 802.11 Architecture – Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols – TCP over Ad-Hoc networks-TCP protocol overview – TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

Unit II	ROUTING IN AD HOC NETWORKS	9	0	0	9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services – DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

Unit III	MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS	9	0	0	9

Introduction – Architecture – Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues – Routing Protocols – Mobile Nodes and Mobile Robots – Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

Unit IV	SENSOR MANAGEMENT	9	0	0	9

Sensor Management – Topology Control Protocols and Sensing Mode Selection Protocols – Time synchronization – Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

Unit V	SECURITY IN AD HOC AND SENSOR NETWORKS	9	0	0	9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks – Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

Total (45L)= 45 Periods

Text Books:

1	Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2	Carlos De Morais Cordeiro, Dharma Prakash Agrawal "Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011

Reference Books:

1	C.Siva Ram Murthy and B.S.Manoj, "Ad Hoc Wireless Networks – Architectures and Protocols", Pearson Education, 2004.

2	C..K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
3	Erdal Çayırcı , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
4	Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.
E-References:	
1	https://nptel.ac.in/courses/106105183
2	https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09/
3	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Identify different issues in wireless ad hoc and sensor networks	L2
CO2	To analyze protocols developed for ad hoc and sensor networks.	L4
CO3	To identify and address the security threats in ad hoc and sensor networks.	L2
CO4	Establish a Sensor network environment for different type of applications	L3
CO5	Be familiar with the OS used in Wireless Sensor Networks and build basic modules	L1

COURSE ARTICULATION MATRIX

Cos/ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3	3	3	2				3	3	3		2
CO2	3	3	2	3	3	3	2				3	3	3		2
CO3	3	3	3	3	3	3	2				3	3	3		2
CO4	3	3	2	3	3	3	2				2	3	3		2
CO5	3	3	2	3	3	3	2				3	3	3		2
Avg	3	3	2	3	3	3	2				2.8	3	3		2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH207	SOFTWARE DEFINED NETWORKS				
		CATEGORY	PEC	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:

1.	To differentiate between traditional networks and software defined networks
2.	To learn advanced and emerging networking technologies
3.	To obtain skills to do advanced networking research and programming
4.	To learn to use software programs to perform varying and complex networking tasks

UNIT I	INTRODUCTION	9	0	0	9

SDN Origins and Evolution – Introduction – Why SDN? – Centralized and Distributed Control and Data Planes – The Genesis of SDN

UNIT II	SDN ABSTRACTIONS	9	0	0	9

How SDN Works – The Openflow Protocol – SDN Controllers: Introduction – General Concepts – Vmware – Nicira – Vmware/Nicira – OpenFlow-Related – Mininet – NOX/POX – Trema – Ryu – Big Switch Networks/Floodlight – Layer 3 Centric – Plexxi – Cisco OnePK

UNIT III	PROGRAMMING SDN'S	9	0	0	9

Network Programmability – Network Function Virtualization – NetApp Development, Network Slicing

UNIT IV	SDN APPLICATIONS AND USE CASES	9	0	0	9

SDN in the Data Center – SDN in Other Environments – SDN Applications – SDN Use Cases – The Open Network Operating System

UNIT V	SDN'S FUTURE AND PERSPECTIVES	9	0	0	9

SDN Open Source – SDN Futures – Final Thoughts and Conclusions

Total (45L) = 45 Periods

Text Books:

1.	Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014
2.	SDN – Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013

Reference Books:

1.	Software Defined Networking with OpenFlow by SiamakAzodolmolky, Packt Publishing, 2013
2.	Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.
3.	Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76

4.	Vivek Tiwari, ―SDN and Open Flow for Beginners‖, Amazon Digital Services, Inc., 2013.
E-Reference	
1	https://www.youtube.com/watch?v=CaukSKg_sI0
2	https://in.coursera.org/learn/sdn
3	https://nptel.ac.in/courses/108107107

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Differentiate between traditional networks and software defined networks	L2
CO2	:	Understand advanced and emerging networking technologies	L2
CO3	:	Obtain skills to do advanced networking research and programming	L3
CO4	:	Learn how to use software programs to perform varying and complex networking tasks	L1
CO5	:	Expand upon the knowledge learned and apply it to solve real world problems	L3

COURSE ARTICULATION MATRIX

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2		2									3		2
CO2		2		2									3		3
CO3	2	2	2	2								2	2		1
CO4	2	2	2	2								2	1		1
CO5	2	2	3	2								2	2		2
Avg	1.2	2	1.4	2								1.2	2.2		1.8

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22ECH208	EMBEDDED SYSTEM FOR NETWORKING				
	CATEGORY	PE	Credit		C
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	To learn embedded communication protocols and BUS
2.	To obtain skillset in basic and embedded ethernet
3.	To obtain skills to do advanced networking research and programming
4.	To specify, design, implement, and debug an embedded system project

UNIT I	EMBEDDED COMMUNICATION PROTOCOLS	9	0	0	9

Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming – ISA/PCI Bus protocols – Fire wire.

UNIT II	USB AND CAN BUS	9	0	0	9

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types – Enumeration –Descriptors –PIC 18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction – Frames –Bit stuffing –Types of errors – Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

UNIT III	ETHERNET BASICS	9	0	0	9

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol.

UNIT IV	EMBEDDED ETHERNET	9	0	0	9

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

UNIT V	WIRELESS EMBEDDED NETWORKING	9	0	0	9

Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization – Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing.

Total (45L) = 45 Periods

Text Books:

1.	Frank Vahid, Tony Givargis, "Embedded Systems Design: A Unified Hardware/Software Introduction", John & Wiley Publications, 2002
2.	Jan Axelson, "Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port", Penram Publications, 1996.

Reference Books:

1.	Dogan Ibrahim, "Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series", Elsevier 2008.

2.	Jan Axelson, “Embedded Ethernet and Internet Complete”, Penram publications, 2003.
3.	Bhaskar Krishnamachari“, “Networking Wireless Sensors”, Cambridge press 2005.
E-Reference	
1	https://www.cisco.com/c/en/us/solutions/internet-of-things/iot-embedded-services.html
2	https://in.coursera.org/courses?query=embedded%20systems
3	https://www.coursera.org/lecture/iot/lecture-3-2-basic-equipment-UMLzi

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom’s Taxonomy Mapped
CO1	:	Understand different communication protocols	L2
CO2	:	Understand data flow in BUS and interfacing	L2
CO3	:	Obtain skills to use internet in local and wide communications	L3
CO4	:	Differentiate UDP and TCP communication	L1
CO5	:	Expand upon the knowledge learned and apply it to solve real world problems	L3

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1		2		2									3		2
CO2		2		2									3		3
CO3	2	2	2	2								2	2		1
CO4	2	2	2	2								2	1		1
CO5	2	2	3	2								2	2		2
Avg	1.2	2	1.4	2								1.2	2.2		1.8

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH209	COGNITIVE RADIO NETWORKS		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	Understand the concepts of cognitive radio
2	Learn spectrum sensing and dynamic spectrum access
3	To introduce the student about fundamental concepts and applications of cognitive radio networks.

Unit I	**INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO**	**9**	**0**	**0**	**9**

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

Unit II	**COGNITIVE RADIO ARCHITECTURE**	**9**	**0**	**0**	**9**

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

Unit III	**SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS**	**9**	**0**	**0**	**9**

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection , Bayesian Approach, Neyman Pearson fusion rule for spectrum sensing, Optimum spectrum sensing - Kullback Leibler Divergence and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

Unit IV	**MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO**	**9**	**0**	**0**	**9**

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

Unit V	**ADVANCED TOPICS IN COGNITIVE RADIO**	**9**	**0**	**0**	**9**

Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques – Requirement and challenges of IoT – Energy efficiency– MIMO Cognitive Radio – Power allocation algorithms.

Total (45L)= 45 Periods

Text Books:

1	Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, “Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2	Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006

Reference Books:

1	Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
2	Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.

3	S..Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, "Cognitive Radio-An Enabler for Internet of things", River Publishers, 2017.
E-References:	
1	https://www.youtube.com/watch?v=FCDZV2U6xxE
2	https://www.youtube.com/watch?v=oFon8h68RtM
3	https://www.udemy.com/course/cognitive-radio-networks/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Able to understand the fundamental concept of cognitive radio networks	L2
CO2	Understand technologies to allow and efficient use of TVWS for radio communication based on two spectrum sharing business models	L2
CO3	Understand the fundamental issues regarding dynamic spectrum access.	L2
CO4	Develop the cognitive radio as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.	L3
CO5	Understand the radio resource management and trading as well as number of optimization techniques for better spectrum exploitation.	L2

COURSE ARTICULATION MATRIX															
COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	1								3		
CO2	3	2	2	1	1								3	2	1
CO3	2	2	2	3	1								3	2	
CO4	1	1	2	1	2								2	3	
CO5	1	1	2	2	2								2	3	1
Avg	1.8	1.8	2	1.6	1.4								2.6	2	0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH210	NEXT GENERATION NETWORKS	Semester			
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To learn Wireless technologies and Ad-hoc Network.
2	To explore NGN architecture and management activities.
3	To gain the knowledge of Cooperation for Next Generation Wireless Networks

Unit I	**BASIC HISTORY OF MOBILE COMPUTING**	**9**	**0**	**0**	**9**

Architecture for mobile computing, Three tier architecture, design considerations for mobile computing, mobile computing through internet, Wireless network architecture, Applications, Security, Concerns and Standards, Benefits, Future. Evolution of mobile computing.

Unit II	**OVERVIEW OF WIRELESS NETWORK AND TECHNOLOGIES**	**9**	**0**	**0**	**9**

Introduction to different generations – Bluetooth - RFID, Mobile IP: Introduction, Advertisement, Registration, TCP connections, two level addressing, abstract mobility management model, performance issue, routing in mobile host, Adhoc networks – Mobile transport layer - Wireless network topologies, Cell fundamentals and topologies - Global system for mobile communication - GSM architecture.

Unit III	**GENERAL PACKET RADIO SERVICE(GPRS)**	**9**	**0**	**0**	**9**

GPRS and packet data network - GPRS network architecture – GPRS network operation - Data services in GPRS - Applications of GPRS - Billing and charging in GPRS.

Unit IV	**INFRASTRUCTURE AND AD-HOC NETWORK**	**9**	**0**	**0**	**9**

System Architecture - Protocol Architecture - Medium Access Control layer - MAC Management - Wireless LAN advantages - IEEE 802.11a - 802.11b standards -Wireless LAN architecture - Mobility in Wireless LAN - Deploying Wireless LAN - Mobile ad hoc networks and sensor networks - Wireless LAN security.

Unit V	**WIRELESS APPLICATION PROTOCOL(WAP), MMS, GPRS APPLICATION CDMA AND 3G**	**9**	**0**	**0**	**9**

Spread-spectrum Technology – FHSS – DSSS - CDMA versus GSM - Wireless data - Third generation networks - Applications in 3G Wireless LAN - WiFi v/s 3G Voice over Internet protocol and convergence - Convergence technologies - Security issues in mobile Information security - Security techniques and algorithms - Security framework for mobile environment.

Total (45L)= 45 Periods

Text Books:

1	Jingming Li Salina, Pascal Salina "Next Generation Networks-perspectives and potentials Wiley, January 2008.
2	Madhusanga Liyanage, Andrei Gurtov, Mika Ylianttila, “Software Defined Mobile Networks beyond LTE Network Architecture”, Wiley, June 2015.

Reference Books:

1	Martin Sauter,”3G,4G and Beyond bringing networks, devices and web together”, Wiley, Second edition-2013

2	Savo G Glisic," Advanced Wireless Networks- Technology and Business models", Wiley, 3rd edition- 2016
3	Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
4	Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis Takis Mathiopoulos, "New Directions in Wireless communications Systems: From Mobile to 5G", CRC Press, 2017.
E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://www.coursera.org/lecture/smart-device-mobile-emerging-technologies/4-5-lte-advanced-part-2-A4XMD
3.	https://www.coursera.org/lecture/network-transformation-101/yet-another-next-generation-yang-data-modeling-language-NXxPA

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	To understand concept of mobile communication.	L2
CO2	To analyse next generation mobile communication system.	L4
CO3	Analyze various protocols of all layers for mobile and adhoc wireless communication networks	L4
CO4	Analyze and examine new generation of mobile technology.	L4
CO5	Recognize and understand cellular technology using long term evolution.	L2

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3
CO1		1	1	2	1								1	2	1
CO2	2	1	2	2	1								1	2	2
CO3	1	1	1	1	1								1	2	1
CO4	1	1	2	1	1								1	2	1
CO5	1	1	1	1	1								1	2	1
Avg	1	1	1.4	1.4	1								1	2	1.2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH301	STATISTICAL THEORY OF COMMUNICATION		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To introduce various decision making system, filtering techniques and statistical operations.
2	To impart knowledge on Estimation theory.
3	To gain knowledge on Information theory.

Unit I	INFORMATION MEASURE	9	0	0	9

Fundamental problem of Communication, Definition and properties of Discrete Entropy, Joint and conditional entropies. Entropy in the continuous case. Noiseless coding: problem of unique decipherability, instantaneous codes. Kraft-McMillan inequality, The noiseless coding theorem. Construction of optimal codes (Huffman's method).

Unit II	NOISY CODING	9	0	0	9

The discrete memoryless channel. Mutual information and channel capacity. Classification of channels. Calculation of channel capacity. Decoding schemes. Shannon's fundamental theorem. Capacity of a band limited Gaussian channel.

