R.M.K COLLEGE OF ENGINEERING AND TECHNOLOGY
(An Autonomous Institution)
R.S.M Nagar, Puduvoyal, Gummidipoondi Taluk, Thiruvallur District, Tamil Nadu- 601206
Affiliated to Anna University, Chennai / Approved by AICTE, New Delhi/ Accredited by NAAC with A Grade
All the Eligible UG Programs are accredited by NBA, New Delhi

REGULATIONS-2021

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Vision and Mission of the Department

Vision:

- To excel in the field of Electronics and Communication Engineering to contribute to the knowledge economy and betterment of human life.

Mission:

- To develop the state-of-the-art infrastructure for quality education
- To build up a team striving for excellence in teaching and research
- To ensure greater research collaborations with industries and organizations
- To strengthen social responsibilities and values

Mapping of Programme Educational Objectives with Department Mission:

Mission	PEO1	PEO2	PEO3	PEO4
To develop the state-of-the-art infrastructure for quality education	2	2	2	1
To build up a team striving for excellence in teaching and research	3	3	2	2
To ensure greater research collaborations with industries and organizations	3	3	3	2
To strengthen social responsibilities and values	1	2	1	1

Contribution 1: Reasonable 2: Significant 3: Strong

PROGRAMME EDUCATIONAL OBJECTIVES:

Graduates of Electronics and Communication Engineering program will

PEO1: excel in their professional and technical career and pursue higher education to be globally competent

PEO2: evaluate the real world problems and provide with technically feasible and economically viable solutions

PEO3: continuously update technologies through lifelong learning

PEO4: exhibit effective communication skills and professionalism in diverse environment

PROGRAMME OUTCOMES:

Engineering Graduates will be able to:

a) **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

b) **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) **Design / development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d) **Conduct investigations of complex problems**: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations**.**

f) **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice**.**

i) **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

j) **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) **Project Management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

The Electronics and Communication Engineering Graduates should be able to

a) Develop and test electronic systems for given specifications.

b) Design and analyze the signal processing systems as per the requirements.

c) Apply appropriate technology for the implementation of modern communication systems.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Programme Educational objectives and the Programme outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	✓	✓	✓	✓	✓					✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓		✓			✓		✓
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

A broad relation between the Course Outcomes and Programme Outcomes is given in the following table

COURSE OUTCOMES		PROGRAMME OUTCOMES											
Sem	Course Name	a	b	c	d	e	f	g	h	i	j	k	l
I	Induction Program with UHV-I		✓							✓	✓		✓
	Communicative English & Life Skills	✓	✓	✓	✓	✓	✓	✓					✓
	Engineering Mathematics I	✓	✓	✓	✓								
	Physics for Electronics Engineering	✓	✓				✓	✓					✓
	Engineering Chemistry	✓	✓	✓						✓			✓
	Problem solving and C Programming	✓		✓		✓					✓		
	Computer Aided Engineering Graphics												
	Physics & Chemistry Laboratory	✓	✓			✓				✓			✓
	C Programming Lab	✓	✓	✓						✓			✓
	Interpersonal Skills - Listening and Speaking Lab									✓	✓		✓
II	Technical English									✓		✓	✓
	Engineering Mathematics II	✓	✓	✓	✓	✓	✓						✓
	Environmental Science and	✓	✓				✓	✓			✓		✓
	Circuit Analysis	✓	✓	✓	✓	✓	✓					✓	✓
	Electronic Devices	✓	✓	✓	✓	✓	✓					✓	✓
	Data Structures	✓	✓	✓									✓
	Engineering Practices Lab	✓	✓	✓	✓	✓						✓	✓
	Data Structures Lab	✓	✓	✓					✓	✓	✓		✓
	Advanced Reading and Writing Lab									✓	✓		✓

III	Linear Algebra and Partial Differential Equations	✓	✓	✓	✓	✓	✓						✓
	Signals and Systems	✓	✓	✓	✓	✓	✓	✓	✓				✓
	Electronic Circuits	✓	✓	✓	✓	✓	✓	✓	✓				✓
	Digital Electronics	✓	✓	✓	✓	✓	✓	✓	✓				✓
	Control Systems	✓	✓	✓	✓	✓	✓						✓
	Python Programming(Lab Integrated)	✓	✓	✓	✓	✓	✓	✓	✓				✓
	Analog and Digital Circuits Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Foundation Lab on Internet of Things	✓	✓	-	✓	✓	✓		✓				✓
	Aptitude and Coding Skills – I	✓	✓	✓	✓	✓	✓	✓	✓				✓
IV	Probability and Random Processes	✓	✓	✓	✓	✓	✓						✓
	Communication Systems	✓	✓	✓	✓	✓							✓
	Microprocessors & Microcontrollers	✓	✓	✓	✓	✓	✓		✓		✓		✓
	Electromagnetic Fields	✓	✓	✓	✓	✓		✓					✓
	Linear Integrated Circuits						✓	✓	✓	✓	✓	✓	✓
	Universal Human Values II – Understanding Harmony	✓	✓	✓	✓	✓							✓
	Microprocessors & Microcontrollers Laboratory	✓	✓	✓	✓	✓	✓	✓	✓				✓
	Linear Integrated Circuits Laboratory	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
	Mini Project and Industrial Internship	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Aptitude and Coding Skills - II									✓	✓		✓
V	Digital Communication	✓	✓	✓	✓	✓	✓					✓	✓
	Transmission Lines and waveguides	✓	✓	✓	✓	✓	✓					✓	✓
	VLSI Design (Lab Integrated)	✓	✓	✓	✓	✓	✓					✓	✓
	Professional Elective I	✓	✓	✓	✓	✓	✓					✓	✓
	Communication Systems Laboratory	✓	✓	✓	✓	✓	✓					✓	✓
	Course based project – I	✓	✓	✓	✓	✓	✓					✓	✓
	Advanced Aptitude and Coding Skills – I	✓	✓	✓	✓	✓	✓	✓	✓				✓
VI	Discrete-Time Signal Processing	✓	✓	✓	✓	✓	✓					✓	✓
	Antennas and wave propagation	✓	✓	✓	✓	✓	✓					✓	✓
	Embedded Systems (Lab Integrated)	✓	✓	✓	✓	✓	✓					✓	✓
	Professional Elective II	✓	✓	✓	✓	✓	✓					✓	✓
	Professional Elective III	✓	✓	✓	✓	✓	✓					✓	✓
	Digital Signal Processing Laboratory	✓	✓	✓	✓	✓	✓					✓	✓
	Course based project - II	✓	✓	✓	✓	✓	✓					✓	✓

	Advanced Aptitude and Coding Skills - II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VII	RF and Microwave Engineering (Lab Integrated)	✓	✓	✓	✓	✓	✓						✓
	Optical Communication and Networks (LabIntegrated)	✓	✓	✓	✓	✓				✓	✓	✓	✓
	Open Elective I						✓		✓				✓
	Project Work - Phase I and Internship	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓
	Design Thinking Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VIII	Project Work - Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

UG CURRICULUM

R2021

I SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
		Induction Program with UHV-I	HS (MC)	3 Weeks				
1	21EL101	Communicative English & Life Skills	HS	2	2	0	0	2
2	21MA101	Engineering Mathematics I	BS	5	3	2	0	4
3	21PH102	Physics for Electronics Engineering	BS	3	3	0	0	3
4	21CH101	Engineering Chemistry	BS	3	3	0	0	3
5	21CS101	Problem solving and C Programming	ES	3	3	0	0	3
6	21ME101	Computer Aided Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7	21PC111	Physics & Chemistry Laboratory	BS	4	0	0	4	2
8	21CS111	C Programming Lab	ES	4	0	0	4	2
9	21EL111	Interpersonal Skills - Listening and Speaking Lab	HS	2	0	0	2	1
TOTAL				**32**	**16**	**2**	**14**	**24**

II SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21EL201	Technical English	HS	2	2	0	0	2
2	21MA201	Engineering Mathematics II	BS	5	3	2	0	4
3	21CH102	Environmental Science and Engineering	HS(MC)	3	3	0	0	3
4	21EC201	Circuit Analysis	PC	4	3	2	0	4
5	21EC202	Electronic Devices	PC	3	3	0	0	3
6	21CS201	Data Structures	ES	3	3	0	0	3
PRACTICALS								
7	21EM111	Engineering Practices Lab	ES	4	0	0	4	2
8	21CS211	Data Structures Lab	ES	4	0	0	4	2
9	21EL211	Advanced Reading and Writing Lab	HS	2	0	0	2	1
TOTAL				**30**	**17**	**4**	**10**	**24**

III SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21MA302	Linear Algebra and Partial Differential Equations	BS	5	3	2	0	4
2	21EC301	Signals and Systems	PC	5	3	2	0	4
3	21EC302	Electronic Circuits	PC	3	3	0	0	3
4	21EC303	Digital Electronics	PC	3	3	0	0	3
5	21EC304	Control Systems	PC	4	2	2	0	3
6	21CS202	Python Programming(Lab Integrated)	ES	5	3	0	2	4
PRACTICALS								
7	21EC311	Analog and Digital Circuits Laboratory	PC	4	0	0	4	2
8	21EC312	Foundation Lab on Internet of Things (IoT)	EEC	2	0	0	2	1
9	21CS313	Aptitude and Coding Skills - I	EEC	2	0	0	2	1
TOTAL				**33**	**17**	**6**	**10**	**25**

IV SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21MA402	Probability and Random Processes	BS	5	3	2	0	4
2	21EC401	Communication Systems	PC	3	3	0	0	3
3	21EC402	Microprocessors & Microcontrollers	PC	3	3	0	0	3
4	21EC403	Electromagnetic Fields	PC	4	4	0	0	4
5	21EC404	Linear Integrated Circuits	PC	3	3	0	0	3
6	21EL301	Universal Human Values II – Understanding	HS(MC)	4	2	2	0	3
PRACTICALS								
7	21EC411	Microprocessors & Microcontrollers Laboratory	PC	4	0	0	4	2
8	21EC412	Linear Integrated Circuits Laboratory	PC	4	0	0	4	2
9	21EC413	Mini Project and Industrial Internship	EEC	2	0	0	2	1
10	21CS414	Aptitude and Coding Skills - II	EEC	2	0	0	2	1
TOTAL				**34**	**18**	**4**	**12**	**26**

V SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21EC501	Digital Communication	PC	3	3	0	0	3
2	21EC502	Transmission Lines and waveguides	PC	3	3	0	0	3
3	21EC503	VLSI Design (Lab Integrated)	PC	5	3	0	2	4
4		Professional Elective I	PE	3	3	0	0	3
PRACTICALS								
5	21EC512	Communication Systems Laboratory	PC	4	0	0	4	2
6	21EC513	Course based project - I	EEC	2	0	0	2	1
7	21CS512	Advanced Aptitude and Coding Skills – I	EEC	2	0	0	2	1
TOTAL				**22**	**12**	**0**	**10**	**17**

VI SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21EC601	Discrete-Time Signal Processing	PC	4	2	2	0	3
2	21EC602	Antennas and wave propagation	PC	3	3	0	0	3
3	21EC603	Embedded Systems (Lab	PC	5	3	0	2	4
4		Professional Elective II	PE	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
PRACTICALS								
6	21EC611	Digital Signal Processing	PC	4	0	0	4	2
7	21EC612	Course based project - II	EEC	2	0	0	2	1
8	21CS613	Advanced Aptitude and Coding Skills – II	EEC	2	0	0	2	1
TOTAL				**26**	**14**	**2**	**10**	**20**

VII SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21EC701	RF and Microwave Engineering (Lab Integrated)	PC	5	3	0	2	4
2	21EC702	Optical Communication and Networks (Lab Integrated)	PC	5	3	0	2	4
3		Management Elective	HSMC	3	3	0	0	3
4		Open Elective I	OE	3	3	0	0	3
PRACTICALS								
5	21EC711	Project Work - Phase I and Internship	EEC	6	0	0	6	3
6	21EC712	Design Thinking Laboratory	EEC	2	0	0	2	1
TOTAL				**24**	**12**	**0**	**12**	**18**

VIII SEMESTER

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	21EC811	Project Work - Phase II	EEC	16	0	0	16	8
TOTAL				**16**	**0**	**0**	**16**	**8**

PROFESSIONAL ELECTIVE I

SEMESTER V

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC901	Introduction to Internet of things	PE	3	3	0	0	3
2	21EC902	FPGA Architecture and Applications	PE	3	3	0	0	3
3	21EC903	Computer Networks	PE	3	3	0	0	3
4	21EC904	Medical Electronics	PE	3	3	0	0	3
5	21EC905	Digital Image and Video Processing	PE	3	3	0	0	3
6	21EC906	Soft Computing	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE II

SEMESTER VI

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC907	Sensors and Actuator Devices	PE	3	3	0	0	3
2	21EC908	RTL Design with VHDL/Verilog HDL	PE	3	3	0	0	3
3	21EC909	Wireless Communication	PE	3	3	0	0	3
4	21EC910	Human Assist Devices	PE	3	3	0	0	3
5	21EC911	Multimedia Compression and Communication	PE	3	3	0	0	3
6	21EC912	Quantum Computing	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE III
SEMESTER VI

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC913	Artificial Intelligence and Machine Learning	PE	3	3	0	0	3
2	21EC914	Low Power VLSI Design	PE	3	3	0	0	3
3	21EC915	4G / 5G Communication Networks	PE	3	3	0	0	3
4	21EC916	Wearable Devices	PE	3	3	0	0	3
5	21EC917	Wireless Sensor Networks	PE	3	3	0	0	3
6	21EC918	Robotics and Applications	PE	3	3	0	0	3

MANAGEMENT ELECTIVES

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21CS939	Principles of Management	HSMC	3	3	0	0	3
2	21CS938	Professional Ethics in Engineering	HSMC	3	3	0	0	3
3	21EC919	Total Quality Management	HSMC	3	3	0	0	3
4	21CS917	Introduction to Innovation, IP Management and Entrepreneurship	HSMC	3	3	0	0	3

CATEGORY OF COURSES & CREDIT DISTRIBUTION

SEMESTER	HSMC	BSC	ESC	PCC	PEC	OEC	EEC	HE	TOTAL CREDIT
I	3	12	9						24
II	6	4	7	7					24
III		4	4	15			2		25
IV	3	4		17			2		26
V				12	3		2	6	17
VI				12	6		2	6	20
VII	3			8		3	4	6	18
VIII							8		8
PROPOSED	15	24	20	71	9	3	20	18	162
ANNA UNIVERSITY	12	25	21	58	18	12	16		162
AICTE	12	25	24	48	18	18	15		160

R2021 (2021-22)

CURRICULUM OF B.E (HONOURS) IN ELECTRONICS AND COMMUNICATION AND ENGINEERING

WITH SPECIALIZATION IN

INTERNET OF THINGS/VLSI/HIGH SPEED COMMUNICATION

INTERNET OF THINGS

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC941	Industrial and Medical IoT	PE	3	3	0	0	3
2	21EC942	Programming and Web Technologies for IoT	PE	3	3	0	0	3
3	21EC943	Deep Learning and Its Applications	PE	3	3	0	0	3
4	21EC944	Robot Operating Systems	PE	3	3	0	0	3
5	21EC945	Design of Smart Cities	PE	3	3	0	0	3
6	21EC946	Image and Video Analytics	PE	3	3	0	0	3

VLSI

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC947	Semiconductor Devices and Fabrication Processes	PE	3	3	0	0	3
2	21EC948	RFIC Design	PE	3	3	0	0	3
3	21EC949	VLSI Algorithms and Architectures	PE	3	3	0	0	3
4	21EC950	VLSI Design Testing and Verification	PE	3	3	0	0	3
5	21EC951	SOC and Low Power VLSI Design	PE	3	3	0	0	3
6	21EC952	Reconfigurable Architectures	PE	3	3	0	0	3

HIGH SPEED COMMUNICATION

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC953	Advanced Wireless Communication	PE	3	3	0	0	3
2	21EC954	Advanced Wireless Networks	PE	3	3	0	0	3
3	21EC955	Software-defined networks	PE	3	3	0	0	3
4	21EC956	Satellite Communication & Navigation Systems	PE	3	3	0	0	3
5	21EC957	Information Storage and Cloud Computing	PE	3	3	0	0	3
6	21EC958	Cryptography and Network Security	PE	3	3	0	0	3

R2021 (2021-22)
B. E. (HONOURS) IN ELECTRONICS AND COMMUNICATION ENGINEERING

Additional 18 credits to be completed from the courses offered in the Professional Elective Verticals.

R2021 (2021-22)
MINOR DEGREE CURRICULUM OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING (FOR OTHER B.E. / B.TECH PROGRAMMES)

MINOR'S DEGREE IN INTERNET OF THINGS

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC901	Introduction to Internet of Things	PE	3	3	0	0	3
2	21EC907	Sensors and Actuator Devices	PE	3	3	0	0	3
3	21EC959	Image and Video Analytics	PE	3	3	0	0	3
4	21EC960	Robotic Operating System	PE	3	3	0	0	3
5	21EC961	Capstone Project	EEC	12	0	0	12	6

OPEN ELECTIVES (Multidisciplinary)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21EC001	PCB Design	OE	3	3	0	0	3
2	21EC002	Embedded Systems	OE	3	3	0	0	3
3	21EC003	Principles of Analog and Digital Communication	OE	3	3	0	0	3
4	21EC004	Sensors and Instrumentation	OE	3	3	0	0	3
5	21EC005	Automotive Electronics	OE	3	3	0	0	3
6	21EC006	Robotic Systems	OE	3	3	0	0	3
7	21EC007	Consumer Electronics	OE	3	3	0	0	3
8	21EC008	Healthcare Electronics	OE	3	3	0	0	3
9	21EC009	Semiconductor Physics	OE	3	3	0	0	3
10	21EC010	Biomedical Instrumentation	OE	3	3	0	0	3
11	21EC011	MATLAB Programming	OE	3	3	0	0	3
12	21EC012	Industrial IoT Applications	OE	3	3	0	0	3

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
21EL101	COMMUNICATIVE ENGLISH & LIFE SKILLS	2	0	0	2

COURSE OBJECTIVES:

- Strengthen their basic reading and writing skills.
- Comprehend listening contexts competently.
- Improve their speaking skills to speak fluently in real contexts.
- Develop vocabulary of a general kind and enhance their grammatical accuracy.

UNIT I	COMMUNICATION BASICS	06

Listening - short texts- short formal and informal conversations. Speaking- introducing oneself - exchanging personal information. Reading - practice in skimming - scanning and predicting. Writing- completing sentences - developing hints- free writing – Everyday expressions- collocations. Life Skills - Overview of Life Skills: significance of life skills.

UNIT II	COMMUNICATION INTERMEDIATE	06

Listening- telephonic conversations. Speaking – sharing information of a personal kind — greeting – taking leave. Reading – short comprehension passages - pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions / open-ended questions) - Writing – paragraph writing- topic sentence - main ideas, short narrative descriptions using some suggested vocabulary and structures. Life skills – Self-awareness: definition, need for self-awareness; Coping with Stress and Emotions.

UNIT III	COMMUNICATION VANTAGE	06

Listening – listening to longer texts and filling up the table - Speaking- asking about routine actions and expressing opinions. Reading- Long texts (cloze reading) - Writing- jumbled sentences - product description - use of reference words and discourse markers. Grammar – Tenses - phrasal verbs - Wh – Questions, yes or no questions and direct / indirect questions – countable & uncountable nouns – modal verbs. Life skills – Assertiveness vs Aggressiveness.

UNIT IV	SYNERGISTIC COMMUNICATION	06

Listening - listening to dialogues or conversations and completing exercises based on them - Speaking- speaking about oneself- speaking about one's friend – Reading - different types of texts- magazines - Writing - letter writing, informal or personal letters - e-mails-conventions of personal email - Language development - synonyms – antonyms. Life Skills –Problem Solving Techniques.

UNIT V	COMMUNICATION HIGHER	06

Listening – listening to TED talks - Speaking – role play – Reading - Biographies – Writing- writing short essays (analytical & issue-based essays) – dialogue writing. Life Skills Leadership & Decision making.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Read articles of a general kind in magazines and newspapers efficiently and identify different life skills.

CO2: Participate efficiently in informal conversations and develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.

CO3: Comprehend conversations and short talks delivered in English.

CO4: Write short essays of a general kind and personal letters and emails in English.

CO5: Develop vocabulary of a general kind by enriching their reading skills.

CO6: Use appropriate thinking and problem- solving techniques to solve new problems.

TEXT BOOKS:

1. Kumar, Suresh E and Sreehari, P. Communicative English. Orient Black Swan, 2007.
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP,2015.

REFERENCES:

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
2. Dhanavel, S P. English and Soft Skills, Volume Two, Orient Black Swan, ISBN 978 93 528769142.
3. Elbow, Peter. Writing Without Teachers. London: Oxford University Press, 1973. Print.
4. Larry James, The First Book of Life Skills; First Edition, Embassy Books, 2016.
5. Larsen, Kristine, Stephen Hawking: A Biography, Greenwood: Publishing Group, 2005.
6. Redston, Chris & Gillies Cunningham Face2Face (Pre-intermediate Student' s Book & Workbook) Cambridge University Press, New Delhi: 2005.

COURSE CODE	COURSE TITLE	L	T	P	C
21MA101	ENGINEERING MATHEMATICS–I	3	2	0	4

COURSE OBJECTIVES:

- Explain the concepts of matrix algebra.
- Make the students understand the idea of curvature, evolutes and envelopes.
- Impart the knowledge of functions of several variables.
- Introduce the concepts of Gamma and Beta integral.
- Develop an understanding on the basics of multiple integrals.

UNIT I	MATRICES	09+06

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II	APPLICATIONS OF DIFFERENTIAL CALCULUS	09+06

Curvature in Cartesian and Polar Co-ordinates–Centre and radius of curvature–Circle of curvature–Evolutes – Envelopes (excluding Evolute as envelope of normals).

UNIT III	FUNCTIONS OF SEVERAL VARIABLES	09+06

Limits – Continuity – Partial derivatives (excluding Euler's theorem) – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV	GAMMA, BETA INTEGRALS, AND APPLICATIONS	09+06

Gamma and Beta Integrals – Properties – Relation between Gamma and Beta functions, Evaluation of integrals using Gamma and Beta functions.

UNIT V	MULTIPLE INTEGRALS	09+06

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Diagonalize a matrix by orthogonal transformation.

CO2: Determine the Evolute and Envelope of curves.

CO3: Examine the maxima and minima of function of several variables.

CO4: Apply Gamma and Beta integrals to evaluate improper integrals.

CO5: Evaluate the area and volume by using multiple integrals.

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2014.
3. T. Veerarajan, Engineering Mathematics, Tata McGraw Hill, 2nd Edition, New Delhi, 2011.

REFERENCES:

1. M. K. Venkataraman, Engineering Mathematics, Volume I, 4th Edition, The National Publication Company, Chennai, 2003.
2. Sivaramakrishna Dass, C. Vijayakumari, "Engineering Mathematics, Pearson Education India, 4th Edition 2019.
3. H. K. Dass, and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Private Limited, 3rd Edition 2014.
4. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, 6th Edition, New Delhi, 2008.
5. S.S. Sastry, Engineering Mathematics, Vol. I & II, PHI Learning Private Limited, 4th Edition, New Delhi, 2014.

COURSE CODE	COURSE TITLE	L	T	P	C
21PH102	PHYSICS FOR ELECTRONICS ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

- To educate the fundamental important concepts in physics and to apply the knowledge in solving scientific and engineering problems.
- To impart the basic concepts of conducting materials, semiconducting materials, opto and nanoelectronic devices, light propagation in waveguides and electro- magnetostatics and electrodynamics.

UNIT I	CONDUCTING MATERIALS	09

Classical free electron theory - Expression for electrical conductivity -Four probe method-determination of resistivity -Expression for Thermal conductivity- Wiedemann-Franz law - Success and failures of CFT -Effect of temperature on Fermi function - Density of energy states- Carrier concentration in metals and average energy of an electron at 0 K – Energy bands in solids.

UNIT II	SEMICONDUCTING MATERIALS	09

Intrinsic semiconductors – Energy band diagram – Direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – determination of band gap - Extrinsic semiconductors - n-type and p-type semiconductors (qualitative) – Variation of Fermi level with temperature and impurity concentration – Hall effect and its applications

UNIT III	OPTO AND NANOELECTRONIC DEVICES	09

Carrier generation and recombination processes in semiconductors (concepts only) – LED - Organic LED - Photodetectors- Photodiodes -Solar cell – Electron density in bulk material (qualitative) -Size dependence of Fermi energy- Band gap of nanomaterial -Quantum confinement-Quantum structures- Density of states in quantum well, quantum wire and quantum dot structures - Quantum dot lasers.

UNIT IV	LASER AND FIBRE OPTICS	09

Population of energy levels, Einstein's A and B coefficients- derivation – Resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Engineering applications in communication.

Fibre optics -principle, numerical aperture and acceptance angle, V-number – Types of optical fibre (Material, Refractive index and Mode) – Losses in optical fibre - Fibre optic communication -Fibre optic sensors (pressure and displacement).

UNIT V	ELECTRO-MAGNETOSTATICS AND ELECTRODYNAMICS	09

Electrostatics*:* Coulomb's law - Gauss's law, Applications of Gauss's law (qualitative) - Maxwell's equation-I (equation only) - Electric field in matter: dielectrics, electric polarization, electric permittivity and susceptibility, relative permittivity, Types of polarization (electronic, ionic, orientation and space charge) - Internal field – Derivation - Clausius-Mossotti equation. Magnetostatics: Biot-Savart law and its applications (qualitative) – Ampere's law and its applications (qualitative)-Lorentz force-Maxwell's equation-II (equations only).Electrodynamics: Faraday's law of induction, Lenz law - Maxwell's equations-III and IV (equations only) – Electromagnetic waves in dielectric medium - Electromagnetic waves in vacuum.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Estimate the conducting properties of materials based on CFE and QFE theories and understand the formation of energy band structures.

CO2: Understand the basic properties of semiconducting materials and apply the concepts to determine Hall coefficient.

CO3: Elucidate the principle and working of various opto and nanoelectronic devices and their applications.

CO4: Attain basic knowledge on the concepts of lasers and apply in fibre optic communication.

CO5: Correlate electric and magnetic field behavior of electro-magnetostatics and electrodynamics.

CO6: Understand the concepts of conducting materials, semiconducting materials and apply the same to determine resistivity and band gap, explicate the principle and working of opto and nanoelectronic devices and analyze Maxwell's equation in different forms (differential and integral) in Electro-Magnetostatics and Electrodynamics.