Unit III	OPTIMIMUM LINEAR SYSTEMS	9	0	0	9

Digital communication in presence of additive white Gaussian noise. The correlation receiver. Matched filter for additive non-white Gaussian noise. Linear estimation using least mean square error criterion. Wiener filters.

Unit IV	TESTING OF STATISTICAL HYPOTHESIS	9	0	0	9

Likelihood ratio tests, Bayes, Neyman Pearson and Mini-max tests. Probability of error. Receiver operating characteristics. Optimum reception of known binary signals in Gaussian noise.

Unit V	PARAMETER ESTIMATION	9	0	0	9

Estimation of unknown parameters random and deterministic: ML, MSE and MAP estimates. Application to Radar. Block diagram of a pulsed radar system. The radar equation detection of steady point targets. Estimation of the range and velocity of steady point targets.

Total (45L)= 45 Periods

Text Books:

1	Yuk Wing Lee, Statistical Theory of Communication, Literary Licensing, LLC 2013
2	S.P. Eugene Xavier, Statistical Theory of Communication, New Age International, 1997

Reference Books:

1	Willis W. Harman, Principles of the Statistical Theory of Communication, McGraw-Hill, 1963
2	Barbara R. Levin, Statistical Communication Theory and Its Applications, Imported Publication 1982
3	I. Ravi Kumar, Compr. Statistical Theory of Communication, Firewall Media, 2001
4	Yuk Wing Lee, Statistical Theory of Communication Hardcover – 1, John Wiley & Sons Inc 1960

E-References:	
1	http://www.spec.gmu.edu/~pparis/classes/notes_630/handouts.pdf
2	https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee53/
3	http://drolet.segfaults.net/EE501/CourseNotesEE501.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Characterize and apply probabilistic techniques in modern decision systems.	L3
CO2	Demonstrate and compare various Estimation techniques	L2
CO3	Apply various source coding techniques to real time data	L3
CO4	Apply appropriate model for estimation and signal modeling for the given problem	L3
CO5	Analyze non-parametric and parametric methods for spectral estimation	L4

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1								3		2
CO2	3	1	1	2	1								3	1	2
CO3	3	1	2	2	2								3	1	2
CO4	3	2	2	1	1								3		1
CO5	3	1	2	2	1								3	2	2
Avg	3	1.4	1.6	1.8	1								3	0.8	1.8
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH302	INFORMATION THEORY AND CODING		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To study the basic concepts of information theory.
2	To understand the concepts of error control coding.
3	To Learn various applications of coding theory.

Unit I	INFORMATION THEORY	9	0	0	9

Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memoryless channels – BSC, BEC – Channel capacity, Shannon limit.

Unit II	BLOCK CODES	9	0	0	9

Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder – CRC.

Unit III	BCH CODES	9	0	0	9

Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non –binary BCH codes: q –ary Linear Block Codes, Primitive BCH codes over GF (q), Reed –Solomon Codes, Decoding of Non –Binary BCH and RS codes: The Berlekamp – Massey Algorithm.

Unit IV	CONVOLUTION CODES	9	0	0	9

Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.

Unit V	CONCATENATED CODES	9	0	0	9

Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes.

Total (45 L) = 45 Periods

Text Books:

1	Shu Lin &Daniel J. Costello, Jr. “Error Control Coding "Pearson / Prentice Hall, Second Edition, 2011.
2	R Bose, “Information Theory, Coding and Cryptography”, TMH 2016.

Reference Books:

1	S. Gravano, “Introduction to Error Control Codes”, Oxford University Press 2007.
2	Amitabha Bhattacharya, “Digital Communication”, TMH 2017.
3	Simon Haykin, “Digital Communication Systems”, Wiley, 2021.
4	Todd K Moon, “Error Correction Coding”, Wiley, Second Edition, 2020.

e-Reference:	
1	https://nptel.ac.in/courses/117101053
2	https://nptel.ac.in/courses/108102117
3	https://nptel.ac.in/courses/117108097

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use algebraic techniques to construct efficient codes	L3
CO2	Identify the parameters of a given code	L4
CO3	State and prove the limits on achievable code performance	L2
CO4	Understand practical aspects of data compression and error-control coding	L2
CO5	Design the encoding and decoding circuits for block codes, convolutional codes, BCH and concatenated codes.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3			2	1								2	1	1
CO2	2			2	1								1	1	1
CO3	3			3	1								2	1	1
CO4	3			2	1								2	2	1
CO5	2			2	1								1	1	
Avg	2.6			2.2	1								1.6	1.2	0.8

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH303	MM WAVE COMMUNICATION		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Analog and Digital Communication, Digital System Design and Signals and Systems		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the fundamentals of Millimeter wave devices and circuits.
2	To understand the various components of Millimeter wave Communications system.
3	To know the antenna design at Millimeter wave frequencies.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.

Unit II	**MM WAVE DEVICES AND CIRCUITS**	**9**	**0**	**0**	**9**

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's.

Unit III	**MM WAVE COMMUNICATION SYSTEMS**	**9**	**0**	**0**	**9**

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations.

Unit IV	**MM WAVE MIMO SYSTEMS**	**9**	**0**	**0**	**9**

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

Unit V	**ANTENNAS FOR MM WAVE SYSTEMS**	**9**	**0**	**0**	**9**

Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

Total (45+15) = 60 Periods

Text Books:

1	Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
2	K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.

Reference Books:

1	Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.
2	Manuel García Sanchez, "Millimeter-Wave (mmWave) Communications", MDPI Books, March 2020.

3	John S. Seybold "Introduction to RF propagation,"John Wiley and Sons, 2005.
4	Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, "Millimeter – Wave Wireless Communication Systems: Theory and Applications," Hindawi Publishing Corporation, 2007.
E-References:	
1	https://onlinecourses.nptel.ac.in/noc23_ee69/preview
2	https://onlinecourses.nptel.ac.in/noc22_ee102/preview
3	https://www.classcentral.com/course/swayam-millimeter-wave-technology-7903

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand wave propagation models for millimeter wave.	L2
CO2	Understand Millimeter devices and circuits.	L2
CO3	Understand Millimeter-wave based communication systems.	L2
CO4	Understand Millimeter-wave based MIMO systems	L2
CO5	Design antenna for Millimeter wave frequencies	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1					2		2	2	
CO2	3	2	1	2	2	1					2		2	2	
CO3	3	2	1	2	2	1					2		2	2	
CO4	3	2	1	2	2	1					2		2	2	
CO5	3	2	1	2	2	1					2		2	2	
Avg	3	2	1	2	2	1					2		2	2	

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH304	SPREAD SPECTRUM COMMUNICATION		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Analog and Digital Communication		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the basics of spread spectrum communication systems.
2	To learn about the performance of spread spectrum in multipath environment.
3	To understand the performance analysis of spread spectrum systems.

Unit I	**SPREADING CODES**	9	0	0	9

Finite-Field Arithmetic- Sequence Generator Fundamentals-State - Machine Representation of Shift Register Generators- Generation and Properties of m-Sequences Gold Codes - Kasami Sequences (Small Set) - Quaternary Sequences - Complementary Code Keying - Walsh–Hadamard Sequences.

Unit II	**SPREAD SPECTRUM SYSTEMS**	9	0	0	9

Direct Sequence Spread Spectrum (DSSS)- Processing Gain- Frequency Hop Spread Spectrum (FHSS)- Coherent and Noncoherent Slow FHSS – Coherent and Noncoherent Fast FHSS- Hybrid DS/FH Spread Spectrum.

Unit III	**SYNCHRONIZATION IN SPREAD SPECTRUM**	9	0	0	9

Baseband Recovery - Carrier Synchronization - Code Synchronization – Pseudonoise Acquisition in Direct Sequence Receivers- Pseudonoise Tracking in Direct Sequence Receivers.

Unit IV	**SPREAD SPECTRUM IN MULTIPATH ENVIRONMENT**	9	0	0	9

Spread Spectrum Communication System Model, Performance of Spread Spectrum Systems without Coding. Performance of Spread Spectrum Systems with Forward Error Correction: Elementary Block Coding Concepts-Optimum Decoding Rule-Calculation of Error Probability-Elementary Convolution Coding Concepts, Decoding and Bit-Error Rate.

Unit V	**PERFORMANCE ANALYSIS OF SPREAD SPECTRUM SYSTEM**	9	0	0	9

Performance of spread spectrum system under AWGN, multi-user Interference, jamming and narrow band interferences Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, Error probability of DS-CDMA system under AWGN and fading channels, RAKE receiver.

Total (45+15) = 60 Periods

Text Books:

1	Rodger E. Ziemer, "Fundamentals of Spread Spectrum Modulation", Morgan & Claypool, Publishers series, 2007.
2	Bernard Sklar & Pabitra Kumar Ray, "Digital Communications Fundamentals and Applications", Third Edition, Pearson Education, Inc, 2021.

Reference Books:

1	Don Torrieri, "Principles of Spread-Spectrum Communication Systems", Springer, 3rd Edition, 2015.
2	L. Peterson, R. E. Ziemer, and D. E. Borth, "Introduction to Spread Spectrum Communications", Upper Saddle River, NJ: Prentice Hall, 1995

3	M.K. Simon, J.K. Omura, R.A. Scholtz, and B.K. Levitt, "Spread Spectrum Communications Handbook", Electronic Edition, McGraw-Hill, 2002
4	Robert C.Dixon, "Spread Spectrum Systems with Commercial Applications", 3rd Edition, John Wiley & Sons, Ins, 1994..
E-Reference:	
1	https://nptel.ac.in/courses/117105077/
2	http://www.rgcetpdy.ac.in/Notes/IT/III%20YEAR/COMMUNICATION%20ENGINEERING-II/Unit%202.pdf
3	https://www.tutorialspoint.com/digital_communication/digital_communication_spread_spectrum_modulation.htm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the spread spectrum codes.	L2
CO2	Arrive at detailed specifications of the spread spectrum systems.	L1
CO3	Design systems based on spread spectrum synchronization.	L3
CO4	Design the spread spectrum in multipath environment.	L3
CO5	Know the concept of Performance analysis of spread spectrum system.	L1

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2		2	2	1								1		1
CO2	2		2	2	1								2		1
CO3	2		2	2	1								2	1	1
CO4	2		2	2	1								2	1	1
CO5	2		2	2	1								2	1	1
Avg	2		2	2	1								1.8	0.6	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH305	MIMO COMMUNICATION		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Analog and Digital Communication		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To give comprehensive coverage of coding techniques for Multiple Input Multiple Output (MIMO) communication systems.
2	To analyze about MIMO communication systems, Space-time block codes, Space-time trellis codes
3	To gain knowledge on MIMO systems for frequency-selective (FS) fading channels.

Unit I	**FADING CHANNELS AND DIVERSITY TECHNIQUES**	9	0	0	9

Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

Unit II	**CAPACITY AND INFORMATION RATES OF MIMO CHANNELS**	9	0	0	9

Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signalling for MIMO communications.

Unit III	**SPACE-TIME BLOCK AND TRELLIS CODES**	9	0	0	9

Transmit diversity with two antennas: The Alamouti scheme – Orthogonal and Quasi-orthogonal space-time block codes – Linear dispersion codes – Generic space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes.

Unit IV	**CONCATENATED CODES AND ITERATIVE DECODING**	9	0	0	9

Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding.

Unit V	**SPACE-TIME CODING FOR FREQUENCY SELECTIVE FADING CHANNELS**	9	0	0	9

MIMO frequency-selective channels – Capacity and Information rates of MIMO FS fading channels – Space-time coding and Channel detection for MIMO FS channels – challenges in MIMO OFDM systems – Antenna selection for MIMO systems.

Total (45+15) = 60 Periods

Text Books:

1	Tolga M. Duman and Ali Ghrayeb, “Coding for MIMO Communication systems”, John Wiley & Sons, West Sussex, England, 2007
2	A.B. Gershman and N.D. Sidiropoulus, “Space-time processing for MIMO communications”, Wiley, Hoboken, NJ, USA, 2005.

Reference Books:

1	E.G. Larsson and P. Stoica, “Space-time block coding for Wireless communications”, Cambridge University Press, 2003.
2	Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 1st Edition, McGraw-Hill Education, India, 2015.

3	H. Jafarkhani, “Space-time coding: Theory & Practice”, Cambridge University Press, 2005.
4	Huaibei Zhou” Advance MIMO systems” Scientific Research Publishing; 1st edition, 2009.
E-Reference:	
1	https://nptel.ac.in/noc/individual_course.php?id=noc17-cs37
2	https://nptel.ac.in/courses/117104115/34
3	https://nptel.ac.in/noc/individual_course.php?id=noc16-ec11

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the diversity techniques and design the MIMO channels.	L2
CO2	Understand the capacity of MIMO channels.	L1
CO3	Analyse the performance of Space time Trellis code.	L4
CO4	Design concatenated codes.	L3
CO5	Understand Frequency selective channels to estimate the capacity of MIMO channels.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2		1	1	1								2	1	1
CO2	1		1	1	1								2		1
CO3	2		2	2	1								2		1
CO4	2		2	2	1								2	1	1
CO5	2		2	2	1								2		1
Avg	1.8		1.6	1.6	1								2	0.4	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH306	SMART ANTENNAS		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Antenna and wave propagation		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To gain basic knowledge on smart antennas.
2	To understand adaptive beam forming.
3	To acquire insight about space-time processing.

Unit I	**INTRODUCTION TO SMART ANTENNAS**	**9**	**0**	**0**	**9**

Need for Smart Antennas- Smart Antenna Configurations- Switched-Beam Antennas- Adaptive Antenna Approach- Space Division Multiple Access (SDMA)- Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits, Drawbacks and Applications of Smart Antennas System.

Unit II	**DOA ESTIMATION FUNDAMENTALS**	**9**	**0**	**0**	**9**

Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Autocovariance, Conventional DOA Estimation Methods, Conventional Beamforming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates.

Unit III	**BEAM FORMING FUNDAMENTALS**	**9**	**0**	**0**	**9**

Classical Beam former, Statistically Optimum Beamforming Weight Vectors, Maximum SNR Beam former, Multiple Sidelobe Canceller and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV).

Unit IV	**INTEGRATION AND SIMULATION OF SMART ANTENNAS**	**9**	**0**	**0**	**9**

Antenna Design, Mutual Coupling, Adaptive Signal Processing Algorithms, DOA, Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart Antenna Systems for Mobile Adhoc Networks (MANETs), Protocol, Simulations, Discussion.

Unit V	**SPACE-TIME PROCESSING**	**9**	**0**	**0**	**9**

Discrete Space–Time Channel and Signal Models, Space– Time Beamforming, Inter-symbol and Co-Channel Suppression, Space–Time Processing for DSCDMA, Capacity, and Data Rates in MIMO Systems.

Total (45L)= 45 Periods

Text Books:

1	Constantine A. Balanis & Panayiotis I. Ioannides, "Introduction to Smart Antennas", Morgan & Claypool Publishers' series-2007
2	Joseph C. Liberti Jr., Theodore S Rappaport, "Smart Antennas for Wireless CommunicationsIS-95 and Third Generation CDMA Applications", PTR – PH publishers, 1st Edition, 1989.

Reference Books:

1	T.S Rappaport, "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE press 1998, PTR – PH publishers 1999.
2	Lal Chand Godara, "Smart Antennas", CRC Press, LLC-20.

3	Frank B. Gross, Smart Antennas with MATLAB®, 2nd Edition, 2015 McGraw-Hill Education.
4	T. K. Sarkar, Michael C. Wicks, Magdalena Salazar-Palma, Robert J. Bonneau, Smart Antennas: 143 (Wiley Series in Microwave and Optical Engineering), Wiley-IEEE Press; 1st edition (20 May 2003).
E-References:	
1	https://onlinecourses.nptel.ac.in/noc20_ee20/preview
2	https://nptel.ac.in/courses/108101092
3	https://archive.nptel.ac.in/courses/117/107/117107035/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand various types of smart antenna and its configurations.	L2
CO2	Analyse various estimation methods.	L4
CO3	Understand and analyse beamforming in smart antennas.	L2 & L4
CO4	Integrate and simulate algorithms related to smart antennas.	L3
CO5	Analyse and understand space-time processing techniques.	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1					2		2	2	
CO2	3	2	1	2	2	1					2		2	2	
CO3	3	2	1	2	2	1					2		2	2	
CO4	3	2	1	2	2	1					2		2	2	
CO5	3	2	1	2	2	1					2		2	2	
Avg	3	2	1	2	2	1					2		2	2	

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH307	RF IC AND MICROWAVE MEMS		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Transmission lines and Microwave Engineering		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	Familiarize the students with different types of MEMS devices and fabrication methods of passive and active MEMS devices.
2	Design micro machined passive components, Transmission lines and Antennas.
3	Analyse Packaging and reliability issues in MEMS structures.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction to MMIC, Processing & Layers, Passive MMIC Elements & Models, Active MMIC Elements & Models Biasing, Amplifiers. Introduction to MMICs Technologies: GaAs/Si/InP: MESFET HEMT BJT HBT. Applications, Circuit basics. Fabrication Technology. MMIC components, Active devices, Passive lumped elements, Microstrip elements. Introduction: RF MEMS for microwave applications, MEMS technology and fabrication, mechanical modelling of MEMS devices, MEMS materials and fabrication techniques.

Unit II	**MEMs SWITCHES**	**9**	**0**	**0**	**9**

MEMS Switches: Introduction to MEMS switches; Capacitive shunt and series switches: Physical description, circuit model and electromagnetic modelling; Techniques of MEMS switch fabrication and packaging; Design of MEMS switches.

Unit III	**RF FILTERS AND PHASE SHIFTERS**	**9**	**0**	**0**	**9**

RF Filters and Phase Shifters: Modeling of mechanical filters, micromachined filters, surface acoustic wave filters, micromachined filters for millimeter wave frequencies; Various types of MEMS phase shifters; Ferroelectric phase shifters.

Unit IV	**TRANSMISSION LINES AND ANTENNAS**	**9**	**0**	**0**	**9**

Transmission Lines and Antennas: Micromachined transmission lines, losses in transmission lines, coplanar transmission lines, micromachined waveguide components; Micromachined antennas: Micromachining techniques to improve antenna performance, reconfigurable antennas.

Unit V	**INTEGRATION AND PACKAGING**	**9**	**0**	**0**	**9**

Integration and Packaging: Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.

Total (45L)= 45 Periods

Text Books:

1	Varadan, V.K., Vinoy, K.J. and Jose, K.J., "RF MEMS and their Applications", John Wiley & Sons. 2002.
2	Rebeiz, G.M., "MEMS: Theory Design and Technology", John Wiley & Sons. 1999.

Reference Books:

1	De Los Santos, H.J, "RF MEMS Circuit Design for Wireless Communications", Artech House. 1999.
2	Trimmer, W., "Micromechanics & MEMS", IEEE Press. 1996.
3	Madou, M., "Fundamentals of Microfabrication", CRC Press. 1997.

4	Sze, S.M., "Semiconductor Sensors", John Wiley & Sons. 1994.
E-References:	
1	https://onlinecourses.nptel.ac.in/noc19_ee57/preview
2	https://www.surrey.ac.uk/cpd-and-short-courses/microwave-circuits-and-systems
3	RF and millimeter-Wave Circuit Design | Coursera

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Identify various types of MMIC and MEMS devices, fabrication methods and packaging standards.	L2
CO2	Design MEMS tuneable capacitors and switches using micromachining techniques.	L3
CO3	Model MEMS filters and Phase shifters for various types of RF applications.	L3
CO4	Design and analysis of Micro machined Transmission lines and Antennas for wireless applications	L3
CO5	Analyse the reliability and design related issues in MEMS structures.	L4

COURSE 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	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1					2		2	2	
CO2	3	2	1	2	2	1					2		2	2	
CO3	3	2	1	2	2	1					2		2	2	
CO4	3	2	1	2	2	1					2		2	2	
CO5	3	2	1	2	2	1					2		2	2	
Avg	3	2	1	2	2	1					2		2	2	

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH308	COGNITIVE RADIO		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To enable the student to understand the requirements in designing software defined radios and cognitive radio and its functionalities
2	To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation
3	To analyse the spectrum management functions using cognitive radio systems and cognitive radio networks.

Unit I	**INTRODUCTION TO COGNITIVE RADIOS**	**9**	**0**	**0**	**9**
Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.					
Unit II	**SPECTRUM SENSING**	**9**	**0**	**0**	**9**
Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models.					
Unit III	**OPTIMIZATION TECHNIQUES OF DYNAMIC SPECTRUM ALLOCATION**	**9**	**0**	**0**	**9**
Linear programming, convex programming, non-linear programming, integer programming, dynamic programming and stochastic programming.					
Unit IV	**DYNAMIC SPECTRUM ACCESS AND MANAGEMENT**	**9**	**0**	**0**	**9**
Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access.					
Unit V	**SPECTRUM TRADING**	**9**	**0**	**0**	**9**
Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA, classification of auctions (single auctions, double auctions, concurrent, sequential).					
Total (45L)= 45 Periods					

Text Books:

1	Ekram Hossain, DusitNiyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press,2009.
2	E. Biglieri, A.J. Goldsmith., L.J. Greenstein, N.B. Mandayam, H.V. Poor, "Principles of Cognitive Radio", Cambridge University Press, 2013.

Reference Books:

1	Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
2	Cognitive Radio Hardbound by Budati Anil Kumar , Peter Ho Chiung Ching , Shuichi Torii , CRC Press 1st Edition 2021
3	Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, " Cognitive RadioCommunications And Networks - Principles And Practice", Elsevier Inc. , 2010.

4	Handbook of Cognitive Radio Editor: Wei Zhang, Springer 2020

E-References:	
1	http://www.xgtechnology.com/innovations/cognitive-radio-networks/
2	https://snscourseware.org/snscenew/notes.php?cw=CW_5d09f853e42f6
3	https://www.techtarget.com/searchnetworking/definition/cognitive-radio

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the fundamental concepts of cognitive radio networks	L2
CO2	Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.	L3
CO3	Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.	L2
CO4	Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.	L2
CO5	Understanding of the applications of auction theory as an economic approach to enable the emerging cognitive radio systems very useful.	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1							3	3	
CO2	3	2	3	3	1	1							3	2	
CO3	3	2	2	3	1	1							2	3	3
CO4	3	2	3	3	2	1							2		3
CO5	3	3	3	3	1	1							2		3
Avg	2.8	2.4	2.6	2.8	1.4	1							2.4	1.6	2.4

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH309	SATELLITE POSITIONING AND NAVIGATION SYSTEMS	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn about the science behind the orbiting satellites and various multiplexing schemes
2	To impart knowledge on earth station parameters used for satellite communication.
3	To gain knowledge of navigation systems especially GPS in detail.

Unit I	ORBITS, PROPAGATION IMPAIRMENTS AND SPACE LINK	9	0	0	9

Introduction, Satellite orbits, Kepler ‘s three laws, Orbital Elements, Eclipse effect, Orbit determination, Look angle determination. Satellite subsystems: Attitude and Orbital Control System (AOCS), Telemetry Tracking and Command (TT&C), Power System, Communications System, Satellite transponder, Space Craft Antennas, Frequency Reuse Antennas. Communication link design: Basic transmission theory, EIRP, Completion Link design with and without frequency reuse, System noise temperature G/T ratio, Noise figure and Noise temperature.

Unit II	SATELLITE MULTIPLE ACCESSES: SATELLITE MOBILE AND SPECIALIZED SERVICES	9	0	0	9

Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N, Time Division Multiple Access (TDMA), Satellite Switched TDMA, Demand Assignment Multiple Access (DAMA), CDMA Spread Spectrum Transmission and Reception. Message Transmission by FDMA: M/G/1 Queue, Message Transmission by TDMA, PURE ALOHA, Satellite Packet Switching, Slotted Aloha, Packet Reservation, Tree Algorithm, VSAT Technologies, Network Configurations, Polling VSAT Networks, Mobile Satellite Networks, CDMA MSAT Network.

Unit III	EARTH STATION TECHNOLOGY	9	0	0	9

Transmitters, Receivers, Antennas, Tracking Systems, Transponders, Small earth station Antennas, Equipment for earth station, Lower Orbit Considerations, Coverage and frequency considerations, Direct broadcasting satellite Television and Radio, Satellite Navigation.

Unit IV	INTRODUCTION TO GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSSs)	9	0	0	9

The History of GPS, The Evolution of GPS, Development of NAVSTAR GPS, GPS working principle, Trilateration, Determining the receiver position in 2D or XY Plane, Determining the receiver position in 3D or X-Y-Z Plane.

Unit V	GPS ORBITS AND SATELLITE POSITION DETERMINATION	9	0	0	9

GPS system segments, Space segment, Control segment, User segment, GPS Signals, Pseudorandom noise (PRN) code, C/A code, P code Navigation data, and Signal structure of GPS. Anti-spoofing (AS), selective availability GPS orbital parameters, description of receiver independent exchange format (RINEX) – Observation data and navigation message data parameters, GPS position determination, least squares

Total (45 L) = 45 Periods

Text Books:

1	Timothy Pratt, Jeremy Allnutt, “Satellite Communications”, 3rd Edition, Wiley, 2019.
2	G S RAO, “Global Navigation Satellite Systems”, McGraw-Hill publications, New Delhi, 2010.

Reference Books:	
1	D.C.Agarwal. R Anand, “Satellite Communications”, Khanna Publishers, 2021.
2	M. Richcharia, “Satellite Communications: Design Principles” 2nd Ed., BSP, 2003.
3	James Ba, Yen Tsui, “Fundamentals of GPS receivers – A software approach”, John Wiley & Sons, 2001.
4	Gunter Seeber, “Satellite Geodesy Foundations-Methods and Applications”, 2003.
e-Reference:	
1	https://nptel.ac.in/courses/117105131
2	https://www.youtube.com/watch?v=H00_PVX2bRw
3	https://youtube.com/playlist?list=PLLy_2iUCG87A55NPtEwWoWPiKs0-9NNT1

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Architect appropriate technologies for the implementation of specified satellite communication systems.	L3
CO2	Understand the various multiple access techniques for satellite services.	L2
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.	L4
CO4	Summarize the working principle of GPS and its history.	L1
CO5	Develop new navigation solutions for determining accurate user position.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1		2	1	1	1	1						2	1	1
CO2	1		1	1	1	1	1						1		1
CO3	2		2	1	1	1	1						2	1	1
CO4	1		1	1	1	1							1		1
CO5	2		2	1	1	1	1						2	2	1
Avg	1.4		1.6	1	1	1	0.8						1.6	0.8	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH310	REMOTE SENSING	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To familiarize about the basic principles of remote sensing
2	To acquire knowledge about the motion of remote sensing satellites in the space
3	To expose the various types of sensors used for remote sensing
4	To gain knowledge about the generation of satellite data products

Unit I	PHYSICS OF REMOTE SENSING	9	0	0	9

Remote Sensing - Definition - Components - Electro Magnetic Spectrum – Basic wave theory – Particle theory – Stefan Boltzman law - Wiens-Displacement Law - Radiometric quantities - Effects of Atmosphere- Scattering – Different types – Absorption-Atmospheric window- Energy interaction with surface features – Spectral reflectance of vegetation, soil and water –atmospheric influence on spectral response patterns- multi concept in Remote sensing -

Unit II	PLATFORMS	9	0	0	9

Orbit elements – Types of orbits – Motions of planets and satellites – Launch of space vehicle – Orbit perturbations and maneuvers – escape velocity - Types and characteristics of different remote sensing platforms – sun synchronous and geo synchronous satellites.