TEXT BOOKS:

1. M.N. Avadhanulu and P.G. Kshirsagar, A Textbook of Engineering Physics, S. Chand and Company, New Delhi, 2014.
2. R.K. Gaur and S.L. Gupta, Engineering Physics, Dhanpat Rai Publications (P) Ltd., Eighth Edition, New Delhi, 2001.
3. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning India, 2012.
4. A. Marikani, Materials Science, PHI Learning Private Limited, Eastern Economy Edition, 2017.
5. R. Wolfson, Essential University Physics, Volume 1 and 2 with Mastering Physics, Global Edition, 3rd Edition, Pearson 2017.
6. S. O. Kasap,, Principles of Electronic Materials and Devices, McGraw-Hill Education, 2007.
7. David J Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited;, 4 th edition, 2015.
8. J. D Kraus, Electromagnetics, McGraw-Hill Inc. 4th edition, 1992.

REFERENCES

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc., 1995.
2. S.M. Sze Semiconductor Devices: Physics and Technology, Second Edition, Wiley,2008.
3. R. E. Hummel, Electronic Properties of Materials, Springer, 2001.
4. G. W. Hanson, Fundamentals of Nano electronics, Pearson Education, 2008.
5. B.Rogers, J. Adams, P. Sumitha, Nanotechnology: Understanding Small Systems, CRC Press, 2014.
6. D. Halliday, R.Resnick and J. Walker , Fundamentals of Physics, Wiley Publications, 2008
7. R. A. Serway and J. W. Jewett, Physics for Scientists and Engineers, Volume 5, Chapters 40-46, 8th Edition, Cengage Learning, 2010.
8. P. M. Fishbane, S. Gasiorowicz , S. Thornton, Physics for Scientists and Engineers, 3rd Edition , Chapters 1-40, 2005.

COURSE CODE	COURSE TITLE	L	T	P	C
21CH101	ENGINEERING CHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

- Understand the role of chemistry in everyday life.
- Develop an understanding of the basic concepts of electro -chemistry and its applications.
- Learn the principles and generation of energy in different types of batteries, fuel cells, nuclear reactors, solar cells and wind mills.
- Make them acquire basic knowledge of polymers, their classification and the applications of speciality polymers in engineering and technology.
- Understand the preparation, properties and applications of nanomaterials in various fields.

UNIT I	CHEMISTRY IN EVERYDAY LIFE	08

Importance of chemistry in everyday life- food additives - types (colours, preservatives, flavours and sweeteners), effects - food adulteration – types of adulteration (intentional, incidental) - effects of food adulterants – cosmetics and personal care products (fairness creams, perfumes, deodorants, shampoos)- effects – beverages-classification – carbonated beverages – nutritive values and effects. Water – impurities – industrial uses of water – hardness, external treatment (demineralization) – desalination (reverse osmosis).

UNIT II	ELECTROCHEMISTRY	10

Introduction – terminology - conductance of electrolytes- specific conductance, equivalent conductance, molar conductance- factors affecting conductance- origin of electrode potential- single electrode potential, standard electrode potential- measurement of single electrode potential-reference electrodes (standard hydrogen electrode, calomel electrode) - electrochemical series, applications – measurement of EMF of the cell – Nernst equation (derivation), numerical problems.

Chemical sensors – principle of chemical sensors- breath analyzer and Clark oxygen analyzer

UNIT III	ENERGY STORAGE DEVICES AND ENERGY SOURCES	09

Batteries – primary battery (alkaline battery) - secondary battery (Pb-acid battery, Ni-metal hydride battery, Li-ion battery) - fuel cells (H_2-O_2 fuel cell).

Nuclear Energy –nuclear reactions – fission, fusion, differences, characteristics– nuclear chain reactions – light water nuclear reactor – breeder reactor.

Renewable energysources- solar energy – thermal conversion (solar water heater and heat collector) - photovoltaic cell– wind energy.

UNIT IV	POLYMERS	09

Introduction – monomer, functionality, degree of polymerization – classification based on sources and applications – effect of polymer structure on properties - types of polymerization (addition, condensation)

- thermoplastic and thermosetting resins – preparation, properties and applications of Teflon, polyvinyl chloride, polycarbonate, Bakelite.

Special polymers - biodegradable polymers - properties and applications of polycaprolactone, polyhydroxyalkanoate – properties and applications of electrically conducting polymers (poly aniline, polyvinylidene fluoride).

UNIT V	NANOCHEMISTRY	09

Introduction – synthesis – top-down process (laser ablation, chemical vapour deposition), bottom-up process (precipitation, electrochemical deposition) – properties of nanomaterials – types (nanorods, nanowires, nanotubes-carbon nanotubes, nanocomposites).

Applications of carbon nanotubes – applications of nanomaterials in electronics, information technology, medical and healthcare, energy, environmental remediation, construction and transportation industries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Illustrate the role of chemistry in everyday life and the industrial uses of water.

CO2: Construct electrochemical cells and to determine the cell potential.

CO3: Compare and analyse the different energy storage devices and to explain potential energy sources.

CO4: Classify different types of polymeric materials and to discuss their properties and applications.

CO5: Explain basic concepts of nanochemistry and to enumerate the applications of nanomaterials in engineering and technology.

TEXT BOOKS:

1. P. C. Jain and Monika Jain, Engineering Chemistry, 17th edition, Dhanpat Rai Publishing Company Pvt. Ltd., New Delhi, 2018.
2. Prasanta Rath, Engineering Chemistry, 1st edition, Cengage Learning India Pvt. Ltd., Delhi, 2015.

REFERENCES:

1. S. Dara and S. S. Umare, A Textbook of Engineering Chemistry, 12th edition, S. Chand & Company, New Delhi, 2010.
2. Kirpal Singh, Chemistry in daily life, 3rd edition, PHI Learning Pvt. Ltd., 2012.
3. J. C. Kuriacose and J. Rajaram, Chemistry in Engineering and Technology, Volume- 1 & Volume -2, Tata McGraw-Hill Education Pvt. Ltd., 2010.
4. Geoffrey A. Ozin, Andre C. Arsenault, Ludovico Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, 2nd edition, RSC publishers, 2015.
5. Prasanna Chandrasekhar, Conducting polymers, fundamentals and applications – A Practical Approach, 1st edition, Springer Science & Business Media, New York, 1999

COURSE CODE	COURSE TITLE	L	T	P	C
21CS101	PROBLEM SOLVING AND C PROGRAMMING	3	0	0	3

COURSE OBJECTIVES:

- To make the students understand the fundamentals of problem solving using Algorithm and Flowchart
- To teach the basic programming constructs for solving simple problems
- To introduce the basic concepts of arrays and strings
- To acquaint the students about functions, pointers, structures and their relationship
- To impart knowledge on the concepts of file handling

UNIT I	INTRODUCTION TO ALGORITHM AND C	09

Introduction to Computer System – Block diagram, Program Development Life Cycle General problem Solving concepts: Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

Imperative languages: Introduction to imperative language, syntax and constructs of a specific language (ANSI C), Applications

Types, Operators: Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Basic I/O using scanf, printf, Operators – Types, Precedence, Associativity, Proper variable naming and Hungarian Notation.

UNIT II	CONTROL FLOW STATEMENTS	07

Control Flow with discussion on structured and unstructured programming: Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, goto labels, structured and unstructured programming.

UNIT III	ARRAYS AND FUNCTIONS	10

Arrays and Strings – Initialization, Declaration – One Dimensional and Two Dimensional arrays – Linear search, Binary Search, Matrix Operations (Addition and Subtraction)

Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, Pre-processor, Standard Library Functions and return types**.**

UNIT IV	STRUCTURES AND POINTERS	10

Basic Structures, Structures and Functions, Array of structures.

Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Initialisation of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations and how they are evaluated. Pointer of structures, Self-referential structures, Table look up, typedef, unions, Bit-fields

UNIT V	FORMATTED I/O AND FILE PROCESSING	09

Formatted Output – fprintf, Formatted Input – fscanf, Variable length argument listFiles - file access including FILE structure, fopen, fread, fwrite, stdin, sdtout and stderr, File Types – Text, Binary - Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions**.**

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop algorithmic solutions to simple computational problems.

CO2: Develop simple applications using basic constructs.

CO3: Write programs using arrays and strings.

CO4: Design and implement applications using functions, pointers and structures.

CO5: Design applications using sequential and random access file processing.

TEXT BOOKS:

1. Brian W Kernighan and Dennis M Ritchie, The C Programming Language, Pearson Education India, 2nd Edition, 2015.
2. Anita Goel and Ajay Mittal, Computer Fundamentals and Programming in C, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011**.**

REFERENCES:

1. B. Gottfried, Programming with C, Schaum Outline Series, 4th Edition, 2018.
2. Herbert Schildt, C: The Complete Reference, McGraw Hill, 4th Edition, 2017.
3. Yashavant Kanetkar, Let Us C, BPB Publications, 16th Edition, 2018.
4. Reema Thareja, Programming in C, 2nd Edition, Oxford University Press, 2018.
5. Zed A. Shaw, Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (like C), (Zed Shaw's Hard Way Series), 1st Edition, Addison-Wesley Professional, 2015.

COURSE CODE	COURSE TITLE	L	T	P	C
21ME101	COMPUTER AIDED ENGINEERING GRAPHICS	2	0	4	4

COURSE OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.

UNIT I	INTRODUCTION TO CONVENTIONS IN ENGINEERING DRAWING AND CAD COMMANDS	18

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Introduction to CAD commands- CAD user interface- coordinate systems, object selection methods, selection of units and precession. Sketching – line, circle, arc, polygon, rectangle and ellipse. Working with object snaps, layers and object properties. Editing the objects – copy, move, trim, extend, working with arrays, mirror, scale, hatch, fillet and chamfer. Conversion of simple pictorial diagrams to orthographic view using CAD software

UNIT II	PLANE CURVES	16

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

UNIT III	PROJECTION OF POINTS, LINES AND PLANE SURFACES	18

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT IV	PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS	20

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method. Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section

UNIT V	DEVELOPMENT OF SURFACES AND ISOMETRIC PROJECTION	18

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions

TOTAL: 90 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Illustrate the fundamentals and standards of engineering drawing and apply the concepts of orthographic projections using CAD software.

CO2: Interpret and construct various plane curves.

CO3: Develop orthographic projections of points, lines and plane surfaces.

CO4: Make use of concepts in projection to draw projections of solids and interpret the concept in section of solids

CO5: Interpret and visualize development of surfaces.

CO6: Interpret and visualize isometric projection of simple solids.

TEXT BOOKS:

1. Natarajan K.V., A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 33rd Edition, 2020.
2. Venugopal K. and Prabhu Raja V., Engineering Graphics, New Age International (P) Limited, 15th Edition, 2019.

REFERENCES:

1. Bhatt N.D. Engineering Drawing, Charotar Publishing House, 53rd edition 2019.
2. Basant Agarwal and Agarwal C.M., Engineering Drawing, Tata McGraw Hill Publishing Company Limited, New Delhi, 3rd Edition, 2019.
3. Engineering Drawing Practice for Schools and Colleges BIS SP46:2003 (R2008), Published by Bureau of Indian Standards (BIS), 2008.
4. Parthasarathy.N.S and Vela Murali, Engineering Graphics, Oxford University, Press, New Delhi, 2019
5. Gopalakrishna. K.R., Engineering Drawing Vol 1 & 2, Subhas Publications, 27th Edition, 2017.

COURSE CODE	COURSE TITLE	L	T	P	C
21PC111	PHYSICS & CHEMISTRY LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter, semiconductors and liquids

LIST OF EXPERIMENTS (Any five experiments to be conducted**)**

1. Determination of wavelength and velocity of ultrasonic waves by Ultrasonic Interferometer.
2. Determination of thermal conductivity of a poor conductor by LEE'S Disc method.
3. (i) Determination of wavelength and divergence angle of semiconductor laser source using diffraction grating.
   a. (ii) Determination of particle size by using diffraction of semiconductor laser beam.
   b. (iii) Analysis of Numerical aperture and acceptance angle of an optical fibre.
4. Determination of Young's Modulus of a beam by non-uniform bending method.
5. Determination of the moment of inertia of the disc and rigidity modulus of wire by Torsional pendulum.
6. Spectrometer - Determination of wavelength of Mercury Spectrum using diffraction grating.
7. Determination of thickness of wire by air wedge method.
8. Determination of Young's Modulus of a beam by Uniform bending method.
9. Determination of band gap of a semiconductor.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Use the ultrasonic interferometer and to determine the wavelength and velocity of ultrasonic waves of a liquid.

CO2: Examine the thermal conductivity of a bad conductor.

CO3: Determine the wavelength of mercury spectrum and also determine the wavelength of a laser source, particle size, divergence angle of semiconductor laser source using diffraction grating and to analyze the numerical aperture and acceptance angle of an optical fibre.

CO4: Examine the Young's modulus of a beam by uniform and non-uniform bending and to estimate the moment of inertia of the disc and rigidity modulus of wire by torsional pendulum.

CO5: Calculate the thickness of a thin wire by the interference pattern.

CO6: Determine the band gap of a semiconductor.

TEXT BOOKS:

1. Physics laboratory manual, Department of Physics, R.M.K. Engineering College, 2019.
2. Wilson J.D. and Hernandez C.A., - Physics Laboratory Experiments, Houghton Mifflin Company, New York, 2005.

CHEMISTRY LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- To make the students acquire practical skills through volumetric and instrumental analysis

LIST OF EXPERIMENTS

1. Determination of total, temporary and permanent hardness of water by EDTA method.
2. Conductometric titration of strong acid vs. strong base.
3. Determination of strength of acids in a mixture using a conductivity meter.
4. Determination of strength of given hydrochloric acid using a pH meter.
5. Estimation of the iron content of the given solution using a potentiometer.
6. Estimation of the iron content of the water sample using a spectrophotometer (thiocyanate method).
7. Estimation of sodium present in water using aflame photometer.
8. Determination of the molecular weight of polyvinyl alcohol using Ostwald viscometer.
9. Determination of corrosion rate by weight loss method.
10. Determination of flash and fire point of a lubricating oil (Pensky Martens apparatus).
11. Determination of concentration of a given solution by constructing a galvanic cell.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyse the given hard water sample and estimate different types of hardness present.

CO2: Observe and analyse the change in conductivity of an acid(s) when added with base through conductometry.

CO3: Examine the change in pH when an acid is added with a base using pH meter.

CO4: Understand the redox reactions and its impact on EMF values through potentiometry.

CO5: Determine the flash and fire point of an oil.

CO6: Assess the corrosion rate of a given metal.

CO7: Construct an electrochemical cell to determine the concentration of the given solution.

REFERENCES:

1. J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas and B. Sivasankar, Vogel's Quantitative Chemical Analysis, 6th edition, Pearson Education Pvt. Ltd., 2009

COURSE CODE	COURSE TITLE	L	T	P	C
21CS111	C PROGRAMMING LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To make the students write simple programs using basic constructs
- To familiarize the concepts of strings, pointers, functions and structures
- To equip the students on the knowledge of file processing concepts

LIST OF EXPERIMENTS

1. Constructing Flow charts using RAPTOR tools.
2. Programs using I/O statements and expression
3. Write a program to find whether the given line is horizontal or vertical.
4. Write a program to calculate the distance between two points p1(x1,y1), p2(x2,y2).
5. Write a program to calculate the force for the given mass and acceleration.
6. Write a program to calculate the Young's modulus.
7. Write a program to calculate the type of solution based on its pH value.
8. Write a program to temperature conversion (Fahrenheit to Celsius and vice versa)
9. Programs using decision-making constructs.
10. Write a program to find whether the given year is leap year or Not? (Hint: not every centurion year is a leap. For example 1700, 1800 and 1900 is not a leap year)
11. Design a calculator to perform the operations, namely, addition, subtraction, multiplication, division and square of a number.
12. Check whether a given number is Armstrong number or not?
13. Given a set of numbers like, find sum of weights based on the following conditions.

    5 if it is a perfect cube.
    4 if it is a multiple of 4 and divisible by 6.
    3 if it is a prime number.

    Sort the numbers based on the weight in the increasing order as shown below
    <10,its weight>, <36,its weight>, <89,its weight>

14. Populate an array with height of persons and find how many persons are above the average height.
15. Populate a two dimensional array with height and weight of persons and compute the Body Mass Index of the individuals.
16. Given a string ―a$bcd./fg‖ find its reverse without changing the position of special characters.(Example input:a@gh%;j and output:j@hg%;a)
17. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
18. From a given paragraph perform the following using built-in functions:
    a. Find the total number of words.
    b. Capitalize the first word of each sentence.
    c. Replace a given word with another word.
19. Solve towers of Hanoi using recursion.
20. Sort the list of numbers using pass by reference.

21. Generate salary slip of employees using structures and pointers. Create a structure Employee with the following members:
EID, Ename, Designation, DOB, DOJ, Basicpay
Note that DOB and DOJ should be implemented using structure within structure.
22. Compute internal marks of students for five different subjects using structures and functions.
23. Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.
24. Count the number of account holders whose balance is less than the minimum balance using sequential access file.
25. Mini project: Create a ―Railway reservation system with the following modules o Booking
    - o Availability checking
    - o Cancellation
    - o Prepare chart

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Write programs for simple applications making use of basic constructs, arrays and strings.
CO2: Develop programs involving functions, recursion, pointers, and structures.
CO3:Create applications using sequential and random access file processing

TEXT BOOKS:

1. Brian W Kernighan and Dennis M Ritchie, The C Programming Language, Pearson Education India, 2nd Edition, 2015.
2. Anita Goel and Ajay Mittal, Computer Fundamentals and Programming in C, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.

REFERENCES:

1. B. Gottfried, Programming with C, Schaum Outline Series, Fourth Edition, 2018
2. Herbert Schildt, C: The Complete Reference, McGraw Hill, Fourth Edition, 2017
3. Yashavant Kanetkar, Let Us C, BPB Publications, 16th Edition, 2018.
4. Reema Thareja, Programming in C, 2nd Edition, Oxford University Press, 2018.
5. Zed A. Shaw, Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (like C), (Zed Shaw's Hard Way Series), 1st Edition, Addison-Wesley Professional, 2015.

COURSE CODE	COURSE TITLE	L	T	P	C
21EL111	INTERPERSONAL SKILLS (LISTENING & SPEAKING)	0	0	2	1

COURSE OBJECTIVES:

- Equip and strengthen the English language skills.
- Provide guidance and practice to engage in specific academic speaking activities and enhance writing skills with specific reference to technical writing(interview skills).
- Improve general and academic listening skills.
- Demonstrate their presentation skills competently

UNIT I **06**

Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics - taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.

UNIT II **06**

Listen to a process information- give information, as part of a simple explanation – conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT III **06**

Deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail.

UNIT IV **06**

Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and participating in conversations.

UNIT V **06**

Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Listen and respond appropriately.

CO2: Participate in group discussions.

CO3: Make effective presentations.

CO4: Participate confidently and appropriately in conversations both formal and informal.

TEXT BOOKS:

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Dhanavel, S P. English and Soft Skills, Volume Two, Orient Black Swan, ISBN 978 93 528769142**.**

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
2. Hughes, Glyn and Josephine Moate, Practical English Classroom. Oxford University Press: Oxford, 2014.
3. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014.
4. Richards, C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010
5. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
21EL201	TECHNICAL ENGLISH	2	0	0	2

COURSE OBJECTIVES:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Demonstrate their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

UNIT I	INTRODUCTION - TECHNICAL ENGLISH	06

Listening- Listening to talks mostly of a scientific/technical nature and completing information- gap exercises- Speaking –Asking for and giving directions- Reading – reading short technical texts from journals- newspapers- Writing- purpose statements – extended definitions – writing instructions – checklists – recommendations-Vocabulary Development- technical vocabulary. Language Development –subject verb agreement - compound words.

UNIT II	READING ANDSTUDY SKILLS	06

Listening- Listening to longer technical talks and completing exercises based on them- Speaking - describing a process-Reading– reading longer technical texts- identifying the various transitions in a text- paragraphing- Writing- interpreting charts, graphs- Vocabulary Development-vocabulary used in formal letters/emails and reports Language Development- impersonal passive voice, numerical adjectives.

UNIT III	TECHNICAL WRITING AND GRAMMAR	06

Listening- Listening to classroom lectures/ talks on engineering/technology -Speaking – introduction to technical presentations- Reading – longer texts both general and technical, practice in speed reading; Writing-Describing a process, use of sequence words- Vocabulary Development- sequence words- Misspelled words. Language Development- embedded sentence

UNIT IV	REPORT WRITING	06

Listening- Listening to documentaries and making notes. Speaking – mechanics of presentations- Reading – reading for detailed comprehension- Writing- Report Writing (accident and survey) - minutes of a meeting - Vocabulary Development- finding suitable synonyms-paraphrasing-. Language Development-reported speech.

UNIT V	GROUP DISCUSSION AND JOB APPLICATIONS	06

Listening- TED talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– email etiquette- job application – cover letter – Résumé preparation (via email and hard copy)- Vocabulary Development- verbal analogies - Language Development- clauses- if conditionals**.**

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Read technical texts and write area- specific texts effortlessly.

CO2: Listen and comprehend lectures and talks in their area of specialization successfully.

CO3: Speak appropriately and effectively in varied formal and informal contexts.

CO4: Write reports and winning job applications

TEXT BOOKS:

1. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
2. Sudharshana.N.P and Saveetha C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

REFERENCES:

1. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007.
2. Herbert, A. J. The Structure of Technical English.Longman.1976.
3. Kumar, Suresh. E. Engineering English. Orient Black swan: Hyderabad, 2015.
4. Means, L. Thomas and Elaine Langlois, English & Communication for Colleges. Cengage Learning, USA: 2007.
5. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi, 2014.

COURSE CODE	COURSE TITLE	L	T	P	C
21MA201	ENGINEERING MATHEMATICS–II	3	2	0	4

COURSE OBJECTIVES:

- Explain various techniques in solving ordinary differential equations.
- Make the students understand the concepts of vector differentiation and integration.
- Introduce the concepts of Laplace transforms and its applications.
- Develop an understanding on analytic function, conformal mapping and complex integration

UNIT I	ORDINARY DIFFERENTIAL EQUATIONS	09+06

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT II	VECTOR CALCULUS	09+06

Gradient, divergence and curl (excluding vector identities) – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (Statement only) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT III	LAPLACE TRANSFORMS	09+06

Laplace transforms – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions – Derivatives and integrals of transforms –Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform – Convolution theorem (Statement only) – Initial and final value theorems – Solution of linear ordinary differential equation of second order with constant coefficients using Laplace transformation techniques

UNIT IV	COMPLEX DIFFERENTIATION AND CONFORMAL MAPPING	09+06

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy- Riemann equations and sufficient conditions (Statement only) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z + k$, kz, $1/z$, z^2 and bilinear transformation

UNIT V	COMPLEX INTEGRATION	09+06

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Statement and applications of Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Solve the higher order linear differential equations.

CO2: Determine the gradient of a scalar field, divergence and curl of a vector fields and interpret their physical meaning and evaluate line, surface and volume integrals by vector integration.

CO3: Apply Laplace Transforms method for solving linear ordinary differential equation.

CO4: Construct an analytic function and analyze conformal mapping.

CO5: Evaluate the real integrals using complex integration.

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition,2014.
3. T. Veerarajan, Engineering Mathematics, Tata McGraw Hill, 2nd Edition, New Delhi, 2 0 1 1 .

REFERENCES:

1. M. K. Venkataraman, Engineering Mathematics, Volume II, 4th Edition, The National Publication Company, Chennai, 2003.
2. Sivaramakrishna Dass, C. Vijayakumari, Engineering Mathematics, Pearson Education India, 4th Edition 2019.
3. H. K. Dass, and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Private Limited, 3rd Edition 2014.
4. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, 6th Edition, New Delhi, 2008.
5. S.S. Sastry, Engineering Mathematics, Vol. I & II, PHI Learning Private Limited, 4th Edition, New Delhi, 2014.

COURSE CODE	COURSE TITLE	L	T	P	C
21CH102	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

- Appreciate the natural resources of environment which are inherently created for supporting life.
- Learn scientific and technological solutions to current day pollution issues.
- Study the interrelationship between living organisms and environment
- Understand the integrated themes of biodiversity.
- Appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value

UNIT I	NATURAL RESOURCES	11

Introduction - scope and importance of environment – need for public awareness.

Forest resources- Use and over-exploitation, deforestation - timber extraction, mining, dams and their effects on forests and tribal people. Water resources - Use and over- utilization of surface and ground water, conflicts over water, dams-benefits and problems. Mineral resources- Use and exploitation, environmental effects of extracting and using mineral resources. Food resources- World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources - Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources. Land resources- Land as a resource, land degradation, soil erosion and desertification – role of an individual in conservation of natural resources - case studies.

UNIT II	POLLUTION AND ITS MANAGEMENT	11

Pollution – causes, effects and control measures - Air pollution- Water pollution - Soil pollution - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards - nuclear accidents and holocaust - role of an individual in prevention of pollution – case studies. Waste management - causes, effects and control measures of municipal solid wastes, e- waste, plastic waste.

UNIT III	ECOSYSTEMS AND BIODIVERSITY	09

Introduction to ecosystems – structure and function of an ecosystem – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids - types, characteristic features, structure and functions of - Forest ecosystem - Grassland ecosystem - Desert ecosystem - Aquatic ecosystems (lakes, oceans)

Introduction to biodiversity – types (genetic, species and ecosystem diversity) –values of biodiversity

– threats to biodiversity - endangered and endemic species – conservation of biodiversity (in-situ and ex-situ conservation) - India as a mega-diversity nation – hot-spots of biodiversity in India

UNIT IV	SOCIAL ISSUES AND THE ENVIRONMENT	08

Sustainable development – sustainable development goals - water conservation, rain water harvesting, watershed management – resettlement and rehabilitation - consumerism and waste products, value education. Disaster management- floods, drought, earthquake, tsunami, cyclone and landslides - case studies. Environmental ethics- issues and possible solutions – environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act – wildlife protection act – forest conservation act.

UNIT V	HUMAN POPULATION AND THE ENVIRONMENT	06

Introduction - population growth, variation among nations, population explosion, family welfare programme – women and child welfare - environment and human health – endemic/epidemic/pandemic, COVID – 19, HIV / AIDS– role of information technology in environment and human health – environmental impact assessment- case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Illustrate the importance and conservation of natural resources.
CO2: Assess the impact of various pollutants and suggest appropriate pollution control methods.
CO3: Explain the basic structure of ecosystem and the conservation of biodiversity.
CO4: Analyze the social issues related to environment and recommend suitable solutions.
CO5: Investigate the trends in population explosion and assess its impact.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik, Perspectives in environmental studies, New Age International, 6th edition, 2018.
2. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2017.
3. Gilbert M. Masters, Wendell P. Ela Introduction to Environmental Engineering and Science, 3rd edition, Pearson Education, 2015.