Unit III	SENSORS	9	0	0	9

Classification of remote sensors – selection of sensor parameters - resolution concept - Spectral, Radiometric and temporal resolution – Quality of images – imaging mode – photographic camera – opto-mechanical scanners – pushbroom and whiskbroom cameras – Panchromatic, multi spectral , thermal,hyperspectral scanners and microwave sensors – geometric characteristics of scanner imagery – Operational Earth resource satellites - Landsat, SPOT, IRS, WorldView, hyperion and hysis, ERS, ENVISAT,Sentinel.

Unit IV	DATA RECEPTION AND DATA PRODUCTS	9	0	0	9

Ground segment organization – Data product generation – sources of errors in received data – referencing scheme – data product output medium – Digital products – Super structure, Fast,GeoTIFF, Hierarchical and HDF formats – Indian and International Satellite Data Products – ordering of data

Unit V	DATA ANALYSIS	9	0	0	9

Data products and their characteristics – Elements of visual interpretation – interpretation keys – Digital image processing – Preprocessing – Image rectification – Image enhancement techniques– Image classification – Supervised and unsupervised classification algorithms for multispectral and hyperspectral images – Accuracy assessment.- hybrid classification techniques – Knowledge based classification, Neural Network Classification, Fuzzy Classification.

Total (45L)= 45 Periods

Text Books:

1	John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition, 2017.
2	Lillesand T.M., and Kiefer,R.W. Remote Sensing and Image interpretation, VI edition of John Wiley & Sons-2015.

Reference Books:	
1	Beniamino Cipriani, Remote Sensing and Image Interpretation, Scitus, 2016
2	John A.Richards, Springer – Verlag, Remate Sensing Digital Image Analysis 5th edition, 2013.
3	George Joseph, Fundamentals of Remote Sensing, Third Edition, Universities Press (India) Pvt Ltd, Hyderabad, 2018
4	Shunlin Liang , Jindi Wang, Acad Pr " Advanced Remote Sensing ", Acad Pr , 2nd Edition, 2019.
E-References:	
1	https://nptel.ac.in/courses/105108077
2	https://ncert.nic.in/textbook/pdf/kegy307.pdf
3	https://www.uotechnology.edu.iq/appsciences/Laser/Lacture_laser/thrid_class/Remote_Sensing/3-Remote_Sensing.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts and laws related to remote sensing	L2
CO2	Acquire knowledge about various remote sensing platforms	L1
CO3	Understand the characteristics of different types of remote sensors	L2
CO4	Gain knowledge about reception, product generation, storage and ordering of satellite data	L1
CO5	Understand the concept of different image processing techniques and interpretation of satellite data	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	3	2	1	1								3		
CO2	3	2	2	1	1								3	2	1
CO3	2	2	2	3	1								3	2	
CO4	1	1	2	1	2								2	3	
CO5	1	1	2	2	2								2	3	1
Avg	1.8	1.8	2	1.6	1.4								2.6	2	0.4

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH401	ADVANCED DIGITAL SIGNAL PROCESSING		Semester			
PREREQUISITES		Category	PE	Credit		3
DIGITAL SIGNAL PROCESSING		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To learn and understand the concepts of stationary and non-stationary random signals and analysis & characterization of discrete-time random processes
2	To enunciate the significance of estimation of power spectral density of random processes
3	To introduce the principles of optimum filters such as Wiener and Kalman filters
4	To introduce the principles of adaptive filters and their applications to communication engineering
5	To introduce the concepts of multi-resolution analysis

Unit I	DISCRETE-TIME RANDOM PROCESSES	9	0	0	9

Random variables - ensemble averages a review, random processes - ensemble averages, autocorrelation and autocovariance matrices, ergodic random process, white noise, filtering random processes, spectral factorization, special types of random processes - AR, MA, ARMA

Unit II	SPECTRUM ESTIMATION	9	0	0	9

Bias and consistency, Non-parametric methods - Periodogram, modified-Periodogram - performance analysis. Bartlett's method, Welch's method, Blackman-Tukey method. Performance comparison. Parametric methods - autoregressive (AR) spectrum estimation – autocorrelation method, Prony's method, solution using Levinson Durbin recursion

Unit III	OPTIMUM FILTERS	9	0	0	9

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications - filtering, linear prediction. IIR Wiener filter - causal and non-causal filters. Recursive estimators - discrete Kalman filter.

Unit IV	ADAPTIVE FILTERS	9	0	0	9

Principles and properties of adaptive filters - FIR adaptive filters. Adaptive algorithms – steepest descent algorithm, the LMS algorithm - convergence. Applications of adaptive filtering – noise cancellation, channel equalization

Unit V	MULTIRESOLUTION ANALYSIS	9	0	0	9

Short-time Fourier transform - Heisenberg uncertainty principle. Principles of multi-resolution analysis - sub-band coding, the continuous and discrete wavelet transform - properties. Applications of wavelet transform - noise reduction, image compression

Total (45 L) = 45 Periods

Text Books:

1	Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2	P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc.

Reference Books:	
1	John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education / Prentice Hall, 2007
2	Sophoncles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000
3	Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, 5th Edition, 2014.
4	S. Kay,” Modern spectrum Estimation theory and application”, Pearson India, 2009.
e-Reference:	
1	https://ekeeda.com/degree-courses/electrical-engineering/advanced-digital-signal-processing
2	https://www.classcentral.com/course/youtube-advanced-digital-signal-processing-course-97386
3	https://nptel.ac.in/courses/117101001

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Articulate and apply the concepts of special random processes in practical applications	L4
CO2	Apply optimum filters appropriately for a given communication application	L3
CO3	Choose appropriate spectrum estimation techniques for a given random process	L2
CO4	Apply appropriate adaptive algorithm for processing non-stationary signals	L3
CO5	Apply and analyse wavelet transforms for signal and image processing based applications	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	1	1						1		2	2	2
CO2	2	2	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	2	3	2	1						2		2	2	2
Avg	2	2	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH402	SPEECH PROCESSING		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
DIGITAL SIGNAL PROCESSING		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the speech production mechanism and the various speech analysis techniques and speech models
2	To understand the speech compression techniques
3	To understand the speech recognition techniques
4	To know the speaker recognition and text to speech synthesis techniques

Unit I	**SPEECH SIGNAL CHARACTERISTICS & ANALYSIS**	9	0	0	3

Speech production process - speech sounds and features- - Phonetic Representation of Speech -- representing speech in time and frequency domains - Short-Time Analysis of Speech - Short- Time Energy and Zero-Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception

Unit II	**SPEECH COMPRESSION**	9	0	0	3

Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Vector Quantization- Linear predictive coding (LPC) - Code excited Linear predictive Coding (CELP)

Unit III	**SPEECH RECOGNITION**	9	0	0	3

LPC for speech recognition- Hidden Markov Model (HMM)- training procedure for HMM- subword unit model based on HMM- language models for large vocabulary speech recognition – Overall recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition.

Unit IV	**SPEAKER RECOGNITION**	9	0	0	3

Acoustic parameters for speaker verification- Feature space for speaker recognition-similarity measures- Text dependent speaker verification-Text independent speaker verification techniques

Unit V	**SPEAKER RECOGNITION AND TEXT TO SPEECH SYNTHESIS**	9	0	0	3

Text to speech synthesis(TTS)-Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of prosody

Total (45 L) = 45 Periods

Text Books:

1	L. R. Rabiner and R. W. Schafer, Introduction to Digital Signal Processing, Foundations and Trends in Signal Processing Vol. 1, Nos. 1–2 (2007) 1–194
2	Ben Gold and Nelson Morgan “Speech and Audio signal processing- processing and perception of speech and music”, John Wiley and sons 2006

Reference Books:	
1	Lawrence Rabiner, Biiing and– Hwang Juang and B.Yegnanarayana “Fundamentals of Speech Recognition”, Pearson Education, 2009
2	Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999
3	Donglos O shanhnessy “Speech Communication: Human and Machine “, 2nd Ed. University press 2001.
4	Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education
e-Reference:	
1	https://www.udemy.com/course/speech-recognition-a-z-with-hands-on-learnkarts/
2	https://onlinecourses.nptel.ac.in/noc22_ee117/preview
3	https://archive.nptel.ac.in/courses/108/108/108108185/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Analyse the speech signal	L4
CO2	Design speech compression techniques	L4
CO3	Configure speech recognition techniques	L3
CO4	Understand speaker recognition systems	L2
CO5	Design text to speech synthesis systems	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	2	1								2	2	2
CO2	2	1	2	1	1								2	2	2
CO3	2	1	2	1	1								2	2	2
CO4	2	1	2	2	1								2	2	2
CO5	2	1	2	2	1								2	2	2
Avg	2	1	2	1.5	1								2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH403	SOFTWARE DEFINED RADIO		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the evolving software defined radio and cognitive radio techniques and their essential functionalities
2	To study the basic architecture and standard for cognitive radio
3	To understand the physical, MAC and Network layer design of cognitive radio
4	To expose the student to evolving applications and advanced features of cognitive radio

Unit I	**INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO**	9	0	0	3

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

Unit II	**COGNITIVE RADIO ARCHITECTURE**	9	0	0	3

Cognition cycle – orient, plan, decide and act phases, Organization, SDR as a platform for Cognitive Radio – Hardware and Software Architectures, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

Unit III	**SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS**	9	0	0	3

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

Unit IV	**MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO**	9	0	0	3

MAC for cognitive radios – Polling, ALOHA, slotted ALOHA, CSMA, CSMA / CA, Network layer design – routing in cognitive radios, flow control and error control techniques.

Unit V	**ADVANCED TOPICS IN COGNITIVE RADIO**	9	0	0	3

Overview of security issues in cognitive radios, auction based spectrum markets in cognitive radio networks, public safety and cognitive radio, cognitive radio for Internet of Things.

Total (45 L) = 45 Periods

Text Books:

1	Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, "Cognitive Radio Communications and Networks", Academic Press, Elsevier, 2010.

2	Huseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
Reference Books:	
1	Jeffrey H. Reed ,"Software Radio: A Modern Approach to Radio Engineering", Pearson Education Low Price Edition,2002
2	Kwang-Cheng Chen, Ramjee Prasad, " Cognitive Radio Networks", John Wiley and Sons, 2009.
3	Ezio Biglieri, Professor Andrea J. Goldsmith, Dr Larry J. Greenstein, Narayan B. Mandayam, H. Vincent Poor, "Principles of Cognitive Radio" , Cambridge University Press, 2012.
4	Travis F. Collins, Robin Getz, Di Pu, Alexander M. Wyglinski, "Software-Defined Radio for Engineers", mobile communication series, 2018.
e-Reference:	
1	https://onlinecourses.nptel.ac.in/noc22_ee78/preview
2	https://www.udemy.com/topic/software-defined-radio-sdr/
3	https://commtech-academy.com/sdr/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Gain knowledge on the design principles on software defined radio and cognitive radio	L2
CO2	Develop the ability to design and implement algorithms for cognitive radio spectrum sensing and dynamic spectrum access	L3
CO3	Build experiments and projects with real time wireless applications	L4
CO4	Apply the knowledge of advanced features of cognitive radio for real world applications	L3
CO5	Study the principal Challenge of receiver design.	L2

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1		2	2	2
CO2	2	1	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	1	2	1	1						1		2	2	2
Avg	2	1.5	2.25	1.25	1						1.25		2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH404	Wavelet Signal Processing		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To study the basics of signal representation and Fourier theory
2	To understand Multi Resolution Analysis and Wavelet concepts
3	To study the wavelet transform in both continuous and discrete domain
4	To understand the design of wavelets using Lifting scheme
5	To understand the applications of Wavelet transform

Unit I	FUNDAMENTALS	9	0	0	3

Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion,Fourier transform, Short time Fourier transform, Time-frequency analysis

Unit II	MULTI RESOLUTION ANALYSIS	9	0	0	3

Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.

Unit III	CONTINUOUS WAVELET TRANSFORMS	9	0	0	3

Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions (Daubechies Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal)– Tiling of Time – Scale Plane for CWT.

Unit IV	DISCRETE WAVELET TRANSFORM	9	0	0	3

Filter Bank and Sub Band Coding Principles – Wavelet Filters – Inverse DWT Computation by Filter Banks – Basic Properties of Filter Coefficients – Choice of Wavelet Function Coefficients – Derivations of Daubechies Wavelets – Mallat's Algorithm for DWT – Multi Band Wavelet Transforms Lifting Scheme- Wavelet Transform Using Polyphase Matrix Factorization – Geometrical Foundations of Lifting Scheme – Lifting Scheme in Z –Domain.

Unit V	APPLICATIONS	9	0	0	3

Wavelet methods for signal processing- Image Compression Techniques: EZW–SPHIT Coding– Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions –Edge Detection and Object Isolation, Image Fusion, and Object Detection.

Total (45 L) = 45 Periods

Text Books:

1	Rao R M and A S Bopardikar, "Wavelet Transforms Introduction to theory and Applications", Pearson Education, Asia, 2000.
2	L.Prasad & S.S.Iyengar, "Wavelet Analysis with Applications to Image Processing", CRC Press, 1997.

Reference Books:	
1	J. C. Goswami and A. K. Chan, “Fundamentals of wavelets: Theory, Algorithms and Applications" WileyInterscience Publication,John Wiley & Sons Inc., 1999.
2	M. Vetterli, J. Kovacevic, “Wavelets and subband coding" Prentice Hall Inc, 1995.
3	Stephen G. Mallat, “A wavelet tour of signal processing" 2 nd Edition Academic Press, 2000.
4	Soman K P and Ramachandran K I, ―Insight into Wavelets From Theory to practice, Prentice Hall, 2004.
E-Reference:	
1	https://ocw.mit.edu/courses/18-327-wavelets-filter-banks-and-applications-spring-2003/
2	https://nptel.ac.in/courses/108101093
3	https://archive.nptel.ac.in/courses/117/101/117101123/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Use Fourier tools to analyse signals	L2
CO2	Gain knowledge about MRA and representation using wavelet bases	L2
CO3	Acquire knowledge about various wavelet transforms	L2
CO4	Design using wavelet transform	L5
CO5	Apply wavelet transform for various signal & image processing applications	L3

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1								2	2	2
CO2	2	1	2	1	1								2	2	2
CO3	2	1	2	1	1								2	2	2
CO4	2	1	2	1	1								2	2	2
CO5	2	1	2	1	1								2	2	2
Avg	2	1	2	1	1								2	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECH405	PATTERN RECOGNITION AND MACHINE LEARNING	Semester			
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Understand the in-depth concept of Pattern Recognition , Bayes Decision Theory Perception and related Concepts
2	To enable the student to understand the working concepts of RF active components and amplifiers
3	Understand the concept of ML Pattern Classification and the concept of DL Pattern Recognition
4	To Understand the basics concepts of machine learning, CNN and RNN to model for real world applications.

Unit I	**INTRODUCTION TO PATTERN RECOGNITION**	9	0	0	3

Induction Algorithms. Rule Induction. Decision Trees. Bayesian Methods. Overview. Naïve Bayes. The Basic Naïve Bayes Classifier. Naive Bayes Induction for Numeric Attributes. Correction to the Probability Estimation. Laplace Correction. No Match. Other Bayesian Methods. Other Induction Methods. Neural Networks. Genetic Algorithms. Instance-based Learning. Support Vector Machines.

Unit II	**STATISTICAL PATTERN RECOGNITION**	9	0	0	3

Classification and regression. Features, Feature Vectors, and Classifiers. Pre-processing and feature extraction. The curse of dimensionality. Polynomial curve fitting. Model complexity. Multivariate non-linear functions. Bayes' theorem. Decision boundaries. Parametric methods. Sequential parameter estimation. Linear discriminant functions. Fisher's linear discriminant. Feed-forward network mappings.

Unit III	**BAYES DECISION THEORY CLASSIFIERS**	9	0	0	3

Bayes Decision Theory. Discriminant Functions and Decision Surfaces. The Gaussian Probability Density Function. The Bayesian Classifier for Normally Distributed Classes. Exact interpolation. Radial basis function networks. Network training. Regularization theory. Noisy interpolation theory. Relation to kernel regression. Radial basis function networks for classification. Comparison with the multi-layer perceptron. Basis function optimization.

Unit IV	**INTRODUCTION TO MACHINE LEARNING**	9	0	0	3

Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm. Feed forward Networks: Multilayer Perceptron, Backpropagation, Radial basis function networks.

Unit V	**CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS**	9	0	0	3

Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function -Structured Outputs - Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- LeNet, AlexNet.Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks - The Long Short-Term Memory and Gated RNNs, Autoencoders.

Total (45 L) = 45 Periods

Text Books:

1	Pattern Classification, 2nd Edition, Richard O. Duda, Peter E. Hart, and David G. Stork. Wiley, 2000
2	Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, September 2014,ISBN 978-0-262-02818-9

Reference Books:

1	"Pattern Recognition and Machine Learning", Christopher M. Bishop. Springer, 2010
2	Practical Machine Learning and Image Processing, Himanshu Singh. Apress, 2019

3	MehryarMohri, AfshinRostamizadeh, AmeetTalwalkar, "Foundations of Machine Learning",MIT Press (MA) 2012.
4	Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, now publishers Inc.,2009.

e-Reference:

1	https://www.geeksforgeeks.org/pattern-recognition-introduction/
2	https://viso.ai/deep-learning/pattern-recognition/
3	https://nptel.ac.in/courses/117108048

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand basic idea behind pattern recognition and machine learning	L2
CO2	Understand statistical pattern recognition	L2
CO3	Apply various decision theory classifiers.	L3
CO4	Understand the basics of machine learning	L2
CO5	Apply the concept of CNN and RNN to model applications	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	1	1						1		2	2	2
CO2	2	2	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	2	3	2	1						2		2	2	2
Avg	2	2	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH406		Semester			
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
Signals and Systems	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To analyze and to design signal processing algorithms both in the temporal and spatial domain
2	To develop a mathematical theory of linear adaptive filters
3	To design optimum and linear filter

Unit I	**INTRODUCTION**	9	0	0	3

Adaptive Filters-Single channel adaptive equalization (temporal filter), multi-channel adaptive beamforming (spatial filter) Stochastic Processes-Stationary processes, Time averages, Ergodic processes, Correlation matrices, Linear Algebra-Eigenvalue decomposition, Eigen filter.

Unit II	**ADAPTIVE FILTERS**	9	0	0	3

Linear Optimum Filtering (Wiener Filters)-Principle of Orthogonality, Wiener-Hopf equations, Error-performance surface, MMSE (minimum mean-squared error), Canonical form of the error-performance surface, MMSE filtering in case of linear Models. Generalized Sidelobe Canceler. Iterative Solution of the Normal Equations-Steepest descent algorithm, Stability of the algorithm, Optimization of the step-size, Least Mean Square (LMS) Algorithm, Recursive Least Squares (RLS) Algorithm

Unit III	**HIGH-RESOLUTION PARAMETER ESTIMATION**	9	0	0	3

Data model (DOA estimation), Eigen decomposition of the spatial correlation matrix at the receive array, Subspace estimates, Estimation of the model order. Spectral MUSIC-DOA estimation, Periodogram. Standard ESPRIT. Selection matrices, Shift invariance property. Signal Reconstruction, Spatial smoothing.

Unit IV	**TENSOR-BASED SIGNAL PROCESSING**	9	0	0	3

Introduction and Motivation, Fundamental Concepts of Tensor Algebra, Elementary Tensor Decompositions-Higher Order SVD (HOSVD), CANDECOMP / PARAFAC (CP) Decomposition, Tensors in Selected Signal Processing Applications.

Unit V	**MAXIMUM LIKELIHOOD ESTIMATORS**	9	0	0	3

Maximum Likelihood Principle, The Fisher Information Matrix and the Cramer Rao Lower Bound (CRLB)-Efficiency, CRLB for 1-D direction finding applications, Asymptotic CRLB.

Total (45 L) = 45 Periods

Text Books:

1	A. H. Sayed, Fundamentals of Adaptive Filtering. John Wiley & Sons, Inc., New York, NY, 2003.
2	T. K. Moon and W. C. Stirling, Mathematical Methods and Algorithms for Signal Processing.

Reference Books:

1	S. Haykin, AdaptiveFilterTheory.Prentice-Hall, 4th edition, 2002.
2	H. L. V.Trees, OptimumArrayProcessing.John Wiley & Sons, Inc., New York, NY, 2002.
3	Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.
4	Adaptive Filtering: Algorithms and Practical Implementation, P. Diniz, Kluwer, 1997.

E-Reference:	
1	https://nptel.ac.in/courses/117105075
2	http://www.infocobuild.com/education/audio-video-courses/electronics/AdaptiveSignalProcessing-IIT-Kharagpur/lecture-30.html
3	https://www.ce.cit.tum.de/msv/courses/master-lectures/adaptive-and-array-signal-processing/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts of temporal and spatial filtering.	L2
CO2	Designing, implementing, and analyzing adaptive filters applied to system identification	L4
CO3	Identify tensors for selected signal processing application	L3
CO4	Apply various techniques to retrieve high resolution parameter estimation	L3
CO5	Understand the concepts of Maximum likelihood estimators	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		1	2	1	1						1		2	2	2
CO2		1	2	1	1						1		2	2	2
CO3		2	3	2	1						2		2	2	2
CO4		2	2	1	1						1		2	2	2
CO5		2	3	2	1						2		2	2	2
Avg		1.6	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH407	MULTIMEDIA PROCESSING		Semester			
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To get familiarity with gamut of multimedia and its significance
2	To acquire knowledge in multimedia components.
3	To acquire knowledge about multimedia tools and authoring
4	To acquire knowledge in the development of multimedia applications.
5	To explore the latest trends and technologies in multimedia

Unit I	INTRODUCTION	9	0	0	3

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Unit II	ELEMENTS OF MULTIMEDIA	9	0	0	3

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Unit III	MULTIMEDIA TOOLS	9	0	0	3

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Unit IV	MULTIMEDIA SYSTEMS	9	0	0	3

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Unit V	MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS	9	0	0	3

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval

Total (45 L) = 45 Periods

Text Books:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, "Fundamentals of Multimedia", Springer, Third Edition, 2021.

2	Prabhat K.Andleigh, Kiran Thakrar, "MULTIMEDIA SYSTEMS DESIGN", Pearson Education, 2015.
Reference Books:	
1	Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018.
2	Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017
3	Multimedia Signal Processing - Theory And Applications In Speech, Music And Communications by Vaseghi, John Wiley And Sons
4	Jan Vozer, "Video Compression for Multimedia", AP Press, New York, 1995.
e-Reference:	
1	https://www.aonlinetraining.com/
2	https://gb.coursera.org/lecture/android-programming-2/multimedia-part-1-NW4wT
3	https://onlinecourses.nptel.ac.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Handle the multimedia elements effectively.	L2
CO2	Articulate the concepts and techniques used in multimedia applications.	L2
CO3	Develop effective strategies to deliver Quality of Experience in multimedia applications	L3
CO4	Design and implement algorithms and techniques applied to multimedia objects.	L5
CO5	Design and develop multimedia applications following software engineering models.	L5

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1		2	2	2
CO2	2	1	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	2	3	2	1						2		2	2	2
Avg	2	1.6	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH408	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	Semester			
PREREQUISITES	Category	PE	Credit		3
Signals and Sy	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn the image fundamentals and mathematical transforms necessary for signal and image processing.
2	To study the various image enhancement techniques.
3	To apply various image restoration procedures in medical images.
4	To gain knowledge about the basic concepts of image compression procedures.
5	To study about the various segmentation techniques applied to Medical Images.

Unit I	BIOMEDICAL SIGNALS AND IMAGES	9	0	0	3

CG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications. Speech Signals: The source-filter model of speech production, spectrographic analysis of speech. Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders. Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT.MRI: Physics and signal processing for magnetic resonance imaging.

Unit II	FUNDAMENTALS OF DETERMINISTIC SIGNAL AND IMAGE PROCESSING	9	0	0	3

Data Acquisition: Sampling in time, aliasing, interpolation, and quantization. Digital Filtering: Difference equations, FIR and IIR filters, basic properties of discrete-time systems, convolution. DTFT: The discrete-time Fourier transform and its properties. FIR filter design using windows. DFT: The discrete Fourier transform and its properties, the fast Fourier transform (FFT), the overlap-save algorithm, digital filtering of continuous-time signals. Sampling Revisited: Sampling and aliasing in time and frequency, spectral analysis. Image processing, I: Extension of filtering and Fourier methods to 2-D signals and systems. Image processing II: Interpolation, noise reduction methods, edge detection, homomorphic filtering.

Unit III	IMAGE SEGMENTATION AND OBJECT RECOGNITION	9	0	0	3

Edge detection- Marr Hidreth edge detector - Canny edge detector, Thresholding foundation - Basic global thresholding - Basic Adaptive thresholding, Region Based segmentation, Watershed segmentation algorithm, Patterns and pattern classes, Recognition based on decision theoretic methods-matching, Optimum statistical classifiers.

Unit IV	IMAGE COMPRESSION	9	0	0	3

Image compression- Fundamentals - Image compression standards- Coding: Run length-, Huffman- Arithmetic-, Bit plane-, Transform- and Lossy- and lossless predictive coding.

Unit V	IMAGE RESTORATION AND RECONSTRUCTION OF MEDICAL IMAGES	9	0	0	3

Image degradation models, Algebraic approach to restoration, inverse filtering, Least mean square filter, Image reconstruction from projections - Radon transforms - Filter back projection algorithm - Fourier reconstruction of MRI Images.

Total (45 L) = 45 Periods

Text Books:

1	Rabiner, L. R., and R. W. Schafer. Digital Processing of Speech Signals. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.