REFERENCES:

1. William P. Cunningham and Mary Ann Cunningham, Environmental Science: A Global Concern, McGraw Hill, 14th edition, 2017.
2. G. Tyler Miller and Scott E. Spoolman, Environmental Science, Cengage Learning India Pvt. Ltd., Delhi, 14th edition, 2014.
3. Erach Bharucha, Textbook of Environmental Studies, Universities Press Pvt. Ltd., Hyderabad, 2nd edition, 2015.

COURSE CODE	COURSE TITLE	L	T	P	C
21EC201	FUNDAMENTALS OF ELECTRICAL ENGINEERING AND CIRCUITS	4	0	0	4

COURSE OBJECTIVES:

- To develop an understanding of the fundamental laws, theorems, elements of electric circuits and to analyze dc and ac circuits
- To understand transient response behaviour of electric circuits.
- To introduce different methods of circuit analysis using network theorems, duality and topology

UNIT I	**FUNDAMENTALS OF ELECTRICAL ENGINEERING**	**12**

Fundamental concepts of dc and ac circuits, Steady state solution of DC circuits, Circuit laws and their applications in solving problems, Introduction to AC Circuits, Sinusoidal steady state analysis, Power and Power factor, Single phase and three phase balanced circuits.

UNIT II	**NETWORK THEOREMS FOR DC AND AC CIRCUITS**	**12**

Source transformation, Superposition theorem, Thevenin's & Norton's theorems, Reciprocity and Maximum power transfer theorem

UNIT III	**RESONANCE AND COUPLED CIRCUITS**	**12**

Resonance - Series resonance - Parallel resonance, Variation of impedance with frequency - Variation in current through and voltage across L and C with frequency, Bandwidth - Q factor – Selectivity, Self inductance - Mutual inductance - Dot rule - Coefficient of coupling - Analysis of multi winding coupled circuits, Series, parallel connection of coupled inductors - Single tuned and double tuned coupled circuits.

UNIT IV	**TRANSIENT ANALYSIS**	**12**

Natural response - Forced response Transient response of RC, RL and RLC circuits to excitation by step signal, impulse signal and exponential sources Complete response of RC, RL and RLC circuits to sinusoidal excitation

UNIT V	**TWO PORT NETWORKS**	**12**

Two port networks, Z parameters, Y parameters, Transmission(ABCD) parameters, Hybrid(H) parameters Interconnection of two port networks

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop the capacity to analyze electrical circuits using mesh and nodal analysis

CO2: Apply the circuit theorems in real time

CO3: Analyse resonance and coupled circuits

CO4: Analyse the transient response for DC circuits

CO5: Explain the two port networks and parameters

CO6: Design, understand and evaluate the AC and DC circuits.

TEXT BOOKS:

1. Charles K. Alexander, Matthew N. O. Sadiku, Fundamentals of Electric Circuits, 6th Edition, Tata McGraw Hill Education Private Limited, India,2017.
2. AbhijitChakrabarti, Circuit Theory Analysis and Synthesis, 7th Edition, Dhanpat Rai and Co.,2018.

REFERENCES:

1. S.K.Bhattacharya Basic Electrical and Electronics Engineering",Pearson India,2011.
2. Joseph Edminister and Mahmood Nahvi, ―Electric Circuits‖, Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, 5th Edition Reprint 2016.
3. W.H.Hayt, J.E.Kemmerly & S.M.Durbin, Engineering Circuit Analysis, 9th Edition, McGraw Hill Education, New Delhi, India,2019.
4. Allan R. Hambley, Electrical Engineering – Principles & Applications, 7th Edition, Pearson Education, Noida, India,2017.
5. A.Bruce Carlson, ―Circuits: Engineering Concepts and Analysis of Linear Electric Circuits‖,Cengage Learning, India Edition 2nd Indian Reprint 2009.
6. Allan H.Robbins, Wilhelm C.Miller, ―Circuit Analysis Theory and Practice‖, Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

COURSE CODE	COURSE TITLE	L	T	P	C
21EC202	ELECTRONIC DEVICES	3	0	0	3

COURSE OBJECTIVES:

- To make the students understand the fundamentals of electronic devices.
- To acquaint the semiconductor properties and formation of PN Junction diode and its characteristics
- To explain the operation and applications of BJT and FET
- To study the operation of special diodes and examine their characteristics
- To describe the functionality of power semiconductor devices and classify various types of optoelectronic devices

UNIT I	PN JUNCTION DIODE	09

Theory of PN junction diode – Energy band structure of open-circuited PN junction – Quantitative theory of PN diode currents – Diode current equation– Static and dynamic resistance levels – Transition and diffusion capacitances, Temperature dependence of V-I characteristics of diode – Switching characteristics, Breakdown in PN junction diodes – Diode as a circuit element – Piecewise Linear diode model – PN diode applications

UNIT II	BIPOLAR JUNCTION TRANSISTOR	09

BJT: Construction of BJT – Transistor biasing – Operation of NPN and PNP transistors–Types of configurations– Transistor as an amplifier - Large signal, dc and small signal CE values of current gain –Breakdown in transistors – Ebers-Moll Model.

UNIT III	FIELD EFFECT TRANSISTOR	09

Construction and operation of N-channel JFET – Characteristic parameters of JFET– Expression for saturation drain current – Slope of V-I characteristics – Biasing for zero current drift - Comparison of BJT and JFET – Applications of JFET, Construction and operation of N- Channel and P-Channel MOSFET – Enhancement and depletion type MOSFET – Characteristics – Threshold voltage – Channel length modulation – Comparison of N-channel and P- channel MOSFETs–Comparison of MOSFET with JFET –Applications of MOSFETs in CMOS circuits.

UNIT IV	SPECIAL SEMICONDUCTOR DEVICES	09

Construction, Principle of operation, characteristics and applications of Zener diode, Backward diode, Varactor diode, Step Recovery Diode, Point contact diode – Metal-Semiconductor junction – Schottky diode – Tunnel diode – Gunn Diode – Impatt Diode – PIN iode – PIN Photodiode - Avalanche Photodiode - DUAL GATE MOSFET – FINFET– MESFET.

UNIT V	POWER SEMICONDUCTOR & OPTOLECTRONIC DEVICES	09

Power Semiconductor Devices: Construction, Principle of operation, characteristics and applications of UJT, PNPN Diode, SCR, LASCR, DIAC, TRIAC, GTO Thyristors – Power BJT – Power MOSFET – DMOS – VMOS.

Optoelectronic Devices: Photoconductive sensors – Photoconductive cell – Photovoltaic sensors – Photo emissive sensors –Light emitters - LCD, Alpha numeric displays, LCD Panels, Plasma display Panels - Optocoupler, CCD, BBD.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the basics of electron devices

CO2: Explain the basics of device physics and working principle of PN Junction diode

CO3: Describe the construction, operation and applications of BJT, JFET and MOSFET

CO4: Understand the device physics of metal-semiconductor junctions.

CO5: Explain the working principle of special semiconductor devices

CO6: Explain the construction and working principle of power semiconductor devices and optoelectronic and display devices

TEXT BOOKS:

1. Donald A Neaman, Semiconductor Physics and Devices, McGraw Hill, 4th Edition, 2017.
2. Salivahanan S and Sureshkumar N, Electronic Devices and Circuits, McGraw Hill Education, 4th Edition, 2017.

REFERENCES:

1. Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 7th Edition, 2015.
2. Jacob Millman, Christos C. Halkias and SatyabrataJit, Electronic Devices and Circuits, McGraw Hill, 4th Edition, 2015.
3. Robert Boylestad and Louis Nashelsky, Electron Devices and Circuit Theory, Pearson, Eleventh Edition, 2013.
4. Thomas L. Floyd, Electronic Devices, Pearson, 9th Edition, 2016.
5. Tyagi M.S, Introduction to Semiconductor Materials and Devices, Wiley, 2008.
6. David A Bell, Electric Circuits and Electronic Devices, Oxford University Press, 2010.
7. Robert F Pierret, Semiconductor Device Fundamentals, Pearson, 1996.

COURSE CODE	COURSE TITLE	L	T	P	C
21CS201	DATA STRUCTURES	3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of ADTs
- To learn linear data structures – lists, stacks, and queues
- To understand and apply Tree data structures
- To understand and apply Graph structures
- To analyze sorting, searching and hashing algorithms

UNIT I	LINEAR DATA STRUCTURES – LIST	09

Algorithm analysis-What to analyze-running time calculations-Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation —singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).

UNIT II	LINEAR DATA STRUCTURES – STACKS, QUEUES	09

Stack ADT – Stack Model - Implementations: Array and Linked list - Applications - Balancing symbols - Evaluating arithmetic expressions - Conversion of Infix to postfix expression- Queue ADT – Queue Model - Implementations: Array and Linked list - Circular Queue – Priority Queue - deQueue – applications of queues.

UNIT III	NON LINEAR DATA STRUCTURES – TREES	09

Tree ADT – tree traversals - Binary Tree ADT – expression trees – applications of trees – binary search tree ADT –Threaded Binary Trees- AVL Trees – B-Tree - B+ Tree – Priority Queues – Applications of priority queues.

UNIT IV	NON LINEAR DATA STRUCTURES – GRAPHS	09

Definition – Representation of Graph – Types of graph - Breadth-first traversal - Depth-first traversal – Topological Sort – Bi-connectivity – Cut vertex – Euler circuits – Applications of graphs.

UNIT V	SEARCHING, SORTING AND HASHING TECHNIQUES	09

Searching- Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort - Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Implement abstract data types for linear data structures.

CO2: Apply the appropriate linear data structures to solve problems.

CO3: Identify and use appropriate tree data structures in problem solving.

CO4: Choose appropriate Graph representations and solve real-world applications.

CO5: Critically analyze the various sorting and searching algorithms.

TEXT BOOKS:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2016.
2. Reema Thareja, Data Structures Using C, 2nd Edition, Oxford University Press, 2014.

REFERENCES:

1. Narasimha Karumanchi, Data Structure and Algorithmic Thinking with Python: Data Structure and Algorithmic Puzzles, CareerMonk Publications, 2020.
2. Jean-Paul Tremblay and Paul Sorenson, An Introduction to Data Structures with Application, McGraw-Hill, 2017.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in Java, 3rd Edition, Pearson Education, 2012.
4. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Fundamentals of Data Structures in C, 2nd Edition, University Press, 2008.
5. Ellis Horowitz, Sartaj Sahni, Dinesh P Mehta, Fundamentals of Data Structures in C++,2nd Edition, Silicon Press, 2007.

COURSE CODE	COURSE TITLE	L	T	P	C
21EM111	ENGINEERING PRACTICES LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

	GROUP A (CIVIL & MECHANICAL)	15

CIVIL ENGINEERING PRACTICE

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.

(b) Study of pipe connections requirements for pumps and turbines.

(c) Preparation of plumbing line sketches for water supply and sewage works.

(d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

1. Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.

(b) Hands-on-exercise:

Woodwork, joints by sawing, planning and cutting.

II	MECHANICAL ENGINEERING PRACTICE	15

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.

(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning

(b) Drilling Practice

Sheet Metal Work:

(a) Forming &Bending:

(b) Model making – Trays and funnels.

(C) Different type of joints

Machine assembly practice:

(a) Study of centrifugal pump

(b) Study of air conditioner

Demonstration on:

(c) Smithy operations, upsetting, swaging, setting down and bending. Example Exercise – Production of hexagonal headed bolt.

(d) Foundry operations like mould preparation for gear and step conepulley.

(e) Fitting: Exercises – Preparation of square fitting and V – fitting models

GROUP B (ELECTRICAL & ELECTRONICS)

III	**ELECTRICAL ENGINEERING PRACTICE**	**15**

1. Study of various safety measures in Electrical System
2. Draw and demonstrate the layout for a residential house wiring using energy meter, switches, fuse, indicator, LED lamp, fluorescent lamp with one of the lamps to be controlled by 2 different switches Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit (series and parallel circuit).
3. Measurement of energy using single-phase energy meter for incandescent lamp and LED lamp.
5. Measurement of resistance to earth of an electrical equipment

IV	**ELECTRONICS ENGINEERING PRACTICE**	**15**

1. Study of Electronic components (fixed and Variable):
   i. Resistor – Measurement of resistance using colour coding and digital multimeter.
   ii. Capacitor – Measurement of capacitance using identification code, LCR meter
   iii. Inductor – Measurement of inductance using colour coding and LCR meter
2. Study of Electronic equipment:
   i. Signal generation using AFO (sine, square, triangle for various frequency and amplitude ranges)
   ii. Measurement of amplitude, frequency, peak-peak, RMS, period, DC level of sine, square and triangle waveform using CRO and DSO.
   iii. Measurement of DC voltage and current using analog and digital meters
3. Study of Electronic accessories:
   i. Circuit connection using Breadboard and wires.
   ii. Circuit connection using general purpose PCB by Soldering practice techniques.
4. Study of logic gates AND, OR, EX-OR and NOT by demonstration.
5. Generation of Clock Signal.
6. Measurement of ripple factor of HWR and FWR.
7. Study of Iron box, fan and regulator (resistive and electronics type), emergency lamp, Power Tools: (a) Range Finder (b) Digital Live-wire detector

TOTAL: 60 PERIODS
(Part A:30 periods and Part B : 30 periods)

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop carpentry components and pipe connections including plumbing works.

CO2: Make use of welding equipments to join the structures

CO3: Analyse the basic machining operations

CO4: Develop the models using sheet metal works

CO5: Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundry and fittings

CO6: Fabricate carpentry components and pipe connections including plumbing works.

CO7: Carry out simple wiring as per the layout given

CO8: Measures various electrical parameters like Voltage, Current, Power factor, Energy, Earth resistance etc.

CO9: Calculate ripple factor of a given waveform, use logic gates for simple applications.

LIST OF EQUIPMENT:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other	15Nos.
Carpentry vice (fitted to workbench)	15Nos.
Standard wood working tools	15Sets.
Models of industrial trusses, door joints, furniture joints	5each
Power Tools: Rotary Hammer	2Nos
Demolition Hammer	2Nos
Circular Saw	2 Nos
Planer	2 Nos
Hand Drilling Machine	2Nos
Jigsaw	2 Nosfittings.

MECHANICAL

1.	Arc welding transformer with cables and holders	5Nos.
2.	Welding booth with exhaust facility	5Nos.
3.	Welding accessories like welding shield, chipping hammer, Wire brush, etc.	5 Sets.
4.	Oxygen and acetylene gas cylinders, blow pipe and other Welding outfit.	2 Nos.
5.	Centre lathe	2 Nos.
6.	Hearth furnace, anvil and smithy tools	2 Sets.
7.	Moulding table, foundry tools	2 Sets.
8.	Power Tool: Angle Grinder	2 Nos
9.	Study-purpose items: centrifugal pump, air-conditioner	2 Nos

ELECTRICAL

1. Assorted electrical components for house wiring (One Way Switch, Two Way Switch, Lamp Holder, Ceiling rose, LED lamp, fluorescent lamp etc) -15 Nos.
2. Electrical measuring instruments (Ammeter, Voltmeter, DRB, DIB etc) - 1 each
3. Earth Tester - 1 No.
4. Energy Meter, Ammeter, Voltmeter, Lamp load / Resistive load - 1 each

ELECTRONICS

1. Soldering guns - 10 No.
2. Assorted electronic components for making circuits (Resistor, Capacitor, Inductor, logic gates etc) - 50 Nos.
3. Small PCBs, Breadboard -10 Nos.
4. Multimeters - 10 Nos.
5. LCR Meter, DSO - 1No.
6. CRO, AFO - 5 Nos.
7. Study purpose items: Iron box, fan and regulator, emergency lamp, Range Finder, Digital Live-wire detector - 1 each

COURSE CODE	COURSE TITLE	L	T	P	C
21CS211	DATA STRUCTURES LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To implement the basic data structures for solving simple problems.
- To implement linear and non-linear data structures
- To understand the different operations of search trees
- To implement graph traversal algorithms
- To get familiarized to sorting and searching algorithms

LIST OF EXPERIMENTS:

1. Array Manipulation
    a. Find k^{th} smallest element in an unsorted array
    b. Find the sub array with given sum
    c. Matrix manipulations – Addition, Subtraction, Multiplication
    d. Job Sequencing: Given an array of jobs where every job has a deadline and a profit. Profit can be earned only if the job is finished before the deadline. It is also given that every job takes a single unit of time, so the minimum possible deadline for any job is 1. How to maximize total profit if only one job can be scheduled at a time. Print the sequence of job ID order to maximize total profit.
2. String manipulations:
    a. Reversing a set of words and count the frequency of each letter in the string.
    b. Pattern Recognition - Find the number of patterns of form 1[0]1 where [0] represents any number of zeroes (minimum requirement is one 0) there should not be any other character except 0 in the [0] sequence in a given binary string.
    c. Remove all the occurrences of string S2 in string S1 and print the remaining.
3. Pointers
    a. Manipulating two dimensional arrays using pointers.
    b. Print all permutations of a given string using pointers.
4. Dynamic Memory Allocation
    a. Find Largest Number.
    b. Print the list in reverse order.

5. Array implementation of List, Stack and Queue ADTs.
6. Linked list implementation of List, Stack and Queue ADTs.
7. Applications of List, Stack and Queue ADTs.
8. Implementation of Binary Trees and operations of Binary Trees.
9. Implementation of Binary Search Trees.
10. Implementation of AVL Trees.
11. Implementation of Heaps using Priority Queues.
12. Graph representation and Traversal algorithms.
13. Implement searching and sorting algorithms. Analyze and compare the time taken for various algorithms with best, average and worst case inputs.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Write functions to implement linear and non-linear data structure operations.

CO2: Suggest and use appropriate linear / non-linear data structure operations for solving a given problem.

CO3: Implement different operations of search trees.

CO4: Implement appropriate Graph representations and traversals to solve real-world applications.

CO5:Implement and analyze the various searching and sorting algorithms.

COURSE CODE	COURSE TITLE	L	T	P	C
21EL211	ADVANCED READING & WRITING	0	0	2	1

COURSE OBJECTIVES:

- Strengthen their reading skills.
- Enhance writing skills with specific reference to technical writing.
- Apply their critical thinking skills.
- Provide more opportunities to develop their project and proposal writing skills

UNIT I	**06**
Reading - Strategies for effective reading - Writing -Write a descriptive paragraph - Predicting content using photos and title.	
UNIT II	**06**
Reading - Use of graphic organizers to review and aid comprehension. Writing - Write an opinion paragraph	
UNIT III	**06**
Reading - speed reading techniques - Writing - Elements of a good essay- Analytical Essay.	
UNIT IV	**06**
Reading - Genre and Organization of Ideas – Writing - Email writing - Job application	
UNIT V	**06**
Reading - Critical reading and thinking -Writing - letter of recommendation - Vision statement	
TOTAL: 30 PERIODS	

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Write different types of essays.

CO2: Write winning job applications.

CO3: Read and evaluate texts critically.

CO4: Display critical thinking in various professional contexts.

TEXT BOOKS:

1. Debra Daise, CharlNorloff, and Paul Carne Reading and Writing (Level 4) Oxford University Press: Oxford, 2011.
2. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011.

REFERENCES:

1. Davis, Jason and Rhonda Liss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006.
2. Elbow, Peter. Writing Without Teachers. London: Oxford University Press, Print, 1973.
3. E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012.
4. Goatly, Andrew. Critical Reading and Writing. Routledge: United States of America, 2000.
5. Petelin, Roslyn and Marsh Durham. The Professional Writing Guide: Knowing Well and Knowing Why. Business & Professional Publishing: Australia, 2004.
6. Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge University Press: Cambridge, 2004.

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
21MA303	LINEAR ALGEBRA AND PARTIAL DIFFERENTIAL EQUATIONS	3	2	0	4

COURSE OBJECTIVES:

- To illustrate the basic notions associated with vector spaces and its properties.
- To interpret the concept of linear transformations and diagonalization.
- To enumerate the orthonormal basis using inner product spaces.
- To describe the solutions of partial differential equations
- To illustrate the concept of Fourier series solutions of partial differential equations

UNIT I	VECTOR SPACES	15

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

UNIT II	LINEAR TRANSFORMATION AND DIAGONALIZATION	15

Linear transformation – Null spaces and ranges – Rank nullity Dimension theorem – Matrix representation of a linear transformations – Eigenvalues and eigenvectors – Diagonalizability

UNIT III	INNER PRODUCT SPACES	15

Inner product, norms – Gram Schmidt orthogonalization process – Adjoint of linear operations Least squares approximation

UNIT IV	PARTIAL DIFFERENTIAL EQUATIONS	15

Formation – Solutions of first order equations – Standard types and equations reducible to standard types – Singular solutions – Lagrange‘s linear equation – Classification of partial differential equations – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT V	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	15

Dirichlet‘s conditions – General Fourier series – Half range expansions – Method of separation of variables – Solutions of one-dimensional wave equation – Fourier series solutions in Cartesian coordinates.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Determine the dimension and bases of the vector spaces.

CO2: Compute the matrix representation of the linear transformation under the given basis.

CO3: Relate the concept of inner product space in orthogonalization.

CO4: Compute the solutions of partial differential equations.

CO5: Utilize the Fourier series for wave equations.

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition, Wiley India, 2011.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 44^{th} Edition, 2017.
3. A.H. Friedberg, A.J. Insel and L. Spence, Linear Algebra, Prentice Hall of India, 5^{th} Edition, New Delhi, 2008.

REFERENCES:

1. G. James, Advanced Modern Engineering Mathematics, Pearson Education, 4^{th} Edition, 2007.
2. S. Kumaresan, Linear Algebra – A Geometric Approach, Prentice – Hall of India, New Delhi, Reprint, 2010.
3. D.C. Lay, Linear Algebra and its Applications, 5^{th} Edition, Pearson Education, 2015.
4. P.V. O'Neil, Advanced Engineering Mathematics, Cengage Learning, 7^{th} Edition, 2012.
5. K. Hoffman and R. Kunze, Linear Algebra, 2^{nd} Edition, Prentice – Hall of India, 2005.
6. S. Lipschutz and M. L. Lipson, Schaum's Outline Series of Linear Algebra, 4^{th} Edition, Tata McGraw Hill of India.

COURSE CODE	COURSE TITLE	L	T	P	C
21EC301	SIGNALS AND SYSTEMS	3	2	0	4

COURSE OBJECTIVES:

- To summarize the basic properties of Signals and Systems and their classification.
- To analyze Continuous Time signals using Laplace transform and Fourier transform.
- To characterize Continuous Time LTI systems using Laplace transform and Fourier transform.
- To analyze Discrete Time signals using DTFT and Z transform.
- To characterize Discrete Time LTI systems using DTFT and Z transform.

UNIT I	CLASSIFICATION OF SIGNALS AND SYSTEMS	15

Continuous time signals (CT signals) - Discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential, Classification of CT and DT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Even & Odd, Causal & Non-Causal, Energy& Power signals - CT systems and DT systems- Classification of systems - Continuous time and Discrete time systems – Static & Dynamic, Linear & Nonlinear, Time-variant & Time - invariant, Causal & Non-causal, Stable & Unstable. Plotting of signals using MATLAB.

UNIT II	ANALYSIS OF CONTINUOUS TIME SIGNALS	15

Fourier series analysis - Spectrum of Continuous Time (CT) signals- Fourier and Laplace transforms in CT Signal analysis - Properties.

UNIT III	LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS	15

Differential Equation-Block diagram representation-impulse response, convolution integrals - Fourier and Laplace transforms in analysis of CT systems.

UNIT IV	ANALYSIS OF DISCRETE TIME SIGNALS	15

Baseband Sampling - DTFT – Properties of DTFT - Z transform – Properties of Z transform. Sampling using MATLAB.

UNIT V	LINEAR TIME INVARIANT DISCRETE TIME SYSTEMS	15

Difference Equations - Block diagram representation - Impulse response - Convolution sum- Discrete Fourier and Z transform analysis of Recursive & Non-Recursive systems. Convolution Sum using MATLAB.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze the properties of Signals and Systems.

CO2: Apply Fourier transform and Laplace transform in Continuous Time signal analysis.

CO3: Analyze Continuous Time LTI systems using Fourier and Laplace transforms.

CO4: Apply DTFT and Z transform in Discrete Time signal analysis.

CO5: Analyze Discrete Time LTI systems using DTFT and Z transform.

CO6: Apply Convolution operation for Continuous and Discrete time systems.

TEXT BOOKS:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, Signals and Systems, 2nd Edition, Pearson, 2015.
2. A.Nagoor Kani, Signals and Systems, McGrawHill, 2018.

REFERENCES:

1. B. P. Lathi, Principles of Linear Systems and Signals, 3rd Edition, Oxford, 2017.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, Signals & Systems - Continuous and Discrete, 4th Edition, Pearson, 2014.
3. M.J.Roberts, Signals & Systems Analysis using Transform Methods & MATLAB, 3rd Edition, Tata McGraw Hill, 2019.
4. Simon Haykin and Barry Van Veen, Signals & Systems, 2nd Edition, Wiley, 2018.
5. A. Anand Kumar, Signals and Systems, 3rd Edition, PHI Learning Private Limited, 2013.

NPTEL LINKS:

https://nptel.ac.in/courses/108/106/108106163/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC302	ELECTRONIC CIRCUITS	3	0	0	3

COURSE OBJECTIVES:

- To analyze biasing of BJT and BJT amplifiers.
- To analyze biasing of MOSFET and MOSFET amplifiers.
- To compute the frequency response of BJT and MOSFET.
- To acquire knowledge of feedback amplifiers and oscillators.
- To illustrate the operation of power amplifiers.

UNIT I	BIASING OF DISCRETE BJT AND BJT AMPLIFIERS	09

Load line, Q-point, Biasing methods for BJT, Analysis of CE, CB and CC amplifiers using hybrid-pi equivalent circuit, BJT Differential amplifier – CMRR, Multistage amplifiers - Cascade amplifier, Darlington amplifier, Cascode amplifier

UNIT II	BIASING OF DISCRETE MOSFET AND MOSFET AMPLIFIERS	09

Load line, Q-point, Biasing methods for MOSFET, Analysis of CS, CD and CG MOSFET amplifiers using hybrid-pi equivalent circuits, MOSFET Differential amplifier – CMRR, Multistage Amplifiers - Cascade amplifier, Cascode amplifier.