2	Rafael C, Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education Asia, Third Edition, 2007.
Reference Books:	
1	William K Pratt, "Digital Image Processing", John Wiley NJ, 4th Edition, 2007
2	Albert Macouski, "Medical Imaging systems", Prentice Hall, New Jersey 2nd edition 1997.
3	Lim, J. S. Two-Dimensional Signal and Image Processing. Upper Saddle River, NJ: Prentice Hall, 1989.
4	Macovski, A. Medical Imaging Systems. Upper Saddle River, NJ: Prentice Hall, 1983.
e-Reference:	
1	https://onlinecourses.nptel.ac.in/noc20_ee41
2	https://onlinecourses.nptel.ac.in/noc21_bt50
3	https://onlinecourses.nptel.ac.in/noc20_ee40

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Identify the equipment used in the analysis of biomedical signal and image processing	L4
CO2	Understand the filtering concepts applied to signal and images.	L2
CO3	Understand how to apply the image processing techniques for various medical images.	L3
CO4	Learn the fundamental concepts of medical image acquisition	L2
CO5	Understand the concepts of image compression and restoration	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		1	2	1	1						1		2	2	2
CO2		1	2	1	1						1		2	2	2
CO3		2	3	2	1						2		2	2	2
CO4		2	2	1	1						1		2	2	2
CO5		2	3	2	1						2		2	2	2
Avg		1.6	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH409	VLSI SIGNAL PROCESSING		Semester			
PREREQUISITES		Category	PE	Credit		3
VLSI design		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To review VLSI design methods.
2	To explore VLSI architecture
3	To implement DSP algorithms onto digital hardware
4	Applications of parallel processing and pipelining.

Unit I	PIPELINING AND PARALLEL PROCESSING	9	0	0	3

Introduction, Pipelining of FIR Digital Filters, Parallel Processing. Pipelining and Parallel Processing for Low Power. Retiming: Introduction, Definition and Properties, Solving System of Inequalities, Retiming Techniques.

Unit II	FOLDING AND UNFOLDING	9	0	0	3

Folding: Introduction -Folding Transform – Register minimization Techniques – Register minimization in folded architectures – folding of multirate systems Unfolding: Introduction – An Algorithm for Unfolding – Properties of Unfolding – critical Path, Unfolding and Retiming – Applications of Unfolding.

Unit III	SYSTOLIC ARCHITECTURE DESIGN	9	0	0	3

Introduction, Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations Containing Delays.

Unit IV	FAST CONVOLUTION	9	0	0	3

Introduction, Cook, Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution, Design of Fast Convolution Algorithm by Inspection.

Unit V	LOW POWER DESIGN	9	0	0	3

Scaling Vs Power Consumption –Power Analysis, Power Reduction techniques – Power Estimation Approaches. Programmable DSP: Evaluation of Programmable Digital Signal Processors, DSP Processors for Mobile and Wireless Communications, Processors for Multimedia Signal Processing

Total (45 L) = 45 Periods

Text Books:

1	Keshab K. Parhi. “VLSI Digital Signal Processing Systems”, Wiley-Inter Sciences, 1999
2	Kung S. Y, H. J. While House, T. Kailath, “VLSI and Modern Signal processing”, 1985, Prentice Hall.

Reference Books:

1	Mohammed Ismail, Terri, Fiez, “Analog VLSI Signal and Information Processing”, McGraw Hill, 1994.
2	Kung. S.Y., H.J. While house T.Kailath, “VLSI and Modern signal processing”, Prentice Hall, 1985.

3	Jose E. France, Yannis Tsividls, "Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing", Prentice Hall, 1994.
4	Medisetti V. K, "VLSI Digital Signal Processing", 1995, IEEE Press (NY), USA.
E-Reference:	
1	https://archive.nptel.ac.in/courses/108/105/108105157/
2	https://www.classcentral.com/course/swayam-vlsi-signal-processing-17837
3	https://nptel.ac.in/courses/108106149

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand VLSI design methodology for signal processing systems.	L2
CO2	Design and analysis of FIR digital filters using pipelined and parallel processing architecture	L4
CO3	Be familiar with VLSI algorithms and architectures for DSP.	L2
CO4	Implementing Cook, Toom Algorithm, Winogard Algorithms.	L3
CO5	Gain knowledge on DSP for mobile and wireless communication	L2

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	2	2	1	1						1		2	2	2
CO2	1	2	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	1	2	3	2	1						2		2	2	2
Avg	2.4	2	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECH410	RADAR SIGNAL PROCESSING		Semester			
PREREQUISITES		Category	PE	Credit		3
Digital signal Processing		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To study about different radar signal processing techniques
2	To learn about radar signal model
3	To study about radar signal detection

Unit I	**INTRODUCTION TO RADAR SYSTEMS**	9	0	0	3

History and application of radar, basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing.

Unit II	**SIGNAL MODELS**	9	0	0	3

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model.

Unit III	**SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS**	9	0	0	3

Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

Unit IV	**RADAR WAVEFORMS**	9	0	0	3

Introduction, the waveform matched filter, Matched filtering of moving targets, the ambiguity function, the pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency Codes.

Unit V	**DOPPLER PROCESSING:**	9	0	0	3

Alternate forms of the Doppler spectrum, moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase centre antenna processing.

Total (45+15) = 60 Periods

Text Books:

1	Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw-Hill, New York, 2005
2	Francois Le Chevalier, “Principles of Radar and Sonar Signal Processing”, Artech House

Reference Books:

1	Ramon Nitzberg, “Radar Signal Processing and Adaptive Systems”, Artech House, 1999.
2	Michael O Kolawole, “ Radar systems, Peak Detection and Tracking”,Elseveir, 2010.

3	August. W Rihaczek, “Principles of High Resolution Radar”, Artech House, 1996.
4	Peyton Z. Peebles, “ Radar Principles”, Wiley India, 2009
E-Reference:	
1	https://onlinecourses.nptel.ac.in/noc19_ee58/preview
2	https://nptel.ac.in/courses/108105154
3	https://abrarhashmi.files.wordpress.com/2020/02/lecture_1_make_radar-fundamentals_final.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Demonstrate the basic operation of Radar concepts.	L2
CO2	Classify the various types of Radars.	L2
CO3	Design and analyze the radar signals and processing.	L4
CO4	Learn advanced signal processing technics for Radar applications	L1
CO5	Process the data received from radar.	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	1	1						1		2	2	2
CO2	2	2	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	2	3	2	1						2		2	2	2
Avg	2	2	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

Minor Degree Programme for Other Departments

S. No.	Course Code	Course Title	Hrs/Wk& Credits			
			L	T	P	C
Electronics and Communication Engineering						
1.	22ECM01	Electron Devices	3	0	0	3
2.	22ECM02	Digital Electronics	3	0	0	3
3.	22ECM03	Electronic Circuits	3	0	0	3
4.	22ECM04	Signal Processing	3	0	0	3
5.	22ECM05	Microprocessors and Microcontrollers	3	0	0	3
6.	22ECM06	Analog and Digital Communication	3	0	0	3
7.	22ECM07	Communication Networks	3	0	0	3
8.	22ECM08	Fundamentals of IoT	3	0	0	3
9.	22ECM09	Wireless sensors and networking	3	0	0	3
10.	22ECM10	Basics of Embedded systems	3	0	0	3

22ECM01	ELECTRON DEVICES				
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**C**
		L	**T**	**P**	**TH**
	PE	**3**	**0**	**0**	**3**

Course Objectives:

1. To introduce components such as diodes, BJTs and FETs, their characteristics and applications
2. To understand, analyse and design of simple diode and transistor circuits.
3. To know the switching characteristics of components and the concept of rectifiers and power supplies

Unit I	**EXTRINSIC SEMICONDUCTOR AND PN JUCTIONS**	**9**	**0**	**0**	**9**

N and P type semiconductor and their energy band structures- Law of electrical neutrality-calculation of location of Fermi level and free electron and hole densities in extrinsic semiconductors-Mobility, drift current and conductivity-diffusion current-continuity equation- Hall effect and its applications. Band structure of PN junction – current component in a PN junction- derivation of diode equation-temperature dependence of diode characteristics and equivalent models.

Unit II	**SWITCHING CHARACTERISTICS OF PN JUNTION AND SPECIAL DIODES**	**9**	**0**	**0**	**9**

Calculation of transition and diffusion capacitance- varactor diode-charge control description of diode-switching characteristics of diode- mechanism of avalanche and Zener breakdown-temperature dependence of breakdown voltages- backward diode-tunneling effect in thin barriers - tunnel diode-photo diode-light emitting diodes.

Unit III	**BIPOLAR JUNCTION TRANSISTORS**	**9**	**0**	**0**	**9**

Construction of PNP and NPN transistors- BJT current components-emitter to collector and base to collector current gains-base width modulation CB, CE and CC characteristics- breakdown characteristics- Ebers-Moll model - transistor switching times- Photo translator.

Unit IV	**FIELD EFFECT TRANSISTORS**	**9**	**0**	**0**	**9**

Construction and characteristics of JFET-relation between pinch off voltage and drain current derivation. MOSFETS - enhancement and depletion types. CMOS circuits. MOS capacitance, BICMOS, SOI CMOS.

Unit V	**RECTIFIERS AND POWER SUPPLIES**	**9**	**0**	**0**	**9**

Half-wave, full-wave and bridge rectifiers with resistive load. Analysis for Vdc and ripple voltage with C, CL, L-C and C-L-C filters. Voltage multipliers Zener diode regulator. Electronically regulated d.c power supplies. Line regulation, output resistance and temperature coefficient.

Total (45L+0T)= 45 Periods

Text Books:

1. JaconMillman& Christos C. Halkias, " Electronic Devices and Circuits" Tata McGraw-Hill, 1991.
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory 8th edition.", PHI, 2002

Reference Books:

1. Donald A. Neaman. " Semiconductor Physics and Devices" 3rd Ed., Tata McGraw-Hill 2002
2. S. Salivahanan, N. Suresh kumar and A. Vallavaraj, Electronic Devices and Circuits, TMH, 1998.
3. Ben, G. Streetman and Sanjay Banerjee, Solid State Electronic Devices, Pearson Education 2000
4. Floyd, "Electronic Devices", Sixth edition, Pearson Education, 2003.

E-References:

1. https://archive.nptel.ac.in/courses/108/108/108108122/
2. https://www.youtube.com/watch?v=qqQ8wO-lNmI
3. https://slideplayer.com/slide/12438044/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Interpret various applications of diode.	L3
CO2	Classify various configurations and biasing technique of BJT	L3
CO3	Apply the knowledge of using special devices for various applications	L2
CO4	Discuss operation, biasing and applications of JFET.	L4
CO5	Design power supplies and rectifiers	L3

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	1										1		
CO2	2	2	1										2		
CO3	2	2	1										3		
CO4	2	2	1										2	2	1
CO5	2	2	1										3	2	2
Avg	2	2	1										2.2	2	
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM02	DIGITAL ELECTRONICS					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**C**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To introduce basic postulates of boolean algebra and show the correlation between expressions
2	To Introduce the methods for Simplifying Boolean expressions
3	To Outline the formal procedures for the analysis and design of combinational circuits and sequential circuits
4	To introduce the Concept of Memories and programmable logic devices
5	To illustrate the concept of synchronous and Asynchronous sequential circuits

Unit I	**NUMBER SYSTEMS AND LOGIC GATES**	**9**	**0**	**0**	**9**

Number Systems - signed Binary numbers - Binary Arithmetic - Binary codes -conversion from one code to another - Boolean Algebra and Minimization Techniques - Canonical forms – Conversion between canonical forms – Simplifications of Boolean expressions using Karnaugh map - LOGIC GATES - Implementations of Logic Functions using gates.

Unit II	**COMBINATIONAL CIRCUITS**	**9**	**0**	**0**	**9**

Design procedure – Adders/Subtractor – Serial adder/ Subtractor - Parallel adder/ Subtractor- BCD adder- Multiplexer/ Demultiplexer - encoder / decoder – code converters.

Unit III	**SEQUENTIAL CIRCUIT**	**9**	**0**	**0**	**9**

Design Procedure - Flip flops: SR, JK, T, D and JKMS – Triggering of Flip-flop - Realization of flip flops – Moore and Mealy – Counters: Asynchronous / Ripple counters – Synchronous counters – Modulo n counter. Register: shift registers- Universal shift register.

Unit IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS:**	**9**	**0**	**0**	**9**

Design of fundamental mode circuits – primitive state / flow table – Minimization of primitive state table –state assignment. Problems in Asynchronous Circuits: Cycles – Races – Hazards. Design of Hazard Free Circuits: Static, Dynamic Hazards elimination

Unit V	**PLD AND MEMORY DEVICES:**	**9**	**0**	**0**	**9**

Classification of memories –RAM organization –ROM organization. Programmable Logic Devices: Programmable Logic Array (PLA) - Programmable Array Logic (PAL). Implementation of combinational logic using MUX, ROM, PAL and PLA.

Total (45 L) = 45 Periods

Text Books:

1	M. Morris Mano, Digital Design, 4.ed.,Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2008
2	R.P.Jain, Modern Digital Electronics, 4th edition, TMH, 2010.

Reference Books:

1	S. Salivahanan and S. Arivazhagan, Digital Circuits and Design, 2nd ed., Vikas Publishing House Pvt. Ltd, New Delhi, 2004
2	Charles H.Roth. “Fundamentals of Logic Design”, Thomson Publication Company, 2003.
3	Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, 5 ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
4	John F.Wakerly, Digital Design: Principles and practices, PHI, 2006

E-Reference:	
1	http://nptel.ac.in/noc/individual_course.php?id=noc15-ec01
2	https://nptel.ac.in/courses/117105080/6
3	https://nptel.ac.in/courses/117105080/12

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Minimize Boolean expressions and implement using logic gates	L3
CO2	Design and analyse combinational logic circuits.	L4
CO3	Design and analyse synchronous and asynchronous sequential logic circuits	L4
CO4	Understand the concepts of memories and PLDs	L2
CO5	Implement circuits using memory and PLDs.	L3

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	3	2					2	1	
CO2	3	3	2	2	3	3	2	1	1				3	2	
CO3	2	2	3	3	2	1	2	1	1				2	2	
CO4	2	1	2	1	2	2	3	1					2	1	
CO5	2	1	2	1	3	2	1	2					3	2	
Avg	2.4	1.8	2.2	1.8	2.6	2	2.2	1.4	0.4				2.4	1.6	
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM03	ELECTRONIC CIRCUITS					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
Electron Devices		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To perform analysis on Small signal amplifiers and large signal amplifiers.
2	To give a comprehensive exposure to all types of discrete amplifiers and oscillators.
3	To understand the various linear and non-linear applications of op-amp

Unit I	**MIDBAND ANALYSIS OF SMALL SIGNAL AMPLIFIERS**	**9**	**0**	**0**	**9**

BJT – Need for biasing - Fixed bias circuit, Load line and quiescent point. Different types of biasing circuits. Use of Self bias circuit as a constant current circuit. CE, CB and CC amplifiers. Method of drawing small-signal equivalent circuit. Mid-band analysis of various types of single stage amplifiers to obtain gain, input impedance and output impedance. Miller's theorem. Darlington connection using similar and Complementary transistors. Methods of increasing input impedance using Darlington connection and bootstrapping. CS, CG and CD (FET) amplifiers. Multistage amplifiers-Basic emitter coupled differential amplifier circuit. Differential gain, CMRR. Use of constant current circuit to improve CMRR.

Unit II	**LARGE SIGNAL AMPLIFIERS**	**9**	**0**	**0**	**9**

Low frequency & High frequency analysis of amplifiers -Hybrid – pi equivalent circuit of BJTs.-High frequency equivalent circuit of FETs. Gain-bandwidth product of FETs. General expression for frequency response of multistage amplifiers. Calculation of overall upper and lower cut off frequencies of multistage amplifiers. Amplifier rise time and sag time and their relation to cut off frequencies. Classification of amplifiers (Class A, B, AB, C&D), Efficiency of class A, RC coupled and transformer-coupled power amplifiers. Class B complementary-symmetry, push-pull power amplifiers. Calculation of power output, efficiency and power dissipation. Crossover distortion and methods of eliminating it. Calculation of actual power handling capacity of transistors with and without heat sink. Heat sink design.

Unit III	**OSCILLATORS**	**9**	**0**	**0**	**9**

Feedback Amplifier: Block diagram - Gain with feedback - Barkhausen Criterion - Mechanism for start of oscillation and stabilization of amplitude - Analysis of Oscillator using Cascade connection of RC and LC filters - RC phase shift Oscillator - Wien bridge Oscillator and Twin-T Oscillators - Analysis of LC Oscillators: Colpitts – Hartley – Clapp - Miller and Pierce oscillators - Frequency range of RC Oscillators - Electrical equivalent circuit of Crystal.

Unit IV	**TUNED AMPLIFIERS AND MULTIVIBRATORS**	**9**	**0**	**0**	**9**

Analysis of single tuned and synchronously tuned amplifiers - Class C tuned amplifiers and their applications - Efficiency of Class C tuned Amplifier- Collector coupled and Emitter coupled Astable Multi vibrator – Mono stable Multi vibrator – Bistable Multi vibrator - Triggering methods – Mono stable and Astable Blocking Oscillators using Emitter and base timing.

Unit V	**OPERATIONAL AMPLIFIERS AND ITS APPLICATIONS**	**9**	**0**	**0**	**9**

Basic structure and principle of operation - Calculation of differential gain - Common Mode gain, CMRR - OP-AMP design - DC and AC characteristics of OP-AMP. Applications: Inverting and non-inverting amplifiers - Integrator and Differentiator - Summing amplifier - Precision rectifier - Schmitt trigger and its applications - Active filters: Low pass, high pass, band pass and band stop filters - Sine wave oscillators – Comparator – Multi vibrator.

Total (45 L) = 45 Periods

Text Books:

1	B.Visvesvara Rao, K.Raja Rajeswari, P.Chalam Raju Pantulu, K.Bhaskara Rama Murthy, "Electronic Circuits-II", Pearson Education,2012
2	D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2011.

Reference Books:

1	Millman J. and Taub H., "Pulse Digital and Switching waveform", 3rd Edition, McGraw-Hill International , 2011.
2	Sedera& Smith, "Micro Electronic Circuits", 4 th Edition, Oxford University Press, Chennai.

3	Michael Jacob, 'Applications and Design with Analog Integrated Circuits', Prentice Hall of India, 1996.
4	K.R.Botkar, 'Integrated Circuits', 10th edition, Khanna Publishers, 2010.
e-Reference:	
1	http://nptel.ac.in/courses/117105080/40
2	http://nptel.ac.in/courses/117108038/1
3	https://freevideolectures.com/course/2915/linear-integrated-circuits

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	To analyze small signal amplifiers and Large signal Amplifiers.	L3
CO2	Analyze the frequency response characteristics of amplifiers	L3
CO3	Develop insight of on oscillator design.	L3
CO4	Construct and analyse tuned amplifiers and multivibrators.	L3
CO5	Develop competence in linear and nonlinear Op amp circuit analysis.	L3

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	1	2									1	2	1
CO2	3	2	1	2									1	2	1
CO3	3	2	1	2									1	2	1
CO4	3	2	1	2									1	2	1
CO5	1	2	1	2									1	2	1
Avg	2.6	2	1	2									1	2	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECM04	SIGNAL PROCESSING					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1. To understand and perform Fourier and Laplace analysis on signals and systems respectively.
2. To analyse the Discrete Fourier Transform, Fast Fourier Transform algorithms.
3. To design and realize IIR, FIR filters.

Unit I	**INTRODUCTION TO SIGNALS AND SYSTEM**	**9**	**0**	**0**	**9**

Classification of Signals: Even and Odd Signal - Energy and power signals - Continuous time (CT) and Discrete time (DT) signals - Continuous and Discrete amplitude signal -. System properties and representation: linearity - Tme-invariance – Causality – Stability - Realizability. - Linear Time-Invariant (LTI) systems: Impulse response and step response – Convolution – Correlation - System representation through differential equations and difference equations.

Unit II	**ANALYSIS OF SIGNAL AND SYSTEMS**	**9**	**0**	**0**	**9**

Introduction to Fourier Transform, Fourier Series, Relating the Laplace Transform to Fourier Transform, Frequency response of continuous time systems. Introduction to z- Transform.

Unit III	**DISCRETE FOURIER TRANSFORM**	**9**	**0**	**0**	**9**

Introduction to DFT – Properties of DFT - Circular convolution - FFT algorithms – Radix-2 FFT algorithms – Decimation in Time and Decimation in Frequency algorithms.

Unit IV	**INFINITE IMPULSE RESPONSE FILTER DESIGN**	**9**	**0**	**0**	**9**

Characteristics of Analog Butterworth filter - Chebyshev filter - Low pass filter, High pass filter, Band pass filter and Band stop filter - Transformation of analog filters in to equivalent digital filters using bilinear transformation method - Realization structure for IIR filters-Direct form - Cascade form - Parallel form.

Unit V	**FINITE IMPULSE RESPONSE FILTER DESIGN**	**9**	**0**	**0**	**9**

Linear phase response of FIR filter - FIR design using window method: Rectangular, Hamming, Hanning and Blackmann Windows - Park-McClellan's method - Realization structures for FIR filters - Linear phase structures and Direct form structure - Comparison of FIR and IIR filters.

Total (45L)= 45 Periods

Text Books:

1. A.Anand Kumar, ” Signals and Systems” , 3rd Edition, PHI, 2013.
2. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, 4th Edition, Pearson Education, 2009.

Reference Books:

1. Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, “Signals and Systems”, 2nd edition, PHI Learning Private Limited, New Delhi, 2010.
2. B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2009.
3. Emmanuel C. Ifeacher, Barry W. Jervis, “Digital Signal Processing: A Practical Approach”, 2nd Edition, Pearson Education, 2004.
4. S.K. Mitra, “Digital Signal Processing, A Computer Based approach”, 4th Edition, McGraw-Hill, 2010.

E-References:

1. http://nptel.ac.in/courses/117104074/
2. https://www.coursera.org/learn/dsp
3. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse and understands different types of signals.	L2, L4
CO2	Represent continuous signals and systems in time and frequency domain using different transforms.	L4
CO3	Analyse the need for Discrete Fourier Transform, Fast Fourier Transform algorithms in digital signals & systems.	L4
CO4	Design and realize IIR filters.	L3
CO5	Design and realize FIR filters.	L3

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	-							2	2	2
CO2	3	2	2	3	3	2							2	2	2
CO3	3	2	2	2	1		1						1	1	1
CO4	3	2	2	2	1		1						1	1	1
CO5	1	1	1	1	1								2	2	1
Avg	2.6	2	2	2.2	1.8	0.4	0.4						1.6	1.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM05	MICROPROCESSORS AND MICROCONTROLLERS				
PREREQUISITES	**CATEGORY**	**OEC**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives:				
1.	To familiarise with 8086 and 8051 architectures.			
2.	To interface 8086 microprocessor and 8051 microcontrollers with peripherals by programming.			
3.	To gain basic knowledge of PIC microcontrollers.			
Unit I	**8086 MICROPROCESSOR ARCHITECTURE**	9		9
Overview of Microcomputer systems-8086 Architecture – Pin Assignments – Internal Architecture – Addressing modes- Instruction Formats- Directives and Operators-Assembly process.				
Unit II	**PROGRAMMING AND INTERFACING OF 8086**	9		9
Fundamental I/O considerations- Programmed I/O- Interrupt I/O- Basic 8086 Configurations- Minimum Mode-Maximum Mode-System Bus timing- I/O Interfaces-Peripheral Interfacing using 8255 PPI - 8279 Keyboard/Display controller - 8251 USART.				
Unit III	**8051 ARCHITECTURE**	9		9
8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization - Instruction set — Addressing modes				
Unit IV	**PROGRAMMING AND INTERFACING OF 8051**	9		9
Assembly language programming.8051Timers - Serial Port Programming - Interrupts Programming - LCD and Keyboard Interfacing - ADC, DAC and Sensor Interfacing - Motor Control.				
Unit V	**PIC MICROCONTROLLERS**	9		9
Main characteristics of PIC microcontrollers – PIC microcontroller families-Memory-Program Memory – RAM Data Memory - Instruction set and timers in PIC				
Total (L+T) = 45 periods				

Text Books:	
1.	Yu-Cheng Liu, Glenn A. Gibson," Microcomputer Systems, The 8086/8088 Family", Pearson, 2e, 2019.
2.	Muhammad Ali Mazidi, Janice GillispieMazidi, RolinD.McKinlay, "The 8051 Microcontroller and Embedded Systems using Assembly and C", 2e, 2022.
Reference Books:	
1.	Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson education, 2011.
2.	Martin Bates ,"PIC Microcontrollers-An Introduction to Microelectronics", 3e, Elsevier,2011.
3.	Mathur Sunil,"Microprocessor 8086 : Architecture, Programming and Interfacing",PHI Learning Pvt. Ltd.,2011.
4.	Salvador PinillosGimenez," 8051 Microcontrollers Fundamental Concepts, Hardware, Software and Applications in Electronics", Springer,2019.
E-References:	
1.	Ashraf Almadhoun,"A Detailed Look Into PIC Microcontroller and Its Architecture",Amazon,2020.
2.	https://nptel.ac.in/courses/108105102
3.	http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Describe and analyse the architecture of 8086 microprocessor and 8051 architectures.	L1
CO2	Develop assembly language programs and Interface peripherals with 8086.	L2, L3
CO3	Develop assembly language programs and Interface peripherals with 8051.	L2, L3
CO4	Determine application specific circuit for real-time applications.	L2
CO5	Associate appropriate PIC microcontroller for a given application.	L2

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2									2		1		
CO2	2	2	2	2									2	2	
CO3	2	2	2	2									2	2	
CO4	2	2	2	2									2	2	2
CO5	2	2		2									2	2	
Avg	2	2	1.2	1.6							0.4		1.8	1.6	0.4

22ECM06	ANALOG AND DIGITAL COMMUNICATION					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

1.	Understand analog and digital communication techniques.
2.	Learn data and pulse communication techniques.
3.	Be familiarized with source and Error control coding.

Unit I	**INFORMATION THEORY**	**9**	**0**	**0**	**9**

Uncertainty, information and entropy – Source coding theorem – Shannon Fano coding – Huffman coding – Discrete memoryless channels – Mutual information – Channel capacity – Channel coding theorem.