UNIT III	FREQUENCY RESPONSE OF BJT AND MOSFET	09

Frequency response of BJT– Transistor amplifier with circuit capacitors, Short circuit current gain, Miller effect and Miller capacitance, High frequency analysis of CE amplifier, Frequency response of MOSFET –High frequency MOSFET model, Unit gain bandwidth, Miller effect and Miller capacitance, High frequency analysis of MOSFET CS amplifier.

UNIT IV	FEEDBACK AMPLIFIERS AND OSCILLATORS	09

Feedback Concepts – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers – analysis of series-series, shunt-shunt and shunt-series feedback amplifiers, Barkhausen criterion, Colpitts, Hartley, Clapp oscillator, Phase shift, Wien bridge and crystal oscillators.

UNIT V	POWER AMPLIFIERS	09

Classification of large signal amplifiers, Class A, B, AB, C, D, Conversion efficiency, Class C tuned amplifier.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze biasing of BJT and BJT amplifiers.

CO2: Analyze biasing of MOSFET and MOSFET amplifiers.

CO3: Compute the frequency response of amplifiers.

CO4: Acquire the knowledge of feedback amplifiers.

CO5: Acquire the knowledge of oscillators.

CO6: Illustrate the operation of power amplifiers.

TEXT BOOKS:

1. Donald. A. Neamen, Electronic Circuits Analysis and Design, 3rd Edition, McGraw Hill Education (India) Private Ltd., 2010.
2. Robert L. Boylestad and Louis Nasheresky, Electronic Devices and Circuit Theory, 11th Edition, Pearson Education / PHI, 2015.

REFERENCES:

1. David A. Bell, Electronic Devices and Circuits, 5thEdition, Oxford University Press, 2010.
2. Sedra and Smith, Micro Electronic Circuits, 7th Edition, Oxford University Press, 2015.
3. Millman J, Halkias.C. and Sathyabrada Jit, Electronic Devices and Circuits, 4th Edition, McGraw Hill Education (India) Private Ltd., 2015.
4. Jacob Millman and Arvin Grabel, Micro Electronics, 2nd Edition, McGraw Hill Education (India) Pvt Limited, 2017.
5. Floyd, Electronic Devices, 9th Edition, Pearson Education, 2012.

NPTEL LINKS:

https://nptel.ac.in/courses/108/102/108102097/

https://nptel.ac.in/courses/108/102/108102095/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC303	DIGITAL ELECTRONICS	3	0	0	3

COURSE OBJECTIVES:

- To acquire the knowledge in Digital fundamentals, Boolean algebra and its applications in digital systems.
- To design various combinational digital circuits using logic gates.
- To analyze and design synchronous and asynchronous sequential circuits.
- To explain the various semiconductor memories and related technology.
- To describe the electronic circuits involved in the making of logic gates.

UNIT I	DIGITAL FUNDAMENTALS	09

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map minimization and Quine-McCluskey method of minimization.

UNIT II	COMBINATIONAL CIRCUIT DESIGN	09

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder/Subtractor – Carry Look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Parity checker – Parity generator – Code converters – Verilog HDL for combinational circuits.

UNIT III	SYNCHRONOUS SEQUENTIAL CIRCUITS	09

Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Asynchronous and Synchronous Counters- Design, Shift registers, Universal Shift Register. Shift register counters- Design of clocked sequential circuits - Moore/Mealy models, state minimization, state assignment, circuit implementation- Verilog HDL for sequential circuits.

UNIT IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS	09

Design of fundamental mode and pulse mode circuits – Cycles and Races, Race free assignments, Hazards, Essential Hazards – Design of Hazard Free Switching circuits**.**

UNIT V	MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS	09

Basic memory structure ROM: PROM – EPROM – EEPROM –Flash memories: RAM – Static and dynamic RAM – Programmable Logic Devices: Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) – Implementation of combinational logic circuits using PLA, PAL. Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their electrical behavior -RTL, TTL, ECL, CMOS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Implement Boolean expression using logic gates.

CO2: Design Combinational circuits for a given function using logic gates.

CO3: Implement synchronous and asynchronous sequential circuits for a given application.

CO4: Summarize the types of memory devices.

CO5: Design the combinational logic circuits using Programmable Logic Devices.

CO6: Analyze the various logic families and their characteristics

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, Digital Design, With an Introduction to the Verilog HDL, VHDL, and System Verilog, 6th Edition, Pearson, 2018.
2. S.Salivahanan and S.Arivazhagan, Digital Circuits and Design, 5th Edition, Oxford University Press, 2018

REFERENCES:

1. A.Anand kumar, Fundamental of digital circuits, 4th Edition, PHI Publication,2016.
2. William Kleitz, Digital Electronics-A Practical approach to VHDL, Prentice Hall International Inc, 2012.
3. Charles H.Roth, Jr. and Larry L. Kinney, Fundamentals of Logic Design, 7th Edition, Thomson Learning, 2014.
4. Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson Education Inc, 2017.
5. John.M Yarbrough, Digital Logic: Applications and Design, 1st Edition, Cengage India, 2006.

NPTEL LINKS:

https://nptel.ac.in/courses/108/105/108105132/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC304	CONTROL SYSTEMS	2	2	0	3

COURSE OBJECTIVES:

- To understand the transfer function models of mechanical and electrical systems.
- To develop adequate knowledge in the time response of systems and steady state error analysis.
- To analyse the open loop and closed loop frequency response of linear systems.
- To introduce stability analysis and design of compensators of linear systems.
- To introduce state variable representation of physical systems.

UNIT I	MATHEMATICAL MODEL OF PHYSICAL SYSTEMS	12

Basic elements in control systems: – Open and closed loop systems – Mathematical model and Electrical analogy of mechanical and thermal systems – Transfer function – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs- Applications of Control system.

UNIT II	TIME RESPONSE ANALYSIS	12

Time response: – Time domain specifications – Types of test input – I and II order-system response – Error coefficients – Generalized error series – Steady state error –- Effects of P, PI, PID modes of feedback control –Time response analysis-Effect of addition of poles and zeros in Second order system.

UNIT III	FREQUENCY RESPONSE ANALYSIS	12

Frequency response analysis – Bode plot – Polar plot – Determination of closed loop response from open loop response – Correlation between frequency domain and time domain specifications.

UNIT IV	STABILITY AND COMPENSATOR DESIGN	12

Characteristics equation – Routh Hurwitz criterion – Root locus construction – Construction of compensators with root locus – Effect of lag, lead and lag-lead compensation on frequency response – Design of lag, lead and lag-lead compensator using Bode plots.

UNIT V	STATE VARIABLE AND STATE SPACE MODELLING	12

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability.

TOTAL: 45 +15=60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop mathematical model of linear mechanical and electrical systems.

CO2: Summarize the time response analysis of first and second order systems.

CO3: Determine the applications of P, PI, PID controllers.

CO4: Analyze the frequency response of open and closed loop systems.

CO5: Estimate the stability and suitable compensators for the given system.

CO6: Examine the state variables, controllability and observability of linear and time invariant system

TEXT BOOKS:

1. Nagarath, I.J. and Gopal, M., Control Systems Engineering, New Age International Publishers, 2017.
2. Benjamin C. Kuo, Automatic Control Systems, Wiley, 2014.

REFERENCES:

1. Katsuhiko Ogata, Modern Control Engineering, Pearson, 2015.
2. Richard C.Dorf and Bishop, R.H., Modern Control Systems, Pearson Education, 14th Edition, 2016.
3. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, Linear Control System Analysis and Design with MATLAB, CRC Taylor& Francis 2013.
4. Rames C.Panda and T. Thyagarajan, An Introduction to Process Modelling Identification and Control of Engineers, Narosa Publishing House, 2017.
5. M.Gopal, Control System: Principle and design, McGraw Hill Education, 2018.
6. NPTEL Video Lecture Notes on Control Engineering by Prof. S. D. Agashe, IIT Bombay.

COURSE CODE	COURSE TITLE	L	T	P	C
21CS202	PYTHON PROGRAMMING (LAB INTEGRATED)	3	0	2	4

COURSE OBJECTIVES:

- To understand and write simple Python programs.
- To write Python programs using functions and understand recursion
- To solve problems using Python data structures –- lists, tuples, dictionaries.
- To understand files, modules and packages in Python.
- To use Exceptions, Standard Libraries and IDE for application development

UNIT I	INTRODUCTION TO PYTHON	09+06

Introduction to Python programming – Arithmetic Operators - values and types - variables, expressions, statements – functions – conditionals and recursion – Iteration.

UNIT II	FUNCTIONS	09+06

Fruitful functions: Return Values, Incremental Development, Composition, Boolean functions, Recursion, Example, Checking Types – Strings: len, Traversal with a for loop, String slices, Immutable, Searching, Looping and Counting, String Methods, in Operator, String Comparison Case Study: Word Play.

UNIT III	LISTS,DICTIONARIES,TUPLES	09+06

Lists: Sequence, Mutable, Traversing, Operations, list slices, list methods, Map, Filter and Reduce, Deleting elements, Lists and Strings, Objects and Values, Aliasing, List Arguments.

Dictionaries: Mapping, Collection of Counters, Looping and Dictionaries, Reverse Lookup, Dictionaries and Lists, Memos, Global Variables.

Tuples: Immutable, Tuple Assignment, Tuple as Return Values, Variable-length Argument Tuples, Lists and Tuples, dictionaries and Tuples, Sequences of Sequences. Case Study: Data Structure Selection.

UNIT IV	FILES,MODULES AND PACKAGES	09+06

Files: Persistence, Reading and Writing, Format Operator, Filenames and Paths, Catching Exceptions - Modules: Importing a module, Packages, Creating a module.

UNIT V	EXCEPTIONS,LIBRARIES	09+06

Exception Handling – Built-in Exceptions – Application Development with Python: Integrated Development Environment, Python Standard Library.

TOTAL:75 PERIODS

LIST OF EXPERIMENTS

1. Compute the GCD of two numbers.

2. Find the square root of a number (Newton‘s method)

3. Exponentiation (power of a number)

4. Operations on Tuples:

   a. finding repeated elements

   b. slice a tuple

   c. reverse a tuple

   d. replace last value of a tuple

5. String manipulation

   a. Get a string from a given string where all occurrences of its first char have been changed to '$', except the first char itself

   b. Python function that takes a list of words and returns the length of the longest one

   c. Python program to remove the characters which have odd index values of a given string

   d. Python program to count the occurrences of each word in a given sentence.

   e. Python program that accepts a comma separated sequence of words as input and prints the unique words in sorted form

   f. Python function to reverses a string if it's length is a multiple of 4

6. List operations

   a. Find the maximum of a list of numbers

   b. Python program to remove duplicates from a list.

   c. Python program to get the smallest number from a list.

   d. Python program to print a specified list after removing the 0th, 4th and 5th elements.

   e. Python program to print the numbers of a specified list after removing even numbers from it.

   f. Python program to find the second smallest number in a list.

7. Linear search and Binary search

8. Selection sort, Insertion sort

9. Merge sort

10. First n prime numbers

11. Multiply matrices

12. Programs that take command line arguments (word count)

13. Find the most frequent words in a text read from a file

14. Simulate elliptical orbits in Pygame

15. Simulate bouncing ball using Pygame

OUT COMES:

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

CO1: Implement simple Python programs.

CO2: Develop Python programs using functions.

CO3: Represent and solve compound data using Python lists, tuples, dictionaries.

CO4: Implement and perform operations on files, modules and packages.

CO5: Apply Exceptions, Standard Libraries and IDE for application development.

TEXT BOOKS:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Martin C. Brown, Python: The Complete Reference, Mc-Graw Hill,. (Unit 4 – Chapter 5 , Unit 5 – Chapter 7, 17)

REFERENCES:

1. David Beazley, Brian K. Jones, Python Cookbook, O'Reilly , Third Edition, 2013.
2. Reema Thareja, Problem Solving and Programming with Python, 2nd Edition, Oxford University Press 2019.
3. Guido van Rossum and Fred L. Drake Jr, ―An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
4. John V Guttag, ―Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
6. Timothy A. Budd, ―Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
7. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
8. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
9. Paul Gries, Jennifer Campbell and Jason Montojo, ―Practical Programming: An Introduction to Computer Science using Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

COURSE CODE	COURSE TITLE	L	T	P	C
21EC311	ANALOG AND DIGITAL CIRCUITS LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To demonstrate the characteristics of basic electronic devices such as Diode and BJT.
- To analyze the frequency response of CE, CB, CC and CS Amplifier.
- To demonstrate the feedback amplifiers and oscillators.
- Perform SPICE simulation of Electronic Circuits.
- Design and implement the Combinational and sequential logic circuits**.**

LIST OF ANALOG EXPERIMENTS

1. Characteristics of PN Junction Diode and Zener diode
2. Input-output Characteristics of BJT
3. Frequency Response of CE, CC and CS amplifiers
4. Darlington Amplifier
5. Cascode/Cascade amplifiers
6. Series and Shunt feedback amplifiers -Frequency response
7. Series and Series feedback amplifiers -Frequency response
8. Shunt and Series feedback amplifiers -Frequency response
9. Shunt and Shunt feedback amplifiers -Frequency response
10. RC Phase shift oscillator
11. Hartley Oscillator
12. Colpitts Oscillator

LIST OF EXPERIMENTS USING SPICE

1. Analysis of Frequency Response of BJT using Spice
2. Analysis of Frequency Response of MOSFET using Spice
3. Wien bridge oscillator using Spice

LIST OF DIGITAL EXPERIMENTS

1. Design and implementation of Adders and subtractors using logic gates
2. Design and implementation of code converters using logic gates
   (i) BCD to excess-3 code and vice versa (ii) Binary to gray and vice-versa
3. Design and implementation of Multiplexer and De-multiplexer using logic gates
4. Design and implementation of encoder and decoder using logic gates
5. Construction and verification of 4-bit ripple counter and Mod-10 / Mod-12 Ripple counters
6. Design and implementation of 3-bit synchronous up/down counter
7. Design and implementation of serial in parallel out shift register

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze the characteristics of basic electronic devices.

CO2: Analyze the frequency response of the amplifiers.

CO3: Analyze the feedback amplifiers and oscillators.

CO4: Simulate frequency response of the amplifiers using spice tool.

CO5: Simulate frequency response of the oscillators using spice tool.

CO6: Design and test the digital logic circuits.

LIST OF EQUIPMENTS		
S.No	Equipments For Analog Lab	Quantity
1	CRO/DSO (30MHz)	15
2	Signal Generator /Function Generators (3 MHz)	15
3	Dual Regulated Power Supplies (0 – 30V)	15
4	Standalone desktop PCs with SPICE software	30
5	Transistor/FET (BJT-NPN-PNP and NMOS/PMOS)	50
Components and Accessories: Resistors, Capacitors, Inductors, diodes, Zener Diodes, PN diodes, Bread Boards.		
SPICE Circuit Simulation Software: (any public domain or commercial software)		

LIST OF EQUIPMENTS		
S.No	Equipments For Digital Lab	Quantity
1	Dual power supply/ single mode power supply	15
2	IC Trainer Kit	15
3	Bread Boards	15
4	Seven segment display	15
5	Multimeter	15
ICs each 50 Nos 7400/ 7402 / 7404 / 7486 / 7408 / 7432 / 7483 / 74150 / 74151 / 74147 / 7445 / 7476/7491/ 555 / 7494 / 7447 /74180 / 7485 / 7473 / 74138 / 7411 / 7474		

COURSE CODE	COURSE TITLE	L	T	P	C
21EC312	FOUNDATION LAB ON INTERNET OF THINGS (IoT)	0	0	2	1

COURSE OBJECTIVES:

- To impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects

LIST OF PRACTICALS

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to ThingSpeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from ThingSpeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Acquire knowledge on Internet of Things and its hardware and software components.

CO2: Demonstrate to interface I/O devices, sensors & communication modules.

CO3: Analyze by connecting and exchanging data with other devices and systems over the Internet.

CO4: Analyze to remotely monitor data and control devices.

CO5: Analyze the issues involved in the design of IoT application in terms of performance, efficiency and response time.

CO6: Develop real life IoT based projects.

REFERENCES:

1. Vijay Madisetti, Arshdeep Bahga, İnternet of Things, A Hands on Approach, University Press,2014.
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, Introduction to Internet of Things: A practical Approach, ETI Labs.
3. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 1st Edition, Auerbach Publications,2017.
4. Jeeva Jose, Internet of Things, Khanna Publishing House, Delhi, 1st Edition, Khanna Publishing House,2018.
5. Adrian McEwen, Designing the Internet of Things, 1st Edition ,Wiley,2013.

List of equipments

Sl.	Description of equipment	Quantity
1.	Arduino UNO with USB cable	10
2.	Bread board (gl-840)	10
3.	Led (3 color each-5)	15
4.	Resistor (10Ω,10k)	15
5.	Hookup wire	60
6.	RGB led	15
7.	Push button	15
8.	IR-sensor	20
9.	Buzzer	20
10.	Piezo sensor	20
11.	Potentiometer (10ke)	20
12.	DHT 11 sensor	20
13.	Bluetooth module	30
14.	7 segment display	20
15.	DC toy motor	20
16.	Ultrasonic sensor	20
17.	Wifi module	20

COURSE CODE	COURSE TITLE	L	T	P	C
21CS313	APTITUDE AND CODING SKILLS – I	0	0	2	1

COURSE OBJECTIVES:

- To develop vocabulary for effective communication and reading skills.
- To build the logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.

List of Exercises:

1. **English – Phase I**

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering.

2. **Logical Reasoning – Phase I**

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency.

3. **Quantitative Ability - Phase I**

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability.

4. **Automata Fix – Phase I**

Logical, Compilation and Code reuse.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Develop vocabulary for effective communication and reading skills.

CO2: Build the logical reasoning and quantitative skills.

CO3: Develop error correction and debugging skills in programming.

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
21MA402	PROBABILITY AND RANDOM PROCESSES	3	2	0	4

COURSE OBJECTIVES:

- To determine the probability value of one dimensional random variables.
- To illustrate the concepts of covariance, correlation and regression.
- To describe the basic concepts of random processes.
- To discuss the knowledge of correlation and spectral densities.
- To employ the significance of linear systems with random inputs in signal processing.

UNIT I	**ONE DIMENSIONAL RANDOM VARIABLES**	**15**

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

UNIT II	**TWO DIMENSIONAL RANDOM VARIABLES**	**15**

Joint distributions – Marginal and Conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables.

UNIT III	**RANDOM PROCESSES**	**15**

Classification – Stationary process – Strictly stationary process – Wide sense stationary process Markov process – Markov chain – Poisson process – Random telegraph process.

UNIT IV	**CORRELATION AND SPECTRAL DENSITIES**	**15**

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

UNIT V	**LINEAR SYSTEMS WITH RANDOM INPUTS**	**15**

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

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamental knowledge of modern probability theory and standard distributions.

CO2: Categorize the probability models and function of random variables based on one and two dimensional random variables.

CO3: Demonstrate and apply the classification of random processes in engineering disciplines.

CO4: Apply the concepts of correlation functions and spectral densities.

CO5: Analyze the response of random inputs to linear time invariant systems.

TEXT BOOKS:

1. O.C. Ibe, Fundamentals of Applied Probability and Random Processes,2nd Edition, Elsevier, 2014..
2. P.Z. Peebles, Probability, Random Variables and Random Signal Principles, Tata McGraw Hill, 4th Edition, New Delhi, 2002.
3. R.D. Yates and D.J. Goodman, Probability and Stochastic Processes, Wiley India Pvt. Ltd., 3rd Edition, 2014.

REFERENCES:

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

COURSE CODE	COURSE TITLE	L	T	P	C
21EC401	COMMUNICATION SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

- To discuss the concepts of various analog modulation schemes and their spectral characteristics.
- To summarize various types of noises in communication system.
- To analyze the effect of noise in communication systems.
- To describe the concepts of sampling and quantization.
- To discuss the concepts of pulse modulation techniques.

UNIT I	AMPLITUDE MODULATION	09

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

UNIT II	ANGLE MODULATION	09

Phase and frequency modulation, Narrow Band and Wide band FM – Modulation index, Spectra, Power relations and Transmission Bandwidth - FM modulation –Direct and Indirect methods, FM Demodulation – FM to AM conversion, FM Discriminators - PLL as FM Demodulator

UNIT III	NOISE CHARACTERIZATION	09

Noise sources – Noise figure, noise temperature and noise bandwidth – Noise in cascaded systems. Hilbert Transform, Pre-envelope & complex envelope - Representation of Narrow band noise –In-phase and quadrature components, Envelope and Phase components.

UNIT IV	PERFORMANCE IN AM AND FM SYSTEMS	09

AM Super heterodyne Receiver - Noise performance analysis in AM systems, AM Threshold effect, FM Super heterodyne Receiver, Noise performance analysis in FM systems – FM Threshold effect, Pre- emphasis and de-emphasis for FM, Comparison of noise performance of AM and FM Systems.

UNIT V	PULSE MODULATION TECHNIQUES	09

Baseband sampling – Aliasing-Quantization - Uniform & non-uniform quantization - quantization noise - Logarithmic Companding – PAM, PPM, PWM, PCM – TDM, FDM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Compare different Amplitude Modulation Schemes for their efficiency and bandwidth.

CO2: Summarize the concepts of Angle Modulation Systems.

CO3: Explain different types of Noise in Communication Systems.

CO4: Analyze the behaviour of a communication system in presence of noise.

CO5: Summarize the principles of Sampling and Quantization.

CO6: Describe the concepts of Pulse modulation Techniques.

TEXT BOOKS:

1. J.G. Proakis, M. Salehi, Fundamentals of Communication Systems, Pearson Education 2014.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons, 2016.

REFERENCES:

1. B.P. Lathi, Modern Digital and Analog Communication Systems, 5th Edition, Oxford University Press, 2018.
2. D. Roody, J. Coolen, Electronic Communications, 4th edition, PHI 2012.
3. Sklar, Digital Communication: Fundamentals and Applications, 2nd Edition, Pearson Education India, 2014.
4. Couch.L., Modern Communication Systems, 8th Edition, Pearson, 2013.
5. H P Hsu, Schaum Outline Series, Analog and Digital Communications, 3rd Edition, TMH 2017.

NPTEL LINK:

https://nptel.ac.in/courses/117/102/117102059/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC402	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3

COURSE OBJECTIVES:

- To explain the Architecture of 8086 microprocessor.
- To summarize the design aspects of I/O and Memory Interfacing circuits.
- To interface microprocessors with supporting chips.
- To explain the Architecture of 8051 microcontroller.
- To demonstrate a microcontroller based system

UNIT I	8086 MICROPROCESSOR	09

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II	8086 SYSTEM BUS STRUCTURE	09

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor - Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III	INTERFACING MICROPROCESSOR	09

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.

UNIT IV	MICROCONTROLLER	09

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

UNIT V	INTERFACING MICROCONTROLLER	09

Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation – Introduction to PIC16X Microcontroller - Comparison of Microprocessor, Microcontroller, PIC microcontroller.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Acquire knowledge on the architecture of 8086 microprocessor and 8051 microcontroller.

CO2: Apply programming techniques in developing the assembly language program for microprocessor applications.

CO3: Analyze various types of interfacing devices with other peripheral devices.

CO4: Apply programming techniques in developing the assembly language program for microcontroller applications.

CO5: Design and Construct Memory Interfacing Circuits.

CO6: Design and construct Microprocessor and Microcontroller based systems.

TEXT BOOKS:

1. Yu-Cheng Liu, Glenn A.Gibson, Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design, 2nd Edition, Pearson, 2015.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2nd Edition, Pearson Education, 2011.

REFERENCES:

1. Doughlas V.Hall, Microprocessors and Interfacing, Programming and Hardware, TMH,2012.
2. A.K.Ray,K.M.Bhurchandi, Advanced Microprocessors and Peripherals 3rd Edition, Tata McGraw Hill, 2012.
3. Martin P Bates, Programming 8 – bit PIC Microcontroller in C with Interactive Hardware Simulation, Newnes, 2008.
4. Walter A Triebel and Avatar Singh, The 8088 and 8096 Microprocessors – Programming, Interfacing, Software, Hardware and Applications, 4th Edition, Pearson, 2007.
5. Scott MacKenzie, Raphael Chung-Wei Phan, The 8051 Microcontroller, 4th Edition, Pearson Education, 2008.

NPTEL LINK:

https://nptel.ac.in/courses/108/105/108105102/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC403	ELECTROMAGNETIC FIELDS	4	0	0	4

COURSE OBJECTIVES:

- To acquire knowledge on conceptual and basic mathematical understanding of three-dimensional coordinate systems using fundamental theorems.
- To analyze fields and potentials due to static electric charges.
- To evaluate static magnetic fields using basic laws.
- To summarize the concepts of coupling between the electric and magnetic fields under time varying conditions.
- To summarize the propagation of plane waves in lossless and lossy media.

UNIT I	INTRODUCTION TO VECTOR ALGEBRA	12

Review of Vector Algebra - Introduction to Co-ordinate Systems – Rectangular – Cylindrical and Spherical Co-ordinate Systems – Introduction to Line, Surface and Volume Integrals – Gradient, Divergence and Curl – Significance of Stokes theorem and Divergence theorem.

UNIT II	STATIC ELECTRIC FIELDS	12

Coulomb's Law in Vector Form – Electric Field Intensity – Principle of Superposition – Electric Field due to discrete charges and continuous charge distributions - Electric Field due to finite and infinite line, circular disc and infinite sheet of charge.

Electric Scalar Potential – Relationship between Potential and Electric field - Potential due to an infinite line and Electrical Dipole - Electric Flux Density – Gauss Law and its Applications. Poisson's and Laplace equations – Electric Polarization - Nature of dielectric materials- Capacitance – Capacitance of various geometries using Laplace equation – Electrostatic Energy and Energy Density – Boundary conditions for Electric Fields – Electric Current – Current Density – Point form of ohm's law – Continuity Equation for Current.

UNIT III	STATIC MAGNETIC FIELDS	12

Biot-Savart Law– Magnetic Field Intensity due to finite and infinite wire, circular and rectangular loop – Ampere's Circuital Law and its applications - Magnetic Flux Density.Lorentz Force Equation – Force on a differential current element, Force between current elements – Force and Torque on a closed loop – Magnetic Moment – Magnetic Vector Potential. Inductance – Inductance of loops and Solenoids – Mutual Inductance. Energy Density in Magnetic Fields – Nature of magnetic materials – Magnetization and Permeability - Magnetic boundary conditions.

UNIT IV	TIME VARYING ELECTRIC AND MAGNETIC FIELDS	12

Faraday's law, Displacement Current – Ampere's Circuital Law – Maxwell's Equation in Integral and Differential form - Maxwell's equation in Phasor form. Poynting Vector – Power Flow in a Co-axial cable – Instantaneous, Average and Complex Poynting Vector.

UNIT V	ELECTROMAGNETIC WAVES	12

Wave Equations and their solutions – Uniform Plane Waves – Wave equation in Phasor form – Plane waves in Free space and in Homogenous medium.

Wave equation for a conducting medium – Plane waves in lossy dielectrics – Propagation in good conductors – Skin effect.

Linear, Elliptical and Circular Polarization – Reflection of Plane Waves from a conductor – Normal incidence – Reflection of Plane Waves by a perfect dielectric – Normal incidence.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Demonstrate the understanding of three-dimensional coordinate systems.

CO2: Analyze fields and potentials due to static charges.

CO3: Analyze static magnetic fields.

CO4: Interpret Maxwell's equations in integral, differential and phasor forms and explain their physical meaning.

CO5: Explain electromagnetic wave propagation in lossless and lossy media.

CO6: Solve simple problems requiring estimation of electric and magnetic field quantities based on the above concepts.

TEXT BOOKS:

1. W.H.Hayt & J.A. Buck,Engineering Electromagnetics,9th Edition, TMH,2020.
2. Matthew N.O.Sadiku,Elements of Engineering Electromagnetics,7th Edition, Oxford University press 2018

REFERENCES:

1. E.C.Jordan & K.G. Balmain, Electromagnetic Waves and Radiating Systems, 2nd Edition, Pearson Education/PHI, 2015.
2. David K.Cheng, Field and Wave Electromagnetics, 2nd Edition Revised, Pearson Edition, 2013.
3. G.S.N. Raju, Electromagnetic Field Theory & Transmission Lines, Pearson Education, 2006.
4. David. J. Griffiths, Introduction to Electrodynamics, 4th Edition, Pearson Education, Noida, India, 2014.
5. Joseph Edminister, Mahmood Nahvi, Schaum's Outline of Electromagnetics, 5th Edition, McGraw-Hill Education, 2019.

NPTEL LINK:

https://nptel.ac.in/courses/117/103/117103065

COURSE CODE	COURSE TITLE	L	T	P	C
21EL301	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY	2	2	0	3

COURSE OBJECTIVES:

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

COURSE TOPICS:

The course has 28 lectures (2 lecture hours) and 14 practice sessions (2 Tutorial hour) in 5 Units:

UNIT I	Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

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

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

UNIT II	Understanding Harmony in the Human Being – Harmony in Myself!

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

6. Programs to ensure Sanyam and Health.

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

UNIT III	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**

1. 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
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension offamily): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and instituteas extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT IV	**Understanding Harmony in the Nature and Existence - Whole existence as coexistence**

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

Include practice sessions to discuss human being as cause of imbalance innature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics**

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate

technologies and management patterns for above production systems.

5. Case studies of typical holistic technologies, management models and production systems.
6. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

COURSE OUTCOMES:

By the end of the course, students

CO1: would become more aware of themselves, and their surroundings (family, society, nature);

CO2: would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

CO3: would have better critical ability.

CO4: Would become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

CO5: would be able to 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.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, ExcelBooks, NewDelhi, 2010

REFERENCES:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, 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 – Pandit Sunderlal
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 CODE	COURSE TITLE	L	T	P	C
21EC404	LINEAR INTEGRATED CIRCUITS	3	0	0	3

COURSE OBJECTIVES:

- To describe the characteristics of operational amplifiers.
- To design op–amp circuits for a variety of engineering applications.
- To outline the working principles of ADC and DAC
- To analyze the functions and applications of analog multipliers and PLL.
- To summarize the concepts of waveform generators and voltage regulators.

UNIT I BASICS OF OPERATIONAL AMPLIFIERS 09

Advantages of ICs over discrete components, Classification, Basic information about Op- Amps – Ideal Operational Amplifier - General Operational Amplifier stages and internal circuit diagrams of IC 741, DC and AC performance characteristics, CMRR, Slew Rate, Open and Closed loop configurations.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 09

. Basic Op-Amp Circuits: Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, Adder, Subtractor, Linear Applications: V-to-I and I-to-V Converters, Instrumentation Amplifier, Integrator, Differentiator, Non-linear Applications: Logarithmic Amplifier, Antilogarithmic Amplifier, Comparators, Schmitt trigger, Active Filters: Low- Pass, High-Pass and Band-Pass Butterworth Filters.

UNIT III ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 09

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current Mode R-2R Ladder types

- switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.

UNIT IV ANALOG MULTIPLIER AND PLL 09

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell –Variable transconductance technique, Analog Multiplier ICs and their applications, PLL: Operation of the basic PLL, Closed loop analysis, Voltage Controlled Oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization.

UNIT V	WAVEFORM GENERATORS AND VOLTAGE REGULATORS	09

Waveform generators: Sine-wave generators, Square wave, Triangular wave generator, Saw- tooth wave generator, IC 555 Timer: Monostable operation and its applications, Astable operation and its applications. IC Voltage regulators: Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low DropOut (LDO) Regulators - Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe the significance and applications of Integrated Circuits.

CO2: Demonstrate various Mathematical Circuit applications using IC 741.

CO3: Classify and comprehend the working principle of Data Converters.

CO4: Apply the Analog Multiplier and Phase Locked Loop for recent applications.

CO5: Design Waveform Generators using Op-amp circuits and analyze IC 555 Timers.

CO6: Demonstrate the use of IC regulators and Low dropout regulators for voltage regulation applications.

TEXT BOOKS:

1. D.Roy Choudhry, Shail B Jain, Linear Integrated Circuits, 5th Edition, New Age International Pvt. Ltd., 2020.
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, TMH, 2016.

REFERENCES:

1. Ramakant A. Gayakwad, Op-amp and Linear ICs, 4th Edition, Prentice Hall / Pearson Education, 2015.
2. Robert F.Coughlin, Frederick F.Driscoll, Operational Amplifiers and Linear Integrated Circuits, 6th Edition, PHI, 2015.
3. Gray and Meyer, Analysis and Design of Analog Integrated Circuits, 5th Edition, Wiley International, 2009.
4. William D.Stanley, Operational Amplifiers with Linear Integrated Circuits, 4th Edition, Pearson Education,2004.
5. Salivahanan S and Kanchana Bhaaskaran V S, Linear Integrated Circuits, 3rd Edition, McGraw Hill Education, 2018.

NPTEL LINK:

ttps://nptel.ac.in/courses/108/108/108108111/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC411	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To familiarize Assembly Language Program concepts, features and Coding methods.
- To write Assembly Language Program for arithmetic and logical operations in 8086.
- To differentiate Serial and Parallel Interface.
- To write Assembly Language Program for arithmetic and logical operations in 8051.
- To interface different I/Os with Microprocessors.

LIST OF EXPERIMENTS:

8086 Programs

1. Basic arithmetic and Logical operations
2. Move a data block without overlap
3. Code conversion and decimal arithmetic.
4. Sorting and searching

8051 Experiments

5. Basic arithmetic and Logical Operations
6. Square and cube program
7. Find 2‘s complement of a number
8. Unpacked BCD to ASCII

Interfacing Experiments of 8086/8051

9. Traffic light controller
10. Key board and Display - 8279
11. Programmable Timer - 8253/8254
12. Programmable peripheral Interface - 8255
13. A/D and D/A interface
14. Stepper motor control
15. Serial Communication between two kits

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Write ALP Programs for Arithmetic and logical operations.

CO2: Analyze to interface different I/Os with processor.

CO3: Analyze waveforms using Microprocessors.

CO4: Write programs in 8051.

CO5: Demonstrate to interface different I/Os with Microcontroller.

CO6:Demonstrate to perform serial communications between two kits

LIST OF EQUIPMENT:		
Sl.No.	**Description of Equipment**	**Quantity**
1.	8086 Microprocessor trainer kit with power supply	15
2.	8051Microcontroller trainer kit	15
3.	Traffic light control interfacing card compatible with 8086 & 8051kits	5
4.	Stepper motor control interfacing compatible with 8086 & 8051kits	5
5.	Digital clock interfacing board compatible with 8086 & 8051kits	5
6.	Keyboard & Display interface board compatible with 8086&8051kits	5
7.	Printer interfacing card compatible with 8086& 8051kits	5
8.	A/D and D/A Interfacing card compatible with 8086 & 8051kits	5
9.	Serial and Parallel interfacing card compatible with 8086 & 8051 kits	5
10.	Programmable Timer interfacing board compatible with 8086 & 8051kits	5

COURSE CODE	COURSE TITLE	L	T	P	C
21EC412	LINEAR INTEGRATED CIRCUITS LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To describe the characteristics of operational amplifiers.
- To apply operational amplifiers in linear and nonlinear applications.
- To analyze the characteristics of oscillators.
- To acquire the basic knowledge of special function IC.
- To simulate operational amplifier circuits using PSPICE.

LIST OF EXPERIMENTS:

DESIGN AND TESTING OF

1. Inverting, Non inverting and differential amplifiers.
2. Integrator and Differentiator.
3. Instrumentation amplifier using Op-amp
4. Active low-pass, High-pass and band-pass filters.
5. Astable & Monostable multivibrators using Op-amp
6. Schmitt Trigger using Op-amp.
7. Phase shift and Wien bridge oscillators using Op-amp.
8. Astable and Monostable multivibrators using NE555 Timer.
9. R-2R Ladder Type D- A Converter using Op-amp.
10. DC power supply using LM723.

SIMULATION USING SPICE:

1. Integrator/Differentiator using op-amp.
2. Active low-pass, High-pass and band-pass filters using Op-amp.
3. Astable and Monostable multivibrators using NE555 timer.
4. Schmitt trigger using Op-amp.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze operational amplifiers in linear and nonlinear applications.

CO2: Design Amplifiers, Oscillators, D-A converters using Operational Amplifiers.

CO3: Design Filters using Op-Amp and performs an experiment on frequency response.

CO4: Design Voltage Regulators and DC power supply using ICs.

CO5: Analyze the performance of Filters using PSPICE.

CO6: Analyze the performance of Multivibrators using PSPICE.

LIST OF EQUIPMENT		
Sl.No.	**Description of Equipment**	**Quantity**
1.	CRO/DSO(Min30MHz)	15
2.	Signal Generator /Function Generators(2MHz)	15
3.	Dual Regulated Power Supplies (0-30V)	15
4.	Digital Multimeter	15
5.	IC tester	5
6.	Stand-alone desktops PC with SPICE Circuit Simulation Software: (any public domain or commercial software)	15
7.	Components and Accessories: Transistors, Resistors, Capacitors, diodes, Zener diodes, Bread Boards, Transformers, wires, Power transistors, Potentiometer, A/D and D/A convertors, LEDs Note: Op amps uA741, LM 301, LM311, LM 324, LM317, LM723, 7805, 7812, 2N3524, 2N3525, 2N3391,AD 633, LM 555, LM 565 may be used.	50

COURSE CODE	COURSE TITLE	L	T	P	C
21EC413	MINI PROJECT AND INDUSTRIAL INTERNSHIP	0	0	2	1

COURSE OBJECTIVES:

- To define, formulate and analyze real world problem in the field of Electronics and Communication
- To acquire knowledge in terms of innovation and product design development process of the project.
- To interpret and associate the team members to work as a team efficiently.
- To create an Industrial environment and culture within the institution.
- To develop a professional attitude towards appearance and behavior in the workplace, time management skills and the ability to prioritize assignments**.**

MINI PROJECT

1. Students should select a problem which addresses some basic home, office or other real life applications.
2. The electronic circuit for the selected problem should have at least 20 to 25 components.
3. Students should understand testing of various components.
4. Soldering of components should be carried out by students.
5. Students should develop a necessary PCB for the circuit.
6. Students should see that final circuit submitted by them is in working condition.
7. 5-10 pages report to be submitted by students.
8. Group of maximum three students can be permitted to work on a single mini project.
9. The mini project must have hardware part. The software part is optional.
10. Department may arrange demonstration with poster presentation of all mini projects developed by the students at the end of semester.
11. It is desirable that the electronic circuit/systems developed by the students have Some novel features.

INTERNSHIP

An internship is the form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in a professional setting. The students can opt for internship in any industry/academic institute/R&D/PSU/Government or semi-government organizations. This caters students, the opportunity to gain valuable applied experience and explore networks in professional fields they are considering for career paths; and give employers the opportunity to guide and evaluate talent.

This will not only help students in gaining professional know-how but also benefits, corporate on fresh perspectives on business issues and even discovering future business leaders

Course Evaluation

Miniproject	Weight
Project final report	30%
Presentation/Simulation/ Demonstration	30%
Internship completion Certificate from company	20%
Vivavoce	20%

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Solve the real time problems using hardware, software, Computational tools.

CO2: Integrate software and the assembled components in the designed PCB.

CO3: Summarize the knowledge inferred through technical report.

CO4: Communicate a practical understanding of how a business organization actually operates.

CO5: Exhibit the ability to effectively work in a professional environment and demonstrate work ethic and commitment in a work-based environment.

CO6: Reflect on personal and professional development needs and set strategic goals for advancing along an intended career path.

COURSE CODE	COURSE TITLE	L	T	P	C
21CS414	APTITUDE AND CODING SKILLS – II	0	0	2	1

COURSE OBJECTIVES:

- To develop advanced vocabulary for effective communication and reading skills.
- To build an enhanced level of logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.
- To apply data structures and algorithms in problem solving.

List of Exercises:

1. **English – Phase II**

   Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. **Logical Reasoning – Phase II**

   Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. **Quantitative Ability - Phase II**

   Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability

4. **Automata Fix – Phase II**

   Logical, Compilation and Code reuse

5. **Automata - Phase II**

   Data Structure Concepts: Array and Matrices, Linked list, String processing and manipulation, Stack/Queue, Sorting and Searching

   Advanced Design and Analysis Techniques: Greedy Algorithms, Minimum Spanning Trees, String Matching, Divide and Conquer, Computational Geometry

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Develop advanced vocabulary for effective communication and reading skills.

CO2: Build an enhanced level of logical reasoning and quantitative skills.

CO3: Develop error correction and debugging skills in programming.

CO4: Apply data structures and algorithms in problem solving.

SEMESTER V

COURSE CODE	COURSE TITLE	L	T	P	C
21EC501	DIGITAL COMMUNICATION	3	0	0	3

COURSE OBJECTIVES:

- To study the limits set by information theory
- To familiarize with the various waveform coding schemes
- To learn the functional behavior of various baseband transmission schemes
- To compare the performance metrics of various bandpass signaling schemes
- To illustrate the error correction and detection capabilities of various channel coding techniques.

UNIT I	**INFORMATION THEORY**	**9**

Discrete Memoryless source, Information, Entropy, Mutual Information - Discrete -Memoryless channels - Binary Symmetric Channel, Channel Capacity - Hartley - Shannon law - Source coding theorem - Shannon - Fano & Huffman codes.

UNIT II	**WAVEFORM CODING AND REPRESENTATION**	**9**

Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles - Linear Predictive Coding - Properties of Line codes - Power Spectral Density of Unipolar / Polar RZ & NRZ - Bipolar NRZ - Manchester.

UNIT III	**BASEBAND TRANSMISSION AND RECEPTION**	**9**

ISI - Nyquist criterion for distortion less transmission - Pulse shaping - Correlative coding - Eye pattern - Receiving Filters - Matched Filter, Correlation receiver, Adaptive Equalization.

UNIT IV	**DIGITAL MODULATION SCHEME**	**9**

Geometric Representation of signals - Generation, detection, Timing Extraction, PSD & BER of Coherent BPSK, BFSK & QPSK - QAM - Carrier Synchronization - Timing Synchronization - Structure of Non-coherent Receivers - Principle of DPSK.

UNIT V	**ERROR CONTROL CODING**	**9**

Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Describe the concepts of information theory and coding

CO2: Compare the various waveform coding techniques

CO3: Describe the baseband transmission and reception schemes

CO4: Illustrate the different digital modulation schemes and equalization techniques

CO5: Determine PSD and BER of various digital modulation schemes

CO6: Construct different error control codes

TEXT BOOKS:

1. Haykin S, Digital Communications, John Wiley, 2005.
2. Sklar B, Digital Communication Fundamentals and Applications, Pearson Education, 2nd Edition, 2009.

REFERENCES:

1. Proakis J.G, Digital Communication, Tata Mc Graw Hill Company, 5th Edition, 2018.
2. Lathi B. P, Modern Digital and Analog Communication Systems, Oxford University Press, 3rd Edition, 2007.
3. Hsu H.P, Schaum's Outline Series – Analog and Digital Communications, Tata Mc Graw Hill Company, 3rd Edition, 2006.
4. Roody D, Coolen J, Electronic Communications, PHI, 4th Edition, 2006.
5. Wayne Tomasi - Electronic Communication Systems, Pearson Education India, 2008.

NPTEL LINKS:

https://nptel.ac.in/courses/108/102/108102120/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC502	TRANSMISSION LINES AND WAVE GUIDES	3	0	0	3

COURSE OBJECTIVES:

- To introduce the various types of transmission lines and its characteristics.
- To provide thorough understanding about high frequency line, power and impedance measurements.
- To solve different transmission line problems using smith chart
- To understand the characteristics of TE,TM,TEM waves in Parallel planes.
- To give insight on different types of waveguides and distribution of electromagnetic fields within waveguides using Maxwell's equations.

UNIT I	INTRODUCTION TO TRANSMISSION LINE THEORY	9

Common types of transmission lines , General theory of Transmission lines– A line of cascaded T sections ,Transmission line -general solution , The infinite line – Wavelength, velocity of propagation – Waveform distortion – the distortion less line – Line not terminated in Z_0 – Reflection coefficient – calculation of current, voltage, power delivered and efficiency of transmission – Input and Transfer impedance – Open and short circuited lines – Reflection factor and Reflection loss.

UNIT II	HIGH FREQUENCY TRANSMISSION LINES	9

Transmission line equations at radio frequencies – Line of Zero dissipation – Voltage and current on the dissipation less line, Standing Waves, Nodes, Standing Wave Ratio – Input impedance of the dissipation less line – Open and short circuited lines – Power and impedance measurement on lines – Reflection losses – Measurement of VSWR and wavelength.

UNIT III	IMPEDANCE MATCHING IN HIGH FREQUENCY LINES	9

Impedance matching: Quarter wave transformer – Half wave transformer- Impedance matching by stubs – Single stub and double stub matching – Smith chart – Solutions of problems using Smith chart.

UNIT IV	GUIDED WAVES BETWEEN PARALLEL PLANES	9

Application of the restrictions to Maxwell's equations – Transmission of TM waves between Parallel planes – Transmission of TE waves between Parallel planes. Transmission of TEM waves between Parallel planes – Manner of wave travel. Velocities of the waves – characteristic impedance - Attenuators.

UNIT V	WAVE GUIDES	9

Application of Maxwell's equations to the rectangular waveguide. TM waves in Rectangular guide. TE waves in Rectangular waveguide – Cylindrical waveguides- Characteristics of wave guide- guide wavelength, cut off wavelength, cut off frequency, wave impedance, phase constant, phase velocity, group velocity, Excitation of different modes in waveguides. Rectangular and Circular Cavity Resonators.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Solve transmission line equations and its parameters.
CO2: Explain signal propagation at Radio frequencies.
CO3: Illustrate impedance matching by stubs using smith charts.
CO4: Investigate the field components of TE, TM, TEM waves in Parallel planes.
CO5: Examine the field components of TE, TM waves in Rectangular and Circular waveguides.

CO6: Discuss the principle of cavity resonators

TEXT BOOKS:

1. John D Ryder, Networks lines and fields, 2nd Edition, Pearson,2015.
2. David K. Cheng, Field and Wave Electromagnetics, 2nd Edition, Pearson, Noida, India,2014.

REFERENCES:

1. Edward C. Jordon and Keith G. Balmain, Electromagnetic waves and Radiating systems, 2nd Edition, PHI, New York, USA,2015.
2. G.S.N Raju Electromagnetic Field Theory and Transmission Lines, 4th Edition, Pearson Education, 2013.
3. Joseph Edminister, Electromagnetics, TMH, 3rd Edition, Schaum's Series, 2017.
4. Umesh Sinha, Transmission Lines and Networks, Filters & Transmission Lines, Sathya Prakash, 2010.
5. Ulaby F.T, Michelson E and Ravaioli U, Fundamentals of Applied Electromagnetics, 6th Edition, Pearson Education, 2015.

NPTEL LINK:

https://nptel.ac.in/courses/117/101/117101056/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC503	VLSI DESIGN (LAB INTEGRATED)	3	0	2	4

COURSE OBJECTIVES:

- To study the fundamental principles of VLSI circuit design in digital domain
- To learn the design and realization of combinational and sequential digital circuits.
- To summarize architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology
- To learn the different FPGA architectures and testability of VLSI circuits
- To learn Hardware Descriptive Language (Verilog/VHDL) and to familiarize fusing of logical modules on FPGAs

UNIT I	INTRODUCTION TO MOS TRANSISTOR	15

MOS Transistor, CMOS logic, Inverter, Layout Design Rules, Gate Layouts, Stick Diagrams, Long-Channel I-V Characteristics, C-V Characteristics, Non ideal I-V Effects, DC Transfer characteristics, RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, Parasitic Delay, Delay in Logic Gate, Scaling.

LIST OF EXPERIMENTS

1. Design of Inverter using LT-SPICE
2. Layout verification of CMOS Inverter, NOR and NAND gates

UNIT II	COMBINATIONAL MOS LOGIC CIRCUITS	15

Circuit Families: Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL, CMOS Power Dissipation. Design of combinational circuits using Verilog.

LIST OF EXPERIMENTS

3. Design of Adder and subtractor
4. Design of Multiplexer and demultiplexer

UNIT III	SEQUENTIAL CIRCUIT DESIGN	15

Static latches and Registers, Dynamic latches and Registers, Pulse Registers, Pipelining, Schmitt Trigger, Monostable Sequential Circuits, Astable Sequential Circuits. Timing Issues: Timing Classification Of Digital System, Synchronous Design, Design of sequential circuits using Verilog.

LIST OF EXPERIMENTS

5. Design of Flipflops
6. Design of Counter
7. Design Of Universal Shift Register
8. Design of Mealy and Moore State Machines
9. Design Of Random Access Memory

UNIT IV	DESIGN OF ARITHMETIC BUILDING BLOCKS AND SUBSYSTEM	15

Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed tradeoffs, Designing Memory and Array structures: Memory Architectures and Building Blocks, Memory Core, Memory Peripheral Circuitry.

LIST OF EXPERIMENTS

10. Design of Arithmetic Logic Unit
11. Design of Ripple carry adder

12. Design of Carry select adder

13. Design of Multiplier

UNIT V	IMPLEMENTATION STRATEGIES AND TESTING	15

FPGA Building Block Architectures, FPGA Interconnect Routing Procedures. Design for Testability: Ad Hoc Testing, Scan Design, BIST, IDDQ Testing, Boundary Scan

TOTAL: 45 PERIODS(THEORY) +30 PERIODS (LAB)=75 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the fundamental principles of VLSI circuit design in digital domain

CO2: Realize the combinational circuits using different logic families

CO3: Understand the memory design in sequential logic circuits

CO4: Analyze the architectural choice and performance tradeoff involved in datapath unit design.

CO5: Understand the different FPGA architectures and its testing

CO6: Design, Simulate to verify the functionality of logic modules using EDA tools and familiarize fusing of logical modules on FPGAs

TEXT BOOKS:

1. Neil H.E. Weste, David Money Harris CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, Pearson , 2017.

2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje. Nikolic, Digital Integrated Circuits: A Design perspective, 2nd Edition , Pearson , 2016.

REFERENCES:

1. M.J. Smith, Application Specific Integrated Circuits‖, Addisson Wesley, 1997.

2. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim ―CMOS Digital Integrated Circuits: Analysis & Design, 4th Edition McGraw Hill Education,2013.

3. Wayne Wolf, Modern VLSI Design: System On Chip, Pearson Education, 2007.

4. John F walkerly, Digital Design Principles and Practices, 3rd Edition., PHI/Pearson Education, 2005.

5. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall PTR, 2nd Edition,2003

NPTEL LINKS:

https://onlinecourses.nptel.ac.in/*noc21*_ee09/preview

LIST OF EQUIPMENT:

Requirements for a batch of 30 students

Sl.No.	Equipment	Quantity
1	Xilinx ISE/Altera Quartus/ equivalent EDA Tools	10
2	Xilinx/Altera/equivalent FPGA Boards	10
3	Cadence/Synopsis/ Mentor Graphics/Tanner/equivalent EDA Tools	10
4	Personal Computer	30

COURSE CODE	COURSE TITLE	L	T	P	C
21EC511	COMMUNICATION SYSTEMS LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To measure the parameters of analog modulation techniques.
- To visualize the effects of multiplexing in time domain.
- To learn the performance of Pulse Modulation schemes.
- To implement the various Digital Modulation schemes.
- To simulate Error control coding schemes.

S.NO.	LIST OF EXPERIMENTS
1.	AM Modulator and Demodulator
2.	FM Modulator and Demodulator
3.	Time Division Multiplexing
4.	Signal Sampling and reconstruction
5.	Pulse Code Modulation and Demodulation
6.	Delta Modulation and Demodulation
7.	Line coding schemes
8.	Simulation of ASK, FSK, and BPSK generation and detection schemes
9.	Simulation of DPSK, QPSK and QAM generation schemes
10.	Simulation of signal constellations of BPSK, QPSK and QAM
11.	Simulation of Linear Block and Cyclic error control coding schemes
12.	Simulation of Convolutional coding scheme

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion, the student will be able to

CO1: Practice Analog Modulation techniques.

CO2: Implement sampling theorem and Time Division Multiplexing

CO3: Analyze the characteristics of Digital Modulation techniques.

CO4: Demonstrate different Line Coding Schemes.

CO5: Simulate Various Digital modulation Schemes.

CO6: Test Error Control Coding Schemes in Communication System.

LIST OF EQUIPMENT:

Sl. No.	Equipment	Quantity
1.	Kits for Signal Sampling, TDM, AM, FM, PCM, DM and Line Coding Schemes	2(Each)
2.	CROs/DSOs	15
3.	Function Generators	15
4.	MATLAB/SCILAB or equivalent freeware package for simulation experiments	15
5.	PCs	15

COURSE CODE	COURSE TITLE	L	T	P	C
21EC512	COURSE BASED PROJECT I	0	0	2	1

COURSE OBJECTIVES:

- To Provide adequate understanding of project/product concepts and creative design process
- Create a methodology to develop solution to the complex systems.

LIST OF EXPERIMENTS

1. Implementation of Design Process.
2. Present the product idea.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop their Intellectual skills to understand concepts, rules or procedures.

CO2: Develop their cognitive strategy to think, organize, learn and behave.

CO3: Demonstrate the ability to provide conceptual design strategies for a product.

CO4: Describe procedure for designing of prototype.

CO5**:** Recognize interdisciplinary strategies for solving complex problems.

CO6: Apply integrative strategies for solving complex problems.

LIST OF EQUIPMENTS

S.NO	EQUIPMENT NAME	QUANTITY
1.	CNC Router	1 No
2.	3D Printer	1 No
3.	3D Scanner	1 No
4.	Laser Cutting Machine	1 No
5.	Centre lathe	2 Nos
6.	Arc Welding transformer with cables and holders	2 Nos
7.	Plumbing tools	2 Sets
8.	Carpentry Tools	2 Sets
9.	Multimeter	10 Nos
10.	Drilling Machine	1 No
11.	Solder Stations	5 Sets
12.	Desoldering Machine	1 No
13.	PCB Milling Machine	1 No
14.	Variable Power Supply	1 No
15.	Electronic Components like Resistors, Transistors, Diode, Inductor, Capacitors, IC etc.,	10 Sets
16.	Personal Desktop Computers	30 Nos

COURSE CODE	COURSE TITLE	L	T	P	C
21CS512	ADVANCED APTITUDE AND CODING SKILLS – I	0	0	2	1

COURSE OBJECTIVES:

- To develop vocabulary for effective communication and reading skills.
- To build the logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.

LIST OF EXERCISES

1. ENGLISH – PHASE I ADVANCED

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering.

2. LOGICAL REASONING – PHASE I ADVANCED

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency.

3. QUANTITATIVE ABILITY - PHASE I ADVANCED

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability.

4. AUTOMATA FIX – PHASE I ADVANCED

Logical, Compilation and Code reuse

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop vocabulary for effective communication and reading skills.

CO2: Build the logical reasoning and quantitative skills.

CO3: Develop error correction and debugging skills in programming.

SUGGESTED BOOKS AND RESOURCES:

1. https://prepinsta.com/home/
2. https://www.hackerrank.com/
3. https://www.indiabix.com/
4. "A Modern Approach to Verbal & Non-Verbal Reasoning" by R.S. Agarwal
5. "Quantitative Aptitude for Competitive Examinations" by RS Agarwal/ S Chand
6. "A Modern Approach to Logical Reasoning" by R.S. Agarwal
7. "The C Programming Language" by Brian Kernighan and Dennis Ritchie
8. "Java: A Beginner's Guide" by Herbert Schildt

SEMESTER VI

COURSE CODE	COURSE TITLE	L	T	P	C
21EC601	DISCRETE TIME SIGNAL PROCESSING	2	2	0	3

COURSE OBJECTIVES:

- To learn Discrete Fourier Transform and Fast Fourier Transform.
- To describe the characteristics of IIR filters and design IIR filters for given specification.
- To familiarize different design methods available for FIR filters and its realization structures.
- To explain the effects of finite precision representation on digital filters.
- To discuss the effect of quantization on digital filters.
- To classify the characteristics and architectural features of Digital Signal Processors.

UNIT I	DISCRETE FOURIER TRANSFORM	12

DFT and its properties – Periodicity, Symmetry and Circular Convolution - FFT algorithms - Radix-2 DIT FFT, Radix-2 DIF FFT - Overlap-add & overlap-save methods.

UNIT II	INFINITE IMPULSE RESPONSE FILTERS	12

Analog filters – Butterworth filters, Chebyshev Type I filters (upto 3rd order), Analog Transformation of prototype LPF to BPF /BSF/ HPF, Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method- Realization structures for IIR filters - direct, cascade, parallel forms.

UNIT III	FINITE IMPULSE RESPONSE FILTERS	12

Design of linear phase FIR filters using Fourier series, Windowing and Frequency sampling methods – Rectangular, Hamming and Hanning - Realization structures for FIR filters – Transversal and Linear phase structures - Comparison of FIR & IIR filters.

UNIT IV	FINITE WORD LENGTH EFFECTS	12

Fixed point and floating-point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

UNIT V	DIGITAL SIGNAL PROCESSORS	12

DSP Architectures Harvard, VonNeuman, VLIW - Types of Digital Signal Processors - Pipelining - Multiply and accumulate unit - TMS 320C5X DSP architecture and addressing modes.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Compute DFT for the given sequence.

CO2: Realise IIR filters for given specification.

CO3: Realise FIR filters using different methods.

CO4: Illustrate the effects of finite precision representation on digital filters.

CO5: Interpret the effect of quantization on digital filters.

CO6: Summarize the characteristics and architectural features of Digital Signal Processors.

TEXT BOOKS:

1. John G. Proakis, Dimitris G. Manolakis, Digital signal processing - principles, algorithms and applications, Pearson Education, Fourth Edition, 2007.
2. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete Time Signal Processing , Pearson, Eighth Indian Reprint, 2004.

REFERENCES:

1. I.C.Ifeachor and B.W. Jervis, Digital Signal Processing A Practical Approach, Pearson, Wiley & sons, Singapore, 2002.
2. M.H.Hayes, Digital Signal Processing, Schaum's outlines, Tata McGraw Hill, 2007.
3. A. NagoorKani, Digital Signal Processing , McGraw Hill Education,Second Edition, 2017.
4. Salivahanan S, Digital Signal Processing, McGraw Hill Education, Fourth Edition, 2019.
5. Andreas Antoniou,Digital Signal Processing, Tata Mc Graw Hill, 2006.

NPTEL LINK:

https://nptel.ac.in/courses/117/102/117102060/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC602	ANTENNA AND WAVE PROPAGATION	3	0	0	3

COURSE OBJECTIVES:

- To give insight of the fundamental characteristics and parameters of antennas.
- To give a thorough understanding of the radiation characteristics of different types of HF and VHF antennas.
- To understand operating principles and design concepts of antenna arrays.
- To design & analyze microwave frequency antennas and also to bring awareness of antenna applications in various types of communication.
- To create an awareness about the different types of propagation of radio waves at different frequencies.

UNIT I	FUNDAMENTALS OF RADIATION	9

Definition of antenna parameters – Radiation Pattern, Gain, Directivity, Radiation Resistance, Effective aperture, Effective length, Band width, Beam width, Input Impedance, Polarization, Baluns, Antenna temperature, Frii's Transmission formula.

UNIT II	HF AND VHF ANTENNAS	9

Wire Antennas, Short dipole, Halfwave dipole, Folded dipole, V-antenna, Rhombic antenna, Loop antenna, Yagi-Uda antenna

UNIT III	ANTENNA ARRAYS	9

Two element array, N element linear array, Broadside and End fire array, Pattern multiplication, Non-uniform excitation- Binomial array, Chebyshev array, Concept of Phased arrays, Adaptive array, Smart antenna.

UNIT IV	UHF AND MICROWAVE ANTENNAS	9

Principle of frequency independent antennas –Spiral antenna, Helical antenna, Log periodic antenna. Radiation from rectangular apertures, Horn antenna, Reflector antenna, Slot antennas, Micro strip antenna, EBG structure, Frequency Reconfigurable antennas, Dielectric antennas.

UNIT V	PROPAGATION OF RADIO WAVES	9

Modes of propagation, Structure of atmosphere, Ground wave propagation, Space wave propagation, Tropospheric propagation, Sky wave propagation, Ionospheric propagation-Structure of Ionosphere, Skip distance, Virtual height, critical frequency, Maximum usable frequency.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify basic antenna parameters and contrast radiation pattern of antenna.

CO2: Comprehend the radiation mechanism of wired antennas and dipoles.

CO3: Design and analyze antenna arrays.

CO4: Design and analyze special antennas such as frequency independent and aperture antennas.

CO5: Identify the type of radio-wave propagation for different communication.

CO6: Appropriate identification of an antenna for a specific application.

TEXT BOOKS:

1. J. D. Krauss, R. J. Marhefka and A. S. Khan, Antenna and Wave Propagation, 4th Edition, Tata McGraw-Hill, New Delhi, India,2012.
2. Warren L. Stutzman and Gary A. Thiele, Antenna theory and Design, 3rd Edition, Wiley & Sons, New York, USA, 2013.

REFERENCES:

1. Edward C. Jordan and Keith G. Bal main, Electromagnetic Waves and Radiating Systems, 2nd Edition ,Prentice Hall of India, 2015.
2. Constantine.A.Balanis, Antenna Theory Analysis and Design, 3rd Edition, Wiley & Sons, New York, USA, 2016.
3. Rajeswari Chatterjee, Antenna Theory and Practice, 2nd Edition, New Age International Publishers, 2006.
4. Robert S. Elliott Antenna Theory and Design Wiley Student Edition, 2006.
5. Albert Sabban, Wideband RF Technologies and Antennas in Microwave Frequencies, Wiley, New York USA, 2016.

NPTEL LINKS:

https://onlinecourses.nptel.ac.in/noc22_ee22/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC603	EMBEDDED SYSTEMS (LAB INTEGRATED)	3	0	2	4

COURSE OBJECTIVES:

- Be familiar with the embedded computing platform design and analysis.
- Learn the architecture, programming and working of ARM processor.
- Be exposed to the basic concepts of real time operating system and scheduling.
- Be familiar with different applications of embedded system
- To learn the applications of embedded systems in various domains.

UNIT I	INTRODUCTION TO EMBEDDED SYSTEM DESIGN	15

Complex systems and microprocessors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques -Designing with computing platforms – consumer electronics architecture –platform-level performance analysis.

LIST OF EXPERIMENTS

1. Study of ARM Microcontroller and Evaluation system.
2. Interfacing LEDs and stepper motor

UNIT II	ARM PROCESSOR AND PERIPHERALS	15

ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

LIST OF EXPERIMENTS

3. Interfacing LED and PWM using ARM
4. Interfacing UART and I2C

UNIT III	EMBEDDED PROGRAMMING	15

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing..

LIST OF EXPERIMENTS

5. Interfacing ADC using ARM.
6. Interfacing DAC using ARM.

UNIT IV	PROCESSES AND OPERATING SYSTEMS	15

Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes –Example Real time operating systems-POSIX-Windows CE – Distributed embedded systems.

LIST OF EXPERIMENTS

7. Introduction to Free RTOS.org.
8. Creating multiple tasks and perform Scheduling algorithm using Free RTOS.

UNIT V	APPLICATIONS OF EMBEDDED SYSTEMS	15

Data compressor - Alarm clock - Audio player - Software Modem-Digital still camera Telephone answering machine-Engine control unit – Video accelerator.

LIST OF EXPERIMENTS

9. Interfacing real time clock and serial port.
10. Interfacing keyboard and LCD

TOTAL: 45 PERIODS(THEORY) +30 PERIODS (LAB)=75 PERIODS

COURSE OUTCOMES:

CO1: Acquire knowledge on basic components of embedded system design.

CO2: Analyze and discuss the issues in designing sequential logic circuits.

CO3: Design of arithmetic building blocks.

CO4: Understand the logic of Testing of ICs.

CO5:Illustrate the various applications of Embedded Systems

CO6: To anlayze the results of logic and timing simulations and to use theses simulation results to debug digital systems.

TEXT BOOKS:

1. Marilyn Wolf, Computers as Components, Principles of Embedded Computing System Design, 4th Edition, Morgan Kaufmann Publisher (An imprint from Elsevier), 2016.
2. Alexander G. Dean, Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach, ARM Education media, Paperback,2017

REFERENCES:

1. LylaB. Das, Embedded Systems: An Integrated Approach Pearson Education, 2013.
2. JonathanW.V alvano, Embedded Microcomputer Systems Real Time Interfacing, 2nd Edition Cengage Learning,2012.
3. Raymond J.A.Buhr, DonaldL. Bailey, An Introduction to Real-Time Systems-From Design to Networking with C/C++, PrenticeHall,1999.
4. C.M.Krishna, Kang G. Shin, Real-time Systems, International Editions, McGraw Hill 1997
5. Sriram V Iyer, Pankaj Gupta, Embedded Real Time Systems Programming, Tata McGraw Hill, 2017.

NPTEL LINKS:

https://nptel.ac.in/courses/106/105/106105193/

LIST OF EQUIPMENTS:

Requirements for a batch of 30 students

Sl. No.	Equipment	Quantity
1.	Embedded trainer kits with ARM board	10

COURSE CODE	COURSE TITLE	L	T	P	C
21EC611	DIGITAL SIGNAL PROCESSING LABORATORY	0	0	4	2

COURSE OBJECTIVES:

- To generate basic Discrete-Time signals using MATLAB.
- To perform basic signal processing operations such as Linear convolution, Circular convolution, Auto correlation, Cross correlation and Frequency analysis in MATLAB
- To implement FIR filters in MATLAB and DSP processor.
- To implement IIR filters in and DSP MATLAB processor.
- To study the architecture of DSP processor.
- To perform MAC operation in DSP processor using various addressing modes..

LIST OF EXPERIMENTS

MATLAB / EQUIVALENT SOFTWARE PACKAGE

1. Generation of elementary Discrete-Time sequences.
2. Linear and Circular convolutions.
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT.
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation.
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations.

DSP PROCESSOR BASED IMPLEMENTATION

1. Study of architecture of Digital Signal Processor.
2. Perform MAC operation using various addressing modes.
3. Generation of various signals and random noise.
4. Design and demonstration of FIR and IIR Filters.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Simulate various discrete time signals
CO2: Analyse frequency response for the given system
CO3: Implement digital filters in DSP
CO4: Apply convolution and correlation in various applications of DSP
CO5: Implement DSP systems using DSP processor
CO6: Develop DSP based systems for various signal processing applications

SUGGESTED BOOKS AND RESOURCES:

1. http://vlabs.iitkgp.ernet.in/dsp/
2. John G. Proakis, Dimitris G. Manolakis, Digital signal processing - principles, algorithms and applications, Pearson Education, Fourth Edition, 2007.
3. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete Time Signal Processing , Pearson, Eighth Indian Reprint, 2004.

4. I.C.Ifeachor and B.W. Jervis, Digital Signal Processing A Practical Approach, Pearson, Wiley & sons, Singapore, 2002

5. M.H.Hayes, Digital Signal Processing, Schaum's outlines, Tata McGraw Hill, 2007.

6. A. NagoorKani, Digital Signal Processing, McGraw Hill Education, Second Edition, 2017.

7. Salivahanan S, Digital Signal Processing, McGraw Hill Education, Fourth Edition, 2019.

LIST OF EQUIPMENTS

Requirements for a batch of 30 students

Sl. No.	Equipment	Quantity
1	Personal Computers	15
2	MATLAB or equivalent software package for simulation experiments	15 User
3	DSP processor	10

COURSE CODE	COURSE TITLE	L	T	P	C
21EC612	COURSE BASED PROJECT II	0	0	2	1

COURSE OBJECTIVES:

- To develop a comprehensive report on the engineering facts applied to a specific problem.
- To analyze the real time problems during project/product development from an engineering perspective.
- To evaluate the effectiveness of the product or a system through the knowledge acquired.
- To synthesize the business opportunities for a new product with a novel design.

LIST OF EXPERIMENTS

1. Develop a prototype.
2. Demonstration of the project/product and submission of report.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand and explain the real time problems through literatures.

CO2: Analyze the methods to develop solution to the systems.

CO3: Classify, compare and analyze business opportunities for a new product.

CO4: Summarize and prepare reports for the experimental determinations.

CO5**:** Evaluate the performance and effectiveness of the existing problems.

CO6: Develop life-long learning skills for a productive career.

LIST OF EQUIPMENTS

S.NO	EQUIPMENT NAME	QUANTITY
1.	CNC Router	1 No
2.	3D Printer	1 No
3.	3D Scanner	1 No
4.	Laser Cutting Machine	1 No
5.	Centre lathe	2 Nos
6.	Arc Welding transformer with cables and holders	2 Nos
7.	Plumbing tools	2 Sets
8.	Carpentry Tools	2 Sets
9.	Multimeter	10 Nos
10.	Drilling Machine	1 No
11.	Solder Stations	5 Sets
12.	Desoldering Machine	1 No
13.	PCB Milling Machine	1 No
14.	Variable Power Supply	1 No
15.	Electronic Components like Resistors, Transistors, Diode, Inductor, Capacitors, IC etc.,	10 Sets
16.	Personal Desktop Computers	30 Nos

COURSE CODE	COURSE TITLE	L	T	P	C
21CS614	ADVANCED APTITUDE AND CODING SKILLS – II	0	0	2	1

COURSE OBJECTIVES:

- To develop advanced vocabulary for effective communication and reading skills.
- To build an enhanced level of logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.
- To apply data structures and algorithms in problem solving.

LIST OF EXERCISES

1. ENGLISH – PHASE II ADVANCED

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering.

2. LOGICAL REASONING – PHASE II ADVANCED

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency.

3. QUANTITATIVE ABILITY - PHASE II ADVANCED

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability.

4. AUTOMATA FIX – PHASE II ADVANCED

Logical, Compilation and Code reuse

5. AUTOMATA – PHASE II ADVANCED

Data Structure Concepts: Array and Matrices, Linked list, String processing and manipulation, Stack/Queue, Sorting and Searching Advanced Design and Analysis Techniques: Greedy Algorithms, Minimum Spanning Trees, String Matching, Divide and Conquer, Computational Geometry

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop advanced vocabulary for effective communication and reading skills.

CO2: Build an enhanced level of logical reasoning and quantitative skills.

CO3: Develop error correction and debugging skills in programming.

CO4: Apply data structures and algorithms in problem solving.

SEMESTER VII

COURSE CODE	COURSE TITLE	L	T	P	C
21EC701	RF AND MICROWAVE ENGINEERING (Lab Integrated)	3	0	2	4

COURSE OBJECTIVES:

- To understand the basics required for circuit representation of RF networks.
- To deal with the issues in the design of RF amplifier.
- To instill knowledge on the properties of various microwave components.
- To understand the concept of microwave generation.
- To learn the microwave measurement techniques.

UNIT I	TWO PORT NETWORK THEORY	15

Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types of interconnection of Two port networks, High Frequency parameters: Formulation of S parameters, Properties of S parameters, Transmission matrix, RF behavior of Wire, Resistor, Capacitor and Inductor.

LIST OF EXPERIMENTS

1. Radiation Pattern of Horn Antenna

UNIT II	RF AMPLIFIERS AND MATCHING NETWORKS	15

Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Gain Considerations, Impedance matching using discrete components: Two component Matching Networks, T and Pi Matching Networks, Microstrip Line Matching Networks.

LIST OF EXPERIMENTS

2. Study of Microwave Filter Characteristics

UNIT III	PASSIVE AND ACTIVE MICROWAVE DEVICES	15

Passive Devices: Hybrid Junctions (E plane, H plane & Magic Tees), Circulator, Isolator, Gyrator Directional coupler, Termination, Attenuator, Phase shifter.

Active Devices: Gunn diode, IMPATT diode, TRAPATT diode, PIN diode, Varactor diode and Schottkey diode, Transferred electron devices, Avalanche transit time devices.

LIST OF EXPERIMENTS

3. E Plane Tee
4. H Plane Tee
5. Magic Tee
6. Characterization of Directional Couplers
7. Gunn Diode Characteristics

UNIT IV	MICROWAVE GENERATION	15

High frequency effects in vacuum tubes, Two Cavity Klystron Amplifier, Reflex Klystron Oscillator, Traveling Wave Tube Amplifier, Cylindrical Magnetron Oscillator.

LIST OF EXPERIMENTS

8. Isolator
9. Circulators

UNIT V	MICROWAVE MEASUREMENTS	15

Measuring Instruments: VSWR meter, Power meter, Spectrum analyzer, Network analyzer. Measurement of Impedance, Frequency, Power, VSWR, Attenuation, S-parameters

LIST OF EXPERIMENTS

10. VSWR and Impedance Measurement

TOTAL: 45 PERIODS(THEORY) +30 PERIODS (LAB)=75 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Demonstrate the characteristics of multi- port RF networks.

CO2: Analyze a RF transceiver system for wireless communication.

CO3: Understand and demonstrate the characteristics of passive microwave components

CO4: Summarize the characteristics of active microwave devices

CO5: Explain the generation of microwave signals.

CO6: Experiment the measurement of microwave signal and parameters.

TEXT BOOKS:

1. Reinhold Ludwig and Gene Bogdanov, RF Circuit Design: Theory and Applications, Pearson Education Inc., 2011
2. Robert E Colin, Foundations for Microwave Engineering, John Wiley & Sons Inc, 2005.

REFERENCES:

1. David M. Pozar, Microwave Engineering, Wiley India (P) Ltd, New Delhi, 2008.
2. Thomas H Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits, Cambridge University Press, 2004.
3. Mathew M Radmanesh, RF and Microwave Electronics, Prentice Hall, 2000.
4. Annapurna Das and Sisir K Das, Microwave Engineering, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2005.
5. Frank Gustrau, RF and Microwave Engineering Fundamentals of Wireless Communications, John Wiley & Sons, 2012.

NPTEL LINKS:

https://onlinecourses.nptel.ac.in/noc21_ee72

LIST OF EQUIPMENTS:

Requirements for a batch of 30 students

Sl. No.	Equipment	Quantity
2.	Microwave test bench	7
3.	E Plane tee, H Plane Tee, Magic tee, Directional Couplers	2 Each
4.	Isolator, Circulator, Horn Antenna	2 Each
5.	Trainer kit for Microwave IC filter characteristics	1
6.	VSWR Meter	2
7.	DSO/CRO	10

COURSE CODE	COURSE TITLE	L	T	P	C
21EC702	OPTICAL COMMUNICATION AND NETWORKS (LAB INTEGRATED)	3	0	2	4

COURSE OBJECTIVES:

- Acquire the knowledge of optical fiber transmission mechanisms and various fiber types.
- Study the factors which produces signal degradation in fibers.
- Learn the concept of sources and power coupling in optical communication.
- Explore the trends of optical fiber measurement systems.
- Enrich the idea of optical fiber networking.

UNIT I	INTRODUCTION TO OPTICAL FIBERS	15

Elements of an Optical Fiber Transmission link-Basic Optical Laws and Definitions-Total internal reflection, Acceptance angle, Numerical aperture, Skew rays - Optical fiber modes and Configurations - Single mode fibers-Graded Index fiber structure –Mode theory of Circular wave guides- Overview of modes, Modes in Step-Index fibers, Linearly Polarized modes.

LIST OF EXPERIMENTS

1. Fiber optic analog and digital link characterization (Frequency Response)
2. Mode characteristics of optical fibers
3. Numerical Aperture measurement

UNIT II	SIGNAL DEGRADATION IN OPTICAL FIBERS	15

Attenuation - Absorption, Scattering losses, Bending losses, Core and Cladding losses. Signal distortion in Optical Wave guides- Group delay, Material dispersion, Waveguide dispersion, Signal distortion in SM fibers, Polarization mode dispersion, Intermodal dispersion - Dispersion Optimization of SM fibers-Characteristics of RI profiles and cut-off wavelength.

LIST OF EXPERIMENTS

4. Measurement of connector losses
5. Measurement of Bending losses
6. Measurement of Attenuation Losses
7. Measurement of Chromatic Dispersion

UNIT III	FIBER OPTICAL SOURCES AND COUPLING	15

Direct and indirect band gap materials-LED structures -Light source materials -Quantum efficiency and LED power, Modulation of a LED. Lasers diodes-modes and Threshold condition -Rate equations -External quantum efficiency -Resonant frequencies - Temperature effects. Introduction to Quantum laser. Power launching and coupling-Lensing schemes-Fiber -to-Fiber joints-Fiber splicing.

LIST OF EXPERIMENTS

8. DC characteristics of LED

UNIT IV	FIBER OPTIC RECEIVER AND MEASUREMENTS	15

Principles of Photodetectors – PIN & APD - Fundamental receiver operation- Receiver configuration– Digital receiver performance- Probability of error – Quantum limit, Pre amplifiers. Fiber attenuation measurements-Dispersion measurements – Fiber refractiveindex profile measurements– Fiber diameter measurements-

LIST OF EXPERIMENTS

9. DC characteristics of PIN photo diode
10. Fiber optic Analog and Digital Link Characterization – EYE diagram and BER (digital)

UNIT V	OPTICAL NETWORKS AND SYSTEM TRANSMISSION	15

Basic networks – SONET / SDH – Broadcast and select WDM networks –Wavelength routed networks – Link power budget -Rise time budget- Operational principles of WDM and EDFA system – Solitons – Optical CDMA – Ultra high-capacity networks- Introduction to Li-Fi and LIDAR

TOTAL: 45 PERIODS(THEORY) +30 PERIODS (LAB)=75 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

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

CO2: Summarize the transmission characteristics associated with dispersion and polarization techniques

CO3: Discuss the Characteristics of various fiber optical sources and detectors

CO4: Explain the optical receiver performance and measure various fiber parameters for designing optical fiber.

CO5: Realize the digital transmission and its associated parameters on system performance.

CO6: Estimate the power budget required for optical network design and improve the performance of WDM/EDFA system

TEXT BOOKS:

1. Gerd Keiser, Optical Fiber Communications, McGraw -Hill International, Fourth Edition, 2010.
2. John.M.Senior, Optical Fiber Communications, Principles and Practice, Prentice Hall of India, Third Edition, 2008.

REFERENCES:

1. Ramaswami, Sivarajan and Sasaki ,Optical Networks, Morgan Kaufmann, 2009.
2. J.Senior, Optical Communication, Principles and Practice, Prentice Hall of India, 3rd Edition, 2008.
3. J.Gower, Optical Communication System, Prentice Hall of India, 2001.

NPTEL LINK:

1. https://nptel.ac.in/courses/108106167
2. https://nptel.ac.in/courses/117104127
3. https://nptel.ac.in/courses/117101002

LIST OF EXPERIMENTS

List of Equipment for a Batch of 30 Students

Sl.No	Equipment	Quantity
1.	Trainer kit for carrying out LED and PIN diode characteristics, Digital multi meter.	2 Nos
2.	Trainer kit for determining the mode characteristics	2 Nos
3.	Trainer kit for analyzing Analog and Digital link performance, 2 Mbps PRBS Data source, 10 MHz signal generator, 20 MHz Digital storage Oscilloscope	2 Nos
4.	Kit for measuring Numerical aperture and Attenuation of fiber	2 Nos
5.	BER Measurement	2 Nos

COURSE CODE	COURSE TITLE	L	T	P	C
21EC711	PROJECT WORK - PHASE I AND INTERNSHIP	0	0	6	3

COURSE OBJECTIVES:

- To expose the students to industry environment and to take up onsite assignment as trainees or interns.
- To interpret and associate the team members to work as a team efficiently
- Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
- Final development of product/process, testing, results, conclusions and future directions.
- Develop a project in the suggestive area of work and prepare a detailed report.

COURSE EVALUATION

Phase I project	**Weight**
Project final report	30%
Presentation	30%
Internship Report	20%
Viva voce	20%

TOTAL: 90 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Able to integrate existing and new technical knowledge for industrial application.
CO2: Analyze the technical aspects of the project with a comprehensive and systematic approach.
CO3: Have an exposure to industrial practices and to work in teams.
CO4: Know the impact of engineering solutions in a global, economic, environmental and societal context.

CO5: Able to understand software evaluation used with industry.

CO6: Understand lifelong learning processes through critical reflection of internship experiences.

COURSE CODE	COURSE TITLE	L	T	P	C
21EC712	DESIGN THINKING LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- Expose students to the design process as a tool for innovation.
- Impart practical knowledge of Design Thinking.
- Learn concepts in Design Thinking.
- Learn various software tools.
- Develop skills required to build real-life products using Design Thinking.

S.NO.	LIST OF EXPERIMENTS
1.	Design a mind map of design thinking process
2.	Construct empathy maps for a given case study-1
3.	Construct empathy maps for a given case study-2
4.	Ideation Technique Set 1 - Thirty circle Exercise and others
5.	Ideation Technique Set 2 – Brainstorming and others
6.	Model a prototype for a toothpick bridge
7.	Validate the prototype of the toothpick bridge
8.	Model a prototype for a marble maze
9.	Validate the prototype of the marble maze
10.	Model a prototype for an electronic system
11.	Validate the prototype of the electronic system
12.	Design thinking using sprintbase software - I
13.	Design thinking using sprintbase software - II

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop a mind map for design thinking process

CO2: Prepare empathy maps and journey maps for problems.

CO3: Construct prototypes and mock-up models through ideation and innovation techniques

CO4: Validate the prototypes using appropriate testing techniques

CO5: Use appropriate software tools for the design thinking process

CO6: Apply deign thinking strategies for real word scenarios

SUGGESTED BOOKS AND RESOURCES:

1. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process
2. https://www.interaction-design.org/literature/article/design-thinking-getting-started-with-empathy
3. https://sprintbase.io/
4. https://www.innovationtraining.org/software-tools-for-design-thinking/
5. IdrisMootee, “Design Thinking for Strategic Innovation”, John Wiley & Sons (2013).

6. “Change by design”, Tim Brown, Harper Collins, 2009
7. “Design Thinking- The Guide Book” – Facilitated by the Royal Civil service Commission, Bhutan
8. Engineering Design By George E. Dieter, George Ellwood Dieter, Linda C. Schmidt, 2012
9. 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization by Vijay Kumar
10. Human-Centered Design Toolkit: An Open-Source Toolkit to Inspire New Solutions in the Developing World by IDEO

SEMESTER VIII

COURSE CODE	COURSE TITLE	L	T	P	C
21EC811	PROJECT WORK - PHASE II	0	0	16	8

COURSE OBJECTIVES:

- Make use of acquired knowledge for the problem identification and definition related to industry/research/societal need.
- Analyze the technical aspects of the project with a comprehensive and systematic approach.
- Select the appropriate modern tool(s) and technique(s) for problem-solving.
- Propose and select the appropriate and cost-effective solution.
- Appraise the importance of an individual/team for effective execution.

PROJECT GUIDELINES

- Review and finalization of the Approach to the Problem relating to the assigned topic.
- Preparing an Action Plan for conducting the investigation, including team work.
- Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
- Final development of product/process, testing, results, conclusions and future directions.
- Develop a project in the suggestive area of work and prepare a detailed report.

Course Evaluation

Project Final report	30%
Presentation	20%
Working Model Demonstration	30%
Viva voce	20%

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the issues related to the recent trends in the field of engineering and its applications.

CO2: Relate engineering issues to broader societal context and able to find the solution for the issues.

CO3: Compile and conclude the project with effective communication amongst peers, mentors, and society.

CO4: Apply the theoretical concepts to solve industrial problems with teamwork.

CO5: Able to understand advanced technology and research in engineering.

CO6: Develop life-long learning skills for a productive career.

MANAGEMENT ELECTIVE

COURSE CODE	COURSE TITLE	L	T	P	C
21EC919	TOTAL QUALITY MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

Students completing this course are expected to:

- Understand the techniques for the implementation of quality management in manufacturing and services processes.
- Explain the Quality Management principles and process.
- Discuss the importance of Quality in an organization.
- Understand the ISO Quality systems.
- Summarise the quality concepts adopted in industry scenario.

UNIT I	INTRODUCTION	9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention

UNIT II	TQM PRINCIPLES	9

Leadership – Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S and case study, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating

UNIT III	TQM TOOLS & TECHNIQUES I	9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process – FMEA and Applications in the Industry - Stages, Types.

UNIT IV	TQM TOOLS & TECHNIQUES II	9

Quality Circles, Cost of Quality, Quality Function Development (QFD) and case study- Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures

UNIT V	QUALITY SYSTEMS	9

Introduction - Benefits of ISO Registration - ISO 9000 Series of Standards - Sector-Specific Standards - AS 9100, TS16949 and TL 9000 - ISO 9001 Requirements – Implementation – Documentation - Internal Audits - Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction - ISO 14000 Series Standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits of EMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the quality philosophies and customer focused managerial system

CO2: Summarize the quality management principles.

CO3: Apply the six sigma concepts in manufacturing and service sector

CO4: Determine the tools and techniques for quality improvement..

CO5: Discuss the standards and auditing system on implementation of TQM

CO6: Analyze standards for the operation of EMS

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, Total Quality Management, Pearson Education Asia, Revised 3rd Edition, Indian Reprint, Sixth Impression, 2020

REFERENCES:

1. James R. Evans and William M. Lindsay, The Management and Control of Quality, 8th Edition, First Indian Edition, Cengage Learning, 2019.
2. Janakiraman. B and Gopal .R.K., Total Quality Management - Text and Cases, Prentice Hall (India) Pvt. Ltd., 2018.
3. Suganthi.L and Anand Samuel, Total Quality Management, Prentice Hall (India) Pvt. Ltd., 2020.
4. ISO 9001-2015 standards

COURSE CODE	COURSE TITLE	L	T	P	C
21CS939	PRINCIPLES OF MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

Students completing this course are expected to:

- Understand the roles of Management and the principles of an organization.
- Discuss the functions and responsibilities of managers.
- Demonstrate the tools and techniques to be used in the performance of the managerial job.
- Analyze and understand the environment of the organization.
- Develop the cognizance of the importance of management principles

UNIT I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	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. Fundamentals of Entrepreneurship, Circular flow of income.

UNIT II	PLANNING	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 - strategic technology planning

UNIT III	ORGANISING	9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority–departmentalization–delegation of authority–centralizationanddecentralization–JobDesign-HumanResource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management ,Career planning and management. Managing personnel records

UNIT IV	DIRECTING	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. Organizational behaviour

UNIT V	CONTROLLING	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 .SQC techniques

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the management thoughts and various challenges of managerial activities in a global business environment..

CO2: Demonstrate the various strategies in Decision making at various levels management in the Organizations.

CO3: Discuss the various types of Organization structure.

CO4: Describe the steps in Staffing process and stages in Career development

CO5: Explain the elements in Direction

CO6: Summarise the various Controlling techniques to maintain standards in Organizations.

TEXT BOOKS:

1. Koontz, H, & Weihrich, H Essentials of Management: An International Perspective (8th ed.), Tata McGraw Hills, New Delhi,2016.
2. Ghuman, K & Aswathapa, K, Management concepts and cases (10th ed.), Tata McGraw Hills, New Delhi,2017.
3. Telsan, M.T. Industrial and Business Management, (4th ed.), S. Chand, New Delhi,2016.

REFERENCES:

1. Robbins, S. , Management, (13th ed.), Pearson Education, New Delhi,2017.
2. Saxena, P.K., Principles of Management: A Modern Approach, Global India publicaions,2016.

COURSE CODE	COURSE TITLE	L	T	P	C
21CS938	PROFESSIONAL ETHICS IN ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

- To familiarize with Engineering Ethics and Human Values.
- To impart knowledge on codes of ethics, safety, responsibilities and rights of engineers.
- To create awareness on global issues related to environmental ethics, computer ethics, weapons development and corporate social responsibility.

UNIT I	HUMAN VALUES	9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Selfconfidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II	ENGINEERING ETHICS	9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III	ENGINEERING AS SOCIAL EXPERIMENTATION	9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law - The Challenger Case Study.

UNIT IV	SAFETY, RESPONSIBILITIES AND RIGHTS	9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Case Studies: Chernobyl and Bhopal Disasters - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR)– Discrimination.

UNIT V	GLOBAL ISSUES	9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Summarize the importance of human values in work place..

CO2: Discuss the senses of engineering ethics, moral dilemmas, moral autonomy and uses of ethical theories

CO3: Describe the role of engineers as responsible experimenters and necessity of codes of ethics in engineering..

CO4: Explain safety, risk, responsibilities and rights in the society.

CO5: Analyze the global issues related to environmental ethics, computer ethics, weapons development and the role of engineers as expert witnesses and advisors.

CO6: Apply ethics in society and discuss the ethical issues related to engineering.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, Ethics in Engineering, Tata McGraw Hill, New Delhi, 2014.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, Engineering Ethics, Prentice Hall of India, New Delhi, 2013.

REFERENCES:

1. Charles B. Fleddermann, Engineering Ethics, Pearson Prentice Hall, New Jersey, 2012.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, Engineering Ethics – Concepts and Cases, Cengage Learning, 2018.
3. John R Boatright, Ethics and the Conduct of Business, Pearson Education, New Delhi, 2012.
4. Edmund G Seebauer and Robert L Barry, Fundamentals of Ethics for Scientists and Engineers, Oxford University Press, Oxford, 2001.

COURSE CODE	COURSE TITLE	L	T	P	C
21CS917	INTRODUCTION TO INNOVATION, IP MANAGEMENT & ENTREPRENEURSHIP	3	0	0	3

COURSE OBJECTIVES:

The Course will enable learners to:

- Develop mindsets to pursue entrepreneurship.
- Understand the basics of Innovation and Entrepreneurship.
- Create, protect, assetize and commercialize intellectual property.
- Identify and discover market needs.
- Manage an innovation program.
- Understand Opportunities and challenges foe entrepreneurs through Startup Models

UNIT I	INNOVATION	9

Innovation Types of Innovation Incremental, disruptive, Lifecycle of Innovation (idea, literature survey, PoT, PoC, etc.), Challenges in Innovation (time, cost, data,infrastructure, etc.).

UNIT II	IPR	9

Types of IPR (patents, copyrights, trademarks, GI, etc.) Lifecycle of IP (creation, protection, assetization, commercialization), Balancing IP Risks and Rewards (Right Access and Right Use of Open Source and 3rd party products, technology transfer and licensing).

UNIT III	ENTREPRENEURSHIP	9

Opportunity Identification in Technology Entrepreneurship (customer pain points, competitive context) Market Research, Segmentation and Sizing Product Positioning, Pricing, and Go-To-Market Strategy IP Valuation (methods, examples, limitations).

UNIT IV	TYPES OF STARTUP BUSINESS MODEL	9

Startup Business Models (fund raising, market segments, channels, etc.) Co- innovation and Open Innovation (academia, startups, corporates) Technology Innovation: Two Case Studies.

UNIT V	PROCESSES IN STARTUP BUSINESS MODEL	9

Innovation, Incubation and Entrepreneurship in Corporate Context Technology-driven Social Innovation and Entrepreneurship Manage Innovation, IP and Entrepreneurship Programs – Processes, Governance and Tools.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of Innovation and Entrepreneurship

CO2: Manage an innovation program

CO3: Create, protect, assetize and commercialize intellectual property

CO4: Understand opportunities and challenges for entrepreneurs

CO5: Developing mindsets to pursue entrepreneurship.

CO6: Identify and discover market needs

TEXT BOOKS:

1. Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth Navi Radjou,Jaideep Prabhu, Simone Ahuja , John Wiley & Sons, 2012.

REFERENCES:

1. Identifying Entrepreneurial Opportunities: Cognition and Categorization in Nascent Entrepreneurs, Matthew J. Karlesky, University of Michigan, 2015.
2. http://www.businessdictionary.com/definition/entrepreneurship.
3. https://www.infoentrepreneurs.org/en/guides/use-innovation-to-grow-your- business/
4. http://sourcesofinsight.com/innovation-life-cycle/
5. https://www.investottawa.ca/
6. https://www.Lead-innovation.com

PROFESSIONAL ELECTIVE 1

COURSE CODE	COURSE TITLE	L	T	P	C
21EC901	INTRODUCTION TO INTERNET OF THINGS	3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To learn about the IoT architecture
- To familiarize various IoT Protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real-world scenario.

UNIT I	INTRODUCTION TO IoT	9

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M.

UNIT II	IoT ARCHITECTURE	9

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture.

UNIT III	IoT PROTOCOLS	9

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – Zigbee Architecture – 6LowPAN – CoAP.

UNIT IV	BUILDING IoT WITH RASPBERRY PI & ARDUINO	9

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces - Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V	CASE STUDIES AND REAL-WORLD APPLICATIONS	9

Real world design constraints – Applications - Industrial automation, smart grid, Commercial building automation - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify IoT enabling technologies.

CO2: Discover different IoT Architecture.

CO3: Understand communication, network and security protocols

CO4: Develop IoT based applications with Raspberry Pi

CO5: Infer the applications of IoT in Real-world scenario.

CO6: Discover the advancements of IoT in various sectors

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015

2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.

REFERENCES:

1. Honbo Zhou, ―The Internet of Things in the Cloud: A Middleware Perspective‖, CRC Press, 2012.
2. Jan Holler, Vlasios Tsiatsis, 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. Olivier Hersent, David Boswarthick, Omar Elloumi, ―The Internet of Things – Key applications and Protocols‖, Wiley, 2012
4. David E. Goldberg, - IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017.
5. Maciej Kranz - Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry, John Wiley & Son, 2016.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105166/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC902	FPGA ARCHITECTURE AND APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

- To understand FPGA design flow and technology mapping
- To articulate the logic implementation of the FSM
- To identify the building blocks of commercially available FPGA/CPLDs.
- To explore FPGA Fabrics by understanding various routing architecture designs.
- To understand basic ASIC design using FPGAs

UNIT I	INTRODUCTION TO FPGA	9

FPGAs Field Programmable Gate Arrays–Logic blocks, Evolution of programmable devices, FPGA Design flow, Applications of FPGA, Technology Mapping for FPGAs.

UNIT II	DESIGN EXAMPLES USING PLDs&FSMs	9

Design of Universal block, Memory, Floating point multiplier, Barrel shifter using PLDs-
Finite State Machines (FSM)- Top-down Design–State Transition Table, state assignments for FPGAs,Problem of initial state assignment for one hot encoding.

UNIT III	BUILDING BLOCKS OF FPGAS/CPLDs	

Programming Technologies, commercially available FPGAs, AMD Xilinx's Virtex and Spartan, micro semi/Lattice FPGA, Intel Altera's FPGA/CPLD- Configurable Logic block functionality, Routing structures, Input/output Block, Impact of logic block functionality on FPGA performance, Model for measuring delay.

UNIT IV	ROUTING ARCHITECTURES	

Routing terminology, general strategy for routing in FPGAs, routing for row – based FPGAs, introduction to segmented channel routing, routing for symmetrical FPGAs, example of routing in a symmetrical FPGA, general approach to routing in symmetrical FPGAs, independence from FPGA routing architectures, FPGA routing structures.

UNIT V	APPLICATIONS AND CASE STUDY	

Case Studies: Parallel adder cell, parallel adder sequential circuits, counters, multiplexers, parallel controllers

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: To discover FPGA Design flow

CO2: To realize and design the finite state machines

CO3: To develop VHDL/Verilog models and synthesize targeting for Virtex, Spartan FPGAs

CO4: To analyze various FPGA routing architectures

CO5: To understand the widespread implementation of FPGAs using short case studies

CO6: To distinguish the architectural and resource difference between Altera and Xilinx

TEXT BOOKS:

1. P.K.Chan& S. Mourad, Digital Design using Field Programmable Gate Array, Prentice Hall, January 2009
2. Stephen.M. Trimberger,Field Programmable Gate Array Technology, Kluwer Academic Publications,1994

REFERENCES:

1. Digital Design-An Embedded systems approach using Verilog, Peter J.Ashendun, Morgan Kaufmann Publishers,2008
2. Design Warriors guide for FPGA-Clive Maxfield,2004
3. John V. Old Field, Richard C. Dorf, Field Programmable Gate Arrays, Wiley, 2008.
4. Trimburger, Introduction to CAD for VLSI, Kluwer Academic publisher, 2002
5. Richard F.Tinder , Engineering Digital Design,Academic press,2000

NPTEL LINK

https://onlinecourses.nptel.ac.in/noc23_ee25/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC903	COMPUTER NETWORKS	3	0	0	3

COURSE OBJECTIVES:

- Understand the division of network functionalities into layers.
- Be familiar with the components required to build different types of networks
- Categorize various unicast and multicast protocols and infer their functionalities
- Learn the flow control and congestion control algorithms
- Illustrate the various services offered by the Application layer

UNIT I	FUNDAMENTALS & LINK LAYER	9

Building a network – Requirements - Layering and protocols - Internet Architecture – Network software – Performance ; Link layer Services - Framing - Error Detection - Flow control

UNIT II	MEDIA ACCESS & INTERNETWORKING	9

Media access control - Ethernet (802.3) - Wireless LANs – 802.11 – Bluetooth - Switching and bridging – Basic Internetworking (IP, CIDR, ARP, DHCP,ICMP)

UNIT III	ROUTING	

Routing (RIP, OSPF, metrics) – Switch basics – Global Internet (Areas, BGP, IPv6), Multicast –addresses – multicast routing (DVMRP, PIM)

UNIT IV	TRANSPORT LAYER	

Overview of Transport layer - UDP - Reliable byte stream (TCP) - Connection management – Flow control - Retransmission – TCP Congestion control - Congestion avoidance (DEC bit, RED) – QoS – Application requirements

UNIT V	APPLICATION LAYER	

Traditional applications -Electronic Mail (SMTP, POP3, IMAP, MIME) – HTTP – Web Services – DNS- SNMP

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify the components required to build different types of networks

CO2: Choose the required functionality at each layer for given application

CO3: Identify solution for each functionality at each layer

CO4: Trace the flow of information from one node to another node in the network

CO5: Understand and differentiate the various unicast and multicast protocols for routing data

CO6: Quote the various utilities of the application layer and identify its functionalities

TEXT BOOKS:

1. Behrouz A. Forouzan, Data Communication and Networking, Fifth Edition, Tata McGraw Hill, 2013.
2. Andrew S. Tanenbaum & David J. Wetherall, Computer Networks , Fifth Edition, Pearson Education, 2012.

REFERENCES:

1. James F. Kurose, Keith W. Ross, Computer Networking - A Top-Down Approach Featuring the Internet, Seventh Edition, Pearson Education, 2016.
2. Nader. F. Mir, Computer and Communication Networks, Pearson Prentice Hall Publishers, Second Edition, 2014
3. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, Computer Networks: An Open-Source Approach, Mc Graw Hill Publisher, 2011.
4. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers 2011.
5. Tanenbaum Andrew S , Structured Computer Organization, Fifth Edition, Prentice Hall India Learning Private Limited, 2009.

NPTEL LINK:

https://nptel.ac.in/courses/106106091

COURSE CODE	COURSE TITLE	L	T	P	C
21EC904	MEDICAL ELECTRONICS	3	0	0	3

COURSE OBJECTIVES:

- To illustrate the concepts of Bio-potential electrodes
- To illustrate the concepts of Biopotential recording
- To describe the techniques used for measurement of non-electrical parameters used in diagnosis
- To summarize the applications of IOT in medicine
- To familiarize the impact of data analytics in medical instrumentation.

UNIT I	BIO POTENTIAL ELECTRODES	9

Origin of bio potential and its propagation, Electrode-electrolyte interface, Polarization, Polarizable and Non-polarizable electrodes, Electrode behavior and Circuit models, Electrode–skin interface, Types of electrodes - Surface, Needle and Micro electrodes

UNIT II	ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING	9

Bio signals characteristics – Frequency and Amplitude ranges. ECG – Einthoven's triangle, Standard 12 lead system. EEG – 10-20 electrode system, Unipolar, Bipolar and Average mode. EMG– Unipolar and Bipolar mode

UNIT III	MEASUREMENT OF NON-ELECTRICAL PARAMETERS	9

Colorimeter, Flame photometer, Spectrophotometer, Blood flow meters, Cardiac output, Respiratory, Blood pressure, Temperature and Pulse measurements

UNIT IV	IOT IN MEDICINE	9

Components of IOT healthcare, Remote health care, Real time monitoring, Internet of Medical Things (IoMT), IoMT basic architecture, Health care systems using IOT – case studies - An IoT Model for Neuro sensors, Secured architecture for IoT enabled Personalized Healthcare Systems

UNIT V	RECENT TRENDS IN MEDICAL INSTRUMENTATION	9

Healthcare Application Development in Mobile and Cloud Environments, Approach to predict Diabetic Retinopathy through data analytics, Diagnosis of chest diseases using artificial neural networks.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explain the concepts of Bio-potential electrodes

CO2: Analyse bioelectric signals for diagnosis of diseases

CO3: Summarize the concepts of non-electrical parameters measurement techniques in the medical field.

CO4: Design IOT systems for real time medical scenarios.

CO5: Illustrate the applications of data analytics in medical instrumentation

CO6:Develop solutions for real time biomedical applications

TEXT BOOKS:

1. Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice Hall of India, New Delhi, 2012.

2. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, Internet of Things and Personalized Healthcare Systems, Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.

REFERENCES:

1. J. G. Webster, Medical Instrumentation Application and Design Wiley Publication, 2015.
2. Khandpur, R.S., Handbook of Biomedical Instrumentation, Third edition, Mc Graw-Hill Education, 2014.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and Sons, New York, 2013.
4. L. Nokes, D. Jennings, T. Flint, B. Turton, Introduction to Medical Electronics Applications, Little, Brown and Company, USA, 2015.
5. Alan S. Morris, Reza Langari, Measurement and Instrumentation Theory and Application, Elsevier, 2020.

NPTEL LINK:

https://nptel.ac.in/courses/108/105/108105101/

https://nptel.ac.in/courses/106105166

COURSE CODE	COURSE TITLE	L	T	P	C
21EC905	DIGITAL IMAGE AND VIDEO PROCESSING	3	0	0	3

COURSE OBJECTIVES:

- To familiarize the image enhancement concepts
- To explain noise models and image restoration process.
- To exercise various segmentation techniques in images.
- To learn the concept of image compression techniques.
- To visualize the 3D formation models and noise filtering methods.

UNIT I	IMAGE ENHANCEMENT	9

Digital image fundamentals, Concept of pixels and gray levels, Image enhancement: point processing-Contrast stretching –Gray level slicing, intensity transformations, histogram Equalization, image averaging, image subtraction, spatial domain methods- smoothing linear filters, sharpening filters- the Laplacian.

UNIT II	IMAGE RESTORATION	9

Degradation model, Noise models - Gaussian, Rayleigh, Exponential, Uniform, Impulse, Periodic, Restoration in the presence of noise only-Spatial filtering -Mean filters- Arithmetic mean filter, Geometric mean filter, Harmonic mean filter , Contraharmonic mean filter, Inverse filtering, Wiener filtering.

UNIT III	IMAGE SEGMENTATION	9

Detection of discontinuities - point, line and edge and combined detection, Thresholding -Intensity thresholding and basic global thresholding, Region oriented segmentation - basic formulation, region growing by pixel aggregation, region splitting and merging, Watershed Algorithm.

UNIT IV	IMAGE COMPRESSION	9

Need for image compression, coding redundancy , spatial and temporal redundancy, fundamentals of information theory , image compression methods- Run length coding, Huffman coding, LZW coding, Wavelet coding, Image compression standard-JPEG Standards.

UNIT V	VIDEO PROCESSING	9

Analog Video, Digital Video, Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Noise Filtering -Intraframe filtering-LMMSE, Adaptive LMMSE, directional, Compression standards and formats (MPEG & H.XXX),

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Comprehend the enhancement techniques in spatial domain

CO2: Illustrate the noise models and techniques for restoration of images.

CO3: Interpret the different segmentation process involved in image processing.

CO4: Implement the compression techniques for redundancy removal in images.

CO5: Implement video processing in real-time applications

CO6: Develop new state of the art image and video processing methods.

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Education, Inc., Second Edition, 2008.
2. A. Murat Tekalp, Digital Video Processing, Prentice Hall, Second Edition,2015.

REFERENCES:

1. JohnW.Woods, Multidimensional Signal, Image and Video Processing , Elsevier, Second Edition 2011.
2. Thomas. B. Moeslund, "Introduction to Video and Image Processing, Springer, 2012
3. Yao Wang, Jorn Ostermann and Ya Qin Zhang, Video Processing and Communications, Prentice Hall Publishers, 2002.
4. JohnW.Woods, Multidimensional Signal, Image and Video Processing , Elsevier, Second Edition 2011.
5. Thomas. B. Moeslund, Introduction to Video and Image Processing, Springer, 2012
6. Yao Wang, Jorn Ostermann and Ya Qin Zhang, Video Processing and Communications, Prentice Hall Publishers, 2002.

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc19_ee55/preview

https://nptel.ac.in/courses/117104020

COURSE CODE	COURSE TITLE	L	T	P	C
21EC906	SOFT COMPUTING	3	0	0	3

COURSE OBJECTIVES:

- To learn the basic concepts of Soft Computing.
- To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems.
- To introduce hybrid soft computing systems.
- To apply soft computing techniques to solve problems.
- To acquire knowedlge on hybrid systems

UNIT I	INTRODUCTION TO SOFT COMPUTING	9

Artificial Neural Network: Introduction, Characteristics, Learning Methods, Evolution of Neural Networks, Basic Models – Fuzzy Logic: Introduction, Crisp Sets, Fuzzy Sets, Fuzzy Relations, Non-Iterative Fuzzy Sets – Genetic Algorithm: Introduction, Biological Background, Traditional Optimization and Search Techniques – Swarm Intelligent Systems.

UNIT II	NEURAL NETWORKS	9

Mcculloch-Pitts Neuron – Linear Separability – Hebb Network – Supervised Learning Network: Perceptron Networks – Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, BPN, RBF, Associative Memory Network, BAM, Hopfield Networks – Unsupervised Learning Networks, Kohonen Self-Organizing Feature Maps, LVQ – CP Networks, ART Network.

UNIT III	FUZZY LOGIC	9

Membership Functions: Features, Fuzzification, Methods of Membership Value Assignments – Defuzzification: Lambda Cuts – Methods – Fuzzy Arithmetic and Fuzzy Measures – Extension Principle – Fuzzy Integrals – Fuzzy Rule Base and Approximate Reasoning: Truth Values and Tables, Formation of Rules – Decomposition and Aggregation of Fuzzy Rules, Fuzzy Reasoning – Fuzzy Inference Systems – Overview of Fuzzy Expert System – Fuzzy Decision Making

UNIT IV	GENETIC ALGORITHM	9

Basic Concepts – Working Principles – Encoding – Fitness Function – Reproduction – Inheritance Operators – Cross Over – Inversion and Deletion – Mutation Operator – Bit-Wise Operators – Convergence of Genetic Algorithm

UNIT V	HYBRID SYSTEMS	9

Hybrid Systems – Neural Networks, Fuzzy Logic and Genetic – GA Based Weight Determination – LR-Type Fuzzy Numbers – Fuzzy Neuron – Fuzzy BP Architecture – Learning in Fuzzy BP – Inference by Fuzzy BP – Fuzzy ARTMAP – GA in Fuzzy Logic Controller Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Choose suitable soft computing techniques for various applications

CO2: Design learning algorithms for neural networks in pattern classification and regression problems

CO3 : Use fuzzy logic in decision making systems

CO4: Apply Genetic Algorithms for optimization of engineering problems
CO5: Integrate various soft computing techniques for complex engineering problems

CO6: Analyze the characteristics of hybrid systems

TEXT BOOKS:

1.Jyh-Shing Roger Jang, Chuen-Tsai Sun and Eiji Mizutani, Neuro-Fuzzy and Soft Computing : A Computational Approach to Learning and Machine Intelligence, Prentice Hall of India, 2004.

2. Sivanandam S N and Deepa S N, Principles of Soft Computing, Wiley India Pvt. Ltd.,Second edition.

REFERENCES:

1. Timothy J Ross, Fuzzy Logic with Engineering Applications, Wiley Publishers, Third Edition, 2010.

2. George J Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications,Prentice Hall, 1995.

3. James A Freeman and David M Skapura, Neural Networks: Algorithms, Applications,and Programming Techniques, Addison Wesley, 2003.

4. Davis E Goldberg, Genetic Algorithms: in Search, Optimization and Machine Learning, Addison Wesley,

5. Padhy N P and Simon S P, Soft Computing: With MATLAB Programming, Oxford University Press, 2015.

NPTEL LINK:

https://nptel.ac.in/courses/106105173

PROFESSIONAL ELECTIVE II

COURSE CODE	COURSE TITLE	L	T	P	C
21EC907	SENSORS AND ACTUATOR DEVICES	3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental principles and operating mechanisms of sensors and actuator devices.
- To familiarize the basic electronic circuits and systems used to interface sensors and actuator devices.
- To acquire the skills to create, construct, and validate basic sensor and actuator devices.
- To analyze, troubleshoot, and debug sensor and actuator systems.
- To develop real-time IoT based applications with sensors and actuators.

UNIT I	SENSORS AND ACTUATORS	9

Introduction to Sensors and Actuator- Sensor and Actuator Characteristics- Types of sensors and actuators - Calibration, accuracy, and precision of sensors - Signal conditioning and amplification of sensor signals.

UNIT II	SEVEN GENERATIONS OF IOT SENSORS	9

Introduction to IoT Sensors - First-generation sensors: temperature, light, and motion sensors - Second-generation sensors: proximity sensors, pressure sensors, and gas sensors - Third-generation sensors: biosensors, chemical sensors, and magnetic sensors - Fourth-generation sensors: intelligent sensors, microelectromechanical systems (MEMS) - Fifth-generation sensors: nanosensors, biometric sensors - Sixth-generation sensors: printed sensors, flexible sensors - Seventh-generation sensors: quantum sensors, carbon nanotube sensors, and neural sensors.

UNIT III	ACTUATORS AND ADVANCED SENSING TECHNIQUES	9

Electromechanical and electrothermal actuators: differences, characteristics, and use cases - Types of actuators: motors, solenoids, relays, and others - Control of actuator devices: DC, AC, and stepper motor control - H-bridge motor driver circuits.

UNIT IV	SENSORS FOR AUTOMOTIVE AND SMART CITIES	9

Introduction to automotive sensors and their applications - Types of automotive sensors: temperature, pressure, speed, position - Sensor requirements for automotive applications: reliability, durability, and accuracy. Introduction to sensors for smart city applications - Types of smart city sensors: air quality, noise, traffic, weather, and others - Sensor requirements for smart city applications: energy efficiency, data accuracy, and real-time monitoring.

UNIT V	DEVELOPING AN IOT BASED APPLICATIONS	9

Smart Energy Monitor Based on IoT, Develop a Face Recognizing Robot, Build an IoT based Smart Home System, IoT Based Air Quality Index Monitoring, IoT Based Contactless Body Temperature Monitor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Build schematic for IoT solutions with sensors.

CO2: Design and develop IoT based sensor systems.

CO3: Select the appropriate sensors for various industrial applications

CO4: Evaluate the wireless sensor technologies for IoT.

CO5: Design and develop an IoT Prototype project

CO6: Identify the IoT networking components with respect to sensors.

TEXT BOOKS:

1. D. Patranabis, Sensors and Transducers, 1st edition, PHI Learning Private Limited, 2013.
2. Maggie Lin and Qiang Lin., Internet of Things Ecosystem: 2nd Edition, 2021.

REFERENCES:

1. Timothy Chou, - Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA, 2020
2. Ravindra P. Singh and Narayan C. Kar, Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, CRC Press, 2014.
3. A.J. Siti Shafrah, R. Badlishah Ahmad, and I.A. Halim, Sensors and Actuators: Control System Instrumentation, Penerbit UTM Press, 2018
4. Sanjay Sharma, Sensors and Actuators: Engineering System Instrumentation, Second Edition, CRC Press, 2015.
5. Clarence W. de Silva, Intelligent Autonomous Systems 13: Proceedings of the 13th International Conference IAS-13, Springer, 2014.

NPTEL LINK:

https://archive.nptel.ac.in/courses/108/108/108108147/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC908	RTL DESIGN WITH VHDL/VERILOG HDL	3	0	0	3

COURSE OBJECTIVES:

- To understand the logic design fundamentals in RTL using Verilog
- To analyze the practical issues and scenarios for the design of combinational logic using Verilog RTL
- To design efficient RTL for sequential design using Verilog coding guidelines
- To understand the Complex Designs Using Verilog RTL
- To write a testbench program for functional verification

UNIT I	INTRODUCTION TO SIMULATION AND SYNTHESIS FLOW FOR THE VERILOG RTL	9

Integrated Circuit Design and Methodologies: RTL Design, Functional Verification, Synthesis, Physical Design. Verilog HDL. Verilog Design Description: Structural Design, Behavior Design. Synthesizable RTL Design. Key Verilog Terminologies

UNIT II	DESIGN OF COMBINATIONAL LOGIC USING VERILOG RTL	9

Introduction to Combinational Logic, Logic Gates and Synthesizable RTL, Arithmetic Circuits, Multiplexers, Decoders, Encoders, Combinational Design Guidelines: Blocking Assignments, Continuous Versus Procedural Assignments, If-Else Versus Case Statements.

UNIT III	DESIGN OF SEQUENTIAL LOGIC USING VERILOG RTL	9

Introduction to Sequential Logic, Flip-Flop, Synchronous and Asynchronous Reset, Synchronous Counters: Up Counter, Down Counter, Up-Down and Ring Counter. Shift Register. Sequential Design Guidelines: Blocking and Non-blocking Assignments, Synchronous Versus Asynchronous Reset, If-Else Versus Case Statements

UNIT IV	COMPLEX DESIGNS USING VERILOG RTL	9

ALU Design, Parity Generators and Detectors, Barrel Shifters, Finite State Machines: Mealy and Moore-Design of RAM and ROM-UART interface

UNIT V	VERIFICATION AND TEST BENCHES	9

Introduction to Test bench program for timing & functional verification: Adder, Comparators, Decoder, ALU, Registers and Case Studies on Memory Design for processor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able
CO1: Understand the basics of Verilog RTL Simulation and
Synthesis flow.
CO2: Design combinational Logic circuit for the real time and practical scenario

CO3: Understand the synthesizable sequential design issues

CO4: Design Complex structure for the required functionality

CO5: write a test bench code for functional verification

CO6: Understand the basics of Verilog RTL Simulation and Synthesis flow.

TEXTBOOKS:

1. Vaibbhav Taraate ,Digital Logic Design Using Verilog Coding and RTL Synthesis, Springer India 2016.
2. Sanjay Churiwala and Sapan Garg , Principles of VLSI RTL Design - A Practical Guide, Springer 2012.

REFERENCES:

1. P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley, 2009
2. Neil H. E. Weste and David Money Harris, CMOS VLSI Design - A Circuits and Systems Perspective, 4th Edition, Pearson, 2010.
3. Samir Palanitkar, Verilog HDL A Guide to Digital Design and synthesis, second Edition, 2007
4. M. Morris Mano and Mechael D. Ciletti, Digital Design: with an introduction to Verilog HDL 5th Edition, Pearson Education, 2013.
5. Michael D Ciletti, Advanced Digital Design with the Verilog HDL, 2nd edition, Pearson education, 2017

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc23_ee29/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC909	WIRELESS COMMUNICATION	3	0	0	3

COURSE OBJECTIVES:

- To Infer the principles of a wireless channel.
- To Understand cellular system concepts and to classify various multiple access techniques.
- To Design and implement various signaling schemes for fading channel.
- To Compare multipath mitigation techniques and analyze their Performance.
- To Gain knowledge on multiple antenna technique.

UNIT I	WIRELESS CHANNELS	9

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

UNIT II	CELLULAR ARCHITECTURE	9

Multiple Access techniques - FDMA, TDMA, CDMA – Capacity calculations–Cellular concept Frequency reuse - channel assignment- hand off- interference & system capacity- trunking& grade of service – Coverage and capacity improvement.

UNIT III	DIGITAL SIGNALING FOR FADING CHANNELS	9

Structure of a wireless communication link, Principles of Offset-QPSK, π/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.

UNIT IV	MULTIPATH MITIGATION TECHNIQUES	9

Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.

UNIT V	MULTIPLE ANTENNA TECHNIQUES	9

MIMO systems – spatial multiplexing -System model -Pre-coding - Beam forming - transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze the basics and fundamentals of wireless channels.

CO2: Familiarize with the concepts of cellular system

CO3: Explore the fundamentals of multiple access techniques

CO4: Design and implement various signaling schemes for fading channel

CO5: Compare Various multipath mitigation techniques and analyze their performance

CO6: Apply the fundamentals of various multiple antenna techniques

TEXT BOOKS:

1. Rappaport,T.S, Wireless communications, Second Edition, Pearson Education India, 2014..
2. Andreas.F. Molisch, Wireless Communications, Second Edition, John Wiley India, 2010.

REFERENCES:

1. UpenaDalal, Wireless Communication, Oxford University Press,2009
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.
3. Simon Haykin & Michael Mohar, Modern Wireless Communications, Pearson Education, 2007.
4. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005 .
5. Van Nee R. and Ramji Prasad, OFDM for wireless multimedia communications, Artech House, 2000 .

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc22_ee65/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC910	HUMAN ASSIST DEVICES	3	0	0	3

COURSE OBJECTIVES:

- To discuss various cardiac assist devices
- To explain the function of dialysers
- To familiarize the hearing tests and hearing aids
- To describe the various orthotic devices and prosthetic devices
- To explain the electrical stimulation techniques used in clinical applications
- To understand AI techniques used in Medical Assist devices

UNIT I	CARDIAC ASSIST DEVICES	9

Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External Principle of External counter pulsation techniques–Intra-aortic balloon pump–Auxiliary ventricle and schematic for temporary bypass of left ventricle–Prosthetic heart valves.

UNIT II	HEMODIALYSERS	9

Artificial kidney–Dialysis action–Hemodialyser unit– Membrane dialysis– Portable dialyser monitoring and functional parameters.

UNIT III	HEARING AIDS	9

Common tests – Audiograms – Air conduction –Bone conduction – Masking techniques– SISI– Hearing aids – Principles –Drawbacks in the conventional unit –DSP based hearing aids.

UNIT IV	PROSTHETIC AND ORTHODIC DEVICES	9

Hand and arm replacement – Different types of models– Externally powered limb prosthesis– Feedback in orthotic system– Functional electrical stimulation– Sensory assist devices.

UNIT V	RECENT TRENDS	9

Transcutaneous electrical nerve stimulator– Bio-feedback– Case study of AI optimized Medical Assist devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: demonstrate the function of cardiac assist devices.
CO2: describe the principle of artificial kidney.
CO3: summarize the different types of hearing aids
CO4:explain the different types for prosthetic and orthotic devices.
CO5: discuss the electrical simulations techniques used in biomedical instruments.
CO6: develop AI based algorithms for medical Assist devices.

TEXT BOOKS:

1. Albert M.Cook and Webster J.G, Therapeutic Medical Devices, Prentice Hall Inc.,New Jersey, 1982
2. Levine S.N. (ed), Advances in Biomedical Engineering and Medical Physics', Vol. I, II, IV, inter university publications, New York, 1968

REFERENCES:

1. Joseph D. Bronzino, Donald R. Peterson. Medical Devices and Human Engineering, CRC Press, New York, 2015.
2. Kolff W.J, Artificial Organs, John Wiley and sons, New York, 1976.

3. Peter Ogrodnik, Medical Device Design Innovation from Concept to Market 2nd Edition –Elsevier, October 26, 2019.
4. Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor and Francics ,CRC Press,2006
5. Andreas.F. Von racum, Hand book of Bio material Evaluation, Mc.Millan Publishers, Edition 1980

NPTEL LINK:

https://archive.nptel.ac.in/courses/127/106/127106232

COURSE CODE	COURSE TITLE	L	T	P	C
21EC911	MULTIMEDIA COMPRESSION AND COMMUNICATION	3	0	0	3

COURSE OBJECTIVES:

- To understand the compression schemes for text, voice, image and video
- To understand various encoding techniques of audios and videos in multimedia systems
- To understand the QoS issues in multimedia network
- To introduce communication protocols for multimedia networking.
- To analyse and design multimedia communication networks

UNIT I	AUDIO COMPRESSION	9

Multimedia components and their characteristics, Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Linear predictive coding (LPC) - Code excited Linear predictive Coding (CELP)

UNIT II	IMAGE AND VIDEO COMPRESSION	9

Graphics Interchange format- Tagged image file format- Digitized pictures- JPEG-Video Encoding-Motion estimation –Overview of H.263 and MPEG.

UNIT III	TEXT COMPRESSION	9

Static and Dynamic Huffman coding – Arithmetic coding –Lempel-Ziv coding – LZW coding.

UNIT IV	GUARANTEED SERVICE MODEL	9

Best Effort service model – Scheduling and Dropping policies – Network Performance Parameters – Quality of Service and metrics – WFQ and its variants – Random Early Detection –Admission Control – Resource Reservation – RSVP - Traffic Shaping Algorithms

UNIT V	MULTIMEDIA COMMUNICATION	9

Stream characteristics for Continuous media – Temporal Relationship – Object Stream Interactions, Recovering from packet loss – RTSP — Multimedia Communication Standards – RTP/RTCP – SIP and H.263.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the basic ideas of compression algorithms related to multimedia components.

CO2: Understand the principles and standards of Text and Audio Compression Technique

CO3: Understand the principles and standards of Image and Video Compression Techniques

CO4: Apply the various techniques in real-time applications

CO5: Implement various applications using compression algorithms

CO6: To carry out research and development in the field of multimedia systems and algorithms

TEXT BOOKS:

1. Fred Halsall, Multimedia communication- Applications, Networks, Protocols and Standards, Pearson Education, 2007.
2. Tay Vaughan, Multimedia Making it work, McGraw-Hill Osborne Media, 2007.

REFERENCES:

1. Kurose and W. Ross, Computer Networking A Top Down Approach, Pearson education, 3rd Edition, 2012
2. KR. Rao,Z S Bojkovic, D A Milovanovic, ―Multimedia Communication Systems: Techniques, Standards, and Networks‖, Pearson Education 2007
3. R. Steimnetz, K. Nahrstedt, Multimedia Computing, Communications and Applications‖, Pearson Education,1st Edition, 1995.
4. Nalin K Sharda, Multimedia Information Networking', Prentice Hall of India, 1999
5. Aura Ganz, Zvi Ganz and Kitti Wongthawaravat, Multimedia Wireless Networks: Technologies, Standards and QoS, Prentice Hall, 2003
6. Ellen Kayata Wesel, Wireless Multimedia Communications: Networking Video, Voice and Data, Addision Wesley, 1998

NPTEL LINK:

https://nptel.ac.in/courses/117/105/117105083/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC912	QUANTUM COMPUTING	3	0	0	3

COURSE OBJECTIVES:

- To analyse the behaviour of basic quantum algorithms
- To discuss simple quantum algorithms and information channels in the quantum circuit model
- To apply the quantum algorithms in superdense coding and quantum teleportation
- To analyse the algorithms with super-polynomial speed-up
- To illustrate a simple quantum error-correcting code

UNIT I	FOUNDATION	9

Overview of traditional computing – Church-Turing thesis – circuit model of computation – reversible computation – quantum physics – quantum physics and computation – Dirac notation and Hilbert Spaces – dual vectors – operators – the spectral theorem – functions of operators – tensor products – Schmidt decomposition theorem

UNIT II	QUBITS AND QUANTUM MODEL OF COMPUTATION	9

State of a quantum system – time evolution of a closed system – composite systems – measurement – mixed states and general quantum operations – quantum circuit model – quantum gates – universal sets of quantum gates – unitary transformations – quantum circuits

UNIT III	QUANTUM ALGORITHMS-I	9

Superdense coding – quantum teleportation – applications of teleportation – probabilistic versus quantum algorithms – phase kick-back – the Deutsch algorithm – the Deutsch- Jozsa algorithm –Simon's algorithm – Quantum phase estimation and quantum Fourier Transform – eigenvalue estimation.

UNIT IV	QUANTUM ALGORITHMS – II	9

Order-finding problem – eigenvalue estimation approach to order finding – Shor's algorithm for order finding – finding discrete logarithms – hidden subgroups – Grover's quantum search algorithm – amplitude amplification – quantum amplitude estimation– quantum counting – searching without knowing the success probability.

UNIT V	QUANTUM COMPUTATIONAL COMPLEXITY AND ERROR CORRECTION	9

Computational complexity – black-box model – lower bounds for searching – general black-box lower bounds – polynomial method – block sensitivity – adversary methods – classical error correction – classical three-bit code – fault tolerance – quantum error correction – three- and ninequbit quantum codes – fault-tolerant quantum computation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyse the behaviour of basic quantum algorithms

CO2: Discuss simple quantum algorithms and information channels in the quantum circuit model

CO3: Apply the quantum algorithms in superdense coding and quantum Teleportation

CO4: Analyse the algorithms with super polynomial speed-up

CO5: Illustrate a simple quantum error-correcting code

CO6: Acquire knowledge on framework of quantum computation

TEXT BOOKS:

1. P. Kaye, R. Laflamme, and M. Mosca, An introduction to Quantum Computing, Oxford University Press, 2007.
2. E. Rieffel and W. Polak ,Quantum Computing A Gentle Introduction, The MIT Press Cambridge, 2011.

REFERENCES:

1. Jack D. Hidary Quantum Computing: An Applied Approach Springer, 2019.
2. V. Sahni, Quantum Computing, Tata McGraw-Hill Publishing Company, 2007.
3. Michael A. Nielsen and Issac L. Chuang, Quantum Computation and Quantum Information, Tenth Edition, Cambridge University Press, 2010
4. Scott Aaronson, Quantum Computing since Democritus, Cambridge ,2013.
5. P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing, Cambridge.

NPTEL LINK:

https://nptel.ac.in/courses/112107289

PROFESSIONAL ELECTIVE III

COURSE CODE	COURSE TITLE	L	T	P	C
21EC913	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	0	3

COURSE OBJECTIVES:

- To impart artificial intelligence principles, techniques and its history.
- To assess the applicability, strengths, and weaknesses of the basic knowledge representation in solving engineering problems.
- To develop a basic understanding of problem solving and learning methods of AI
- To develop a basic knowledge in Data Science concepts
- To develop intelligent systems by assembling solutions to concrete computational problems

UNIT I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	9

Definitions - Importance of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Introduction to Python - Basic Libraries in Python (Pandas, Numpy, Matplotlib) - Conditional-Iterative Statements and Function - Basic Data Exploration - Advanced Functions for Data Manipulation.

UNIT II	INTRODUCTION TO MACHINE LEARNING	9

Introduction to Machine Learning - Types of Machine Learning – Supervised and Unsupervised - Data exploration - Target Variables, Independent Numerical Variables, Categorical Variables - Splitting of Data - Feature Scaling of Data.

UNIT III	INTRODUCTION TO DATA SCIENCE	9

Introduction to Data science - Introduction to Statistics – Central Tendency - Data Distribution - Probabilities of Discret and Continuous Variables- Introduction to Inferential Statistics - Hypothesis Testing - T tests - Chi Squared Tests – Correlation.

Understanding the types of Predictive Models - Univariate Analysis - Bivariate Analysis- Treating Missing Values - How to treat Outliers - Transforming the Variables - Basics of Model Building.

UNIT IV	LINEAR REGRESSION AND LOGISTIC REGRESSION	9

Linear Regression - Introduction to Linear Regression, Gradient Descent, Feature Engineering - Building First Predictive Model using Regression and Evaluate Performance.

Logistic Regression - Basics of Logistic Regression, Evaluation Metrics, Implementing Logistic Regression

UNIT V	DECISION TREE, ENSEMBLE MODELS AND CLUSTERING	9

Introduction to Decision Tree - Improving Model Performance by Pruning/Hyperparameters Tuning. Basics of Ensemble Techniques - Random Forest - Implementation of Bagging and Random Forest. Clustering - Understanding K-means - Implementation of K-means.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Evaluate Artificial Intelligence (AI) methods and describe their foundations.

CO2: Discuss types of Machine Learning

CO3: Evaluate the predictive models and analyse the Probabilities based on data.

CO4: Apply Linear and Logistic Regression algorithms.

CO5: Apply Decision Tree, Ensemble Model and Clustering

CO6: Discuss current scope and limitations of AI and societal implications

TEXT BOOKS:

1. Andrew Ng, Machine Learning Yearning, 2018.
2. Poole, D. and Mackworth, A., Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

REFERENCES:

1. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow, 2nd Edition, Packt Publishing, 2017.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. Alpaydin, E., Introduction to Machine Learning. 3rd edition, The MIT Press, 2020
4. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2009.
5. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/106/106106139/

https://archive.nptel.ac.in/courses/106/106/106106179/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC914	LOW POWER VLSI DESIGN	3	0	0	3

COURSE OBJECTIVES:

- To identify sources of power in an IC.
- To identify the power reduction techniques based on technology independent and technology dependent methods
- To identify suitable techniques to reduce the power dissipation
- To estimate power dissipation of various MOS logic circuits
- To develop algorithms for low power dissipation

UNIT I	POWER DISSIPATION IN CMOS	9

Hierarchy of Limits of Power – Sources of Power Consumption – Physics of Power Dissipation in CMOS FET Devices – Basic Principle of Low Power Design.

UNIT II	POWER OPTIMIZATION	9

Logic Level Power Optimization – Circuit Level Low Power Design – Gate Level Low Power Design – Architecture Level Low Power Design – VLSI Subsystem Design of Adders, Multipliers, PLL, Low Power Design

UNIT III	DESIGN OF LOW POWER CMOS CIRCUITS	9

Computer Arithmetic Techniques for Low Power System – Reducing Power Consumption in Combinational Logic, Sequential Logic, Memories – Low Power Clock – Advanced Techniques – Special Techniques, Adiabatic Techniques – Physical Design, Floor Planning, Placement and Routing.

UNIT IV	POWER ESTIMATION	9

Power Estimation Techniques, Circuit Level, Gate Level, Architecture Level, Behavioral Level, – Logic Power Estimation – Simulation Power Analysis –Probabilistic Power Analysis

UNIT V	SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER CMOS CIRCUITS	9

Synthesis for Low Power – Behavioral Level Transform –Algorithms for Low Power – Software Design for Low Power.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: To know the sources of power consumption in CMOS circuits

CO2: To design and analyze various MOS logic circuits

CO3: To apply low power techniques for low power dissipation

CO4: To estimate the power dissipation of ICs

CO5: Able to develop algorithms to reduce power dissipation by software

CO6: To learn the design concepts of low power circuits

TEXT BOOKS:

1. Kaushik Roy and S.C.Prasad, Low power CMOS VLSI circuit design, John Wiley & Sons, 2013.
2. Dimitrios Soudris, Christians Pignet, Costas Goutis, Designing CMOS Circuits for Low Power, Springer,2011

REFERENCES:

1. A.P.Chandrasekaran and R.W.Brodersen, Low power digital CMOS design, Springer US, 2012.
2. Gary Yeap, Practical low power digital VLSI design, Springer US, 2012.
3. Abdelatif Belaouar, Mohamed.I.Elmasry, Low power digital VLSI design: Circuits and Systems, Springer Verlag, 2012.
4. James B.Kulo, Shih-Chia Lin, Low voltage SOI CMOS VLSI devices and Circuits, John Wiley & sons,2011.
5. Steven M.Rubin, Computer Aids for VLSI Design, 3rd edition, R.L. Ranch Press, 2012.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105034/#

COURSE CODE	COURSE TITLE	L	T	P	C
21EC915	4G/5G COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES:

- To know about technology and evolution of LTE networks.
- To introduce 5G massive