Unit II	**ANALOG COMMUNICATION**	**9**	**0**	**0**	**9**

Noise: Source of Noise – External Noise- Internal Noise- Noise Calculation. Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).

Unit III	**DIGITAL COMMUNICATION**	**9**	**0**	**0**	**9**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

Unit IV	**PULSE COMMUNICATION AND MULTIPLE ACCESS TECHNIQUES**	**9**	**0**	**0**	**9**

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication System (PAM – PTM – PCM). Multiple access techniques: FDMA, CDMA, TDMA, SDMA.

Unit V	**ERROR CONTROL CODING**	**9**	**0**	**0**	**9**

Linear block codes - Cyclic codes - Convolution codes – Maximum likelihood decoding of convolutional codes – Sequential decoding of convolutional codes – Trellis codes – Applications.

Total (45L)= 45 Periods

Text Books:

1.	Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2014.
2.	J.G.Proakis, M.Salehi, ―Fundamentals of Communication Systems‖, Pearson Education 2014.

Reference Books:

1.	B.P.Lathi, ―Modern Digital and Analog Communication Systems‖, 4th Edition, Oxford University Press, 2013.
2.	D.Roody, J.Coolen, ―Electronic Communications, 4th edition PHI 2015.
3.	B.Sklar, ―Digital Communications Fundamentals and Applications‖, 5th Edition Pearson Education 2017
4.	H P Hsu, Schaum Outline Series - ―Analog and Digital Communications‖ TMH, 5th edition 2006

E-References:

1.	https://onlinecourses.nptel.ac.in/noc21_ee74/preview
2.	https://nptel.ac.in/courses/117101051
3.	https://www.digimat.in/nptel/courses/video/117105143/L51.html

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom’s Taxonomy Mapped
CO1	:	Apply the concepts of Random Process to the design of Communication systems	L3
CO2	:	Apply analog and digital communication techniques.	L3
CO3	:	Understand the use of data and pulse communication techniques.	L2

CO4	:	Analyze Source and Error control coding.	L4
CO5	:	Design AM communication systems and Angle modulated communication systems	L3

COURSE ARTICULATION MATRIX														
COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	1								3		
CO2	3	2	2	1	1								3	2	1
CO3	2	2	2	3	1								3	2	
CO4	1	1	2	1	2								2	3	
CO5	1	1	2	2	2								2	3	1
Avg	1.8	1.8	2	1.6	1.4								2.6	2	0.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM07	COMMUNICATION NETWORKS					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:	
1.	Understand the division of network functionalities into layers.
2.	Be familiar with the components required to build different types of networks
3.	Be exposed to the required functionality at each layer
4.	Learn the flow control and congestion control algorithms

Unit I	**FUNDAMENTALS & LINK LAYER**	9	0	0	9
Overview of Data Communications- Networks – Building Network and its types– Overview of Internet - Protocol Layering - OSI Mode – Physical Layer – Overview of Data and Signals - introduction to Data Link Layer - Link layer Addressing- Error Detection and Correction					
Unit II	**MEDIA ACCESS & INTERNETWORKING**	9	0	0	9
Overview of Data link Control and Media access control - Ethernet (802.3) - Wireless LANs – Available Protocols – Bluetooth – Bluetooth Low Energy – WiFi – 6LowPAN–Zigbee - Network layer services – Packet Switching – IPV4 Address – Network layer protocols (IP, ICMP, Mobile IP)					
Unit III	**ROUTING**	9	0	0	9
Routing - Unicast Routing – Algorithms – Protocols – Multicast Routing and its basics – Overview of Intradomain and interdomain protocols – Overview of IPv6 Addressing – Transition from IPv4 to IPv6					
Unit IV	**TRANSPORT LAYER**	9	0	0	9
Introduction to Transport layer –Protocols- User Datagram Protocols (UDP) and Transmiision Control Protocols (TCP) –Services – Features – TCP Connection – State Transition Diagram – Flow, Error and Congestion Control - Congestion avoidance (DECbit, RED) – QoS – Application requirements					
Unit V	**APPLICATION LAYER**	9	0	0	9
Application Layer Paradigms – Client Server Programming – World Wide Web and HTTP - DNS- Electronic Mail (SMTP, POP3, IMAP, MIME) – Introduction to Peer to Peer Networks – Need forCryptography and Network Security – Firewalls.					
Total (45L)= 45 Periods					

Text Books:	
1.	Behrouz A Forouzan, Data Communications and Networking, 4th Edition, 2020
2.	James F. Kurose, Keith W. Ross, Computer Networking - A Top-Down Approach Featuring the Internet, Seventh Edition, Pearson Education, 2016.
Reference Books:	
1.	Nader. F. Mir," Computer and Communication Networks", Pearson Prentice Hall Publishers, 2nd Edition, 2014.
2.	Alberto Leon-Garcia, IndraWidjajaCommunication Networks 2nd Edition McGraw-Hill Education, 2003
3.	Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill Publisher, 2011.
4.	Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers, 2011.
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee61/preview
2.	https://www.ee.iitb.ac.in/~sarva/courses/EE706/2012/EE706LecNotes.pdf
3.	http://www.cs.kent.edu/~farrell/net01/lectures/

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the basic concept in modern data communication and different level of layers in the protocol	L2
CO2	Analyse the functions and services of data link layer	L4
CO3	Categorize the functions and services of network layer	L2
CO4	Examine the basic functions of transport layer and congestion in networks	L2
CO5	Analyse the concepts of various network applications and data security	L4

COURSE ARTICULATION MATRIX															
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1		1								2		1
CO2	2	1	2		1								2	1	1
CO3	2	1	1										3	1	2
CO4	3	2	1		2								2		2
CO5	2	1	1		1								1	1	1
Avg	2.2	1.2	1.2		1								2	0.6	1.4
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM08	INTERNET OF THINGS					
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
None		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives

1	To understand Smart Objects and IoT Architectures
2	To learn about various IOT-related protocols
3	To build simple IoT Systems using Arduino and Raspberry Pi
4	To understand data analytics and cloud in the context of IoT
5	To develop IoT infrastructure for popular applications

Unit I	**FUNDAMENTALS OF IoT**	**9**	**0**	**0**	**9**

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

Unit II	**IoT Protocols**	**9**	**0**	**0**	**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

Unit III	**DESIGN AND DEVELOPMENT**	**9**	**0**	**0**	**9**

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

Unit IV	**DATA ANALYTICS AND SUPPORTING SERVICES**	**9**	**0**	**0**	**9**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

Unit V	**CASE STUDIES/INDUSTRIAL APPLICATIONS**	**9**	**0**	**0**	**9**

Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – Grid Blocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

Total (45 L) = 45 Periods

Text Books:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2	ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015

Reference Books:

1	Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2).
2	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
3	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.

4	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
e-Reference:	
1	https://online.stanford.edu/courses/xee100-introduction-internet-things
2	https://www.udemy.com/topic/internet-of-things/
3	https://www.netacad.com/courses/iot

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the concept of IoT.	L2
CO2	Analyze various protocols for IoT.	L3
CO3	Design a PoC of an IoT system using Rasperry Pi/Arduino	L3
CO4	Apply data analytics and use cloud offerings related to IoT.	L3
CO5	Analyze applications of IoT in real time scenario	L4

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1						1		2	2	2
CO2	2	1	2	1	1						1		2	2	2
CO3	2	2	3	2	1						2		2	2	2
CO4	2	2	2	1	1						1		2	2	2
CO5	2	2	3	2	1						2		2	2	2
Avg	2	1.6	2.4	1.4	1						1.4		2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22ECM09	WIRELESS SENSORS AND NETWORKING					
PRE-REQUISITE		CATEGORY	PE	Credit		3
1.	Wireless networks	Hours/Week	L	T	P	TH
			3	0	0	3

Course Objectives:						
1.	Learn fundamental of Ad hoc network and architecture					
2.	Understand the MAC and routing protocols.					
3.	Have an in-depth knowledge on QoS, security and sensor network platforms					
Unit I	**ROUTING PROTOCOLS**	9	0	0	9	
Elements of Ad hoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Ad hoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).						
Unit II	**ARCHITECTURES OF WSN**	9	0	0	9	
WSN application examples, Types of applications, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Single-Node Architecture: Hardware Components, Energy Consumption of Sensor Nodes, Operating systems and execution environments Network Architecture: Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, gateway concepts.						
Unit III	**MAC PROTOCOLS AND ROUTING PROTOCOLS**	9	0	0	9	
Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262 - ITU-T Recommendation H.263.						
Unit IV	**QUALITY OF SERVICE AND ADVANCED APPLICATION SUPPORT**	9	0	0	9	
Quality of Service: Coverage and deployment, Reliable data transport, Single packet delivery, Block delivery, Congestion control and rate control - Advanced application support: Advanced in-network processing, Security and Application-specific support.						
Unit V	**SENSOR NETWORK PLATFORMS AND TOOLS**	9	0	0	9	
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.						
Total (45L) = 45 Periods						

Text Books:	
1.	C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008
2.	Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.
Reference Books:	
1.	Feng Zhao and LeonidesGuibas, "Wireless sensor networks ", Elsevier publication - 2004.
2.	Charles E. Perkins, ―Ad Hoc Networking‖, Addison Wesley, 2000.
3.	William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004
4.	I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, Computer Networks, Elsevier, 2002, 394 - 422.
E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://nptel.ac.in/courses/106105183
3.	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to		Bloom’s Taxonomy Mapped
CO1	Know the basics of Ad hoc networks and Wireless Sensor Networks	L2
CO2	Have a knowledge on architecture of Wireless Sensor Networks	L3
CO3	Apply the knowledge to identify MAC and routing protocols	L3

CO4	Understand the transport layer and security issues possible in Ad hoc and sensor networks	L2
CO5	Be familiar with the OS used in Wireless Sensor Networks and build basic modules	L1

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3	3	3	2				3	3	3		2
CO2	3	3	2	3	3	3	2				3	3	3		2
CO3	3	3	3	3	3	3	2				3	3	3		2
CO4	3	3	2	3	3	3	2				2	3	3		2
CO5	3	3	2	3	3	3	2				3	3	3		2
Avg	3	3	2	3	3	3	2				2.8	3	3		2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															

22ECM10	BASICS OF EMBEDDED SYSTEMS				
PREREQUISITES	**CATEGORY**	**PE**	**Credit**		**3**
Microprocessors and Mmicrocontrollers	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Objectives	
1	To impart knowledge on embedded system architecture and embedded development Strategies
2	To understand the bus Communication in processors and peripheral interfacing
3	To understand basics of Real Time Operating System

UNIT I	**BASICS OF EMBEDDED SYSTEMS**	9	0	0	9

Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Examples - Programming Languages - Recent Trends in Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning - Development Environment.

UNIT II	**MEMORY MANAGEMENT AND INTERRUPTS**	9	0	0	9

Memory Access Procedure - Types of Memory - Memory Management Methods - DMA – Memory Interfacing - Polling Vs Interrupts - Types of Interrupts - Interrupt Latency - Interrupt Priority – Programmable Interrupt Controllers - Interrupt Service Routines

UNIT III	**COMMUNICATION INTERFACES**	9	0	0	9

Interfacing Buses - Serial Interfaces - RS232/UART - RS422/RS485 - I2C Interface - SPI Interface - USB – CAN - IRDA - Ethernet - IEEE 802.11 – Bluetooth

UNIT IV	**REAL TIME OPERATING SYSTEMS**	9	0	0	9

Real-Time Concepts - Task Management - Task Scheduling - Classification of Scheduling Algorithms - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing - Priority Inheritance Protocol - Priority Ceiling Protocol - Inter Task Communication - Mutex - Semaphores - Message Queues - Timers - Commercial RTOS.

UNIT V	**VALIDATION AND DEBUGGING**	9	0	0	9

Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer – Background Debug Mode - InCircuit Emulator CASE STUDY: RFID Systems - GPS Navigation System – Development of Protocol Converter

Total (45 L) = 45 Periods

Text Books:	
1	Sriram V Iyer and Pankaj Gupta, ―Embedded Real-time Systems Programming‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2	Arnold S Berger, ―Embedded Systems Design - An Introduction to Processes, Tools and Techniques, Elsevier, New Delhi, 2011.
Reference Books:	
1	Prasad K V K K, ―Embedded/Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Himal Impressions, New Delhi, 2003
2	Heath, "Embedded Systems Design‖", Newnes an Imprint of Elsevier, Massachusetts, 2003.
3	Tammy Noergaard, "Embedded Systems Architecture‖, Newnes an Imprint of Elsevier, Massachusetts, 2006.
4	Raj Kamal, 'Embedded System-Architecture, Programming, Design', McGraw Hill, 2013
e-Reference:	
1	https://lecturenotes.in/subject/225/embedded-system-es

2	https://nptel.ac.in/courses/108102045/19
3	https://www.coursera.org/learn/introduction-embedded-systems.

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Course Outcomes: Upon completion of this course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Outline the concepts of embedded systems	L2
CO2	Understand the concept of memory management system and interrupts.	L2
CO3	Know the importance of interfaces.	L2
CO4	Understand real time operating system concepts.	L2
CO5	To realize the applications of validation and debugging.	L3

COURSE ARTICULATION MATRIX														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	3							3	3	3		2
CO2	3	3	2	3							3	3	3		2
CO3	3	3	3	3							3	3	3		2
CO4	3	3	2	3							2	3	3		2
CO5	3	3	2	3							3	3	3		2
Avg	3	3	2	3							2.8	3	3		2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)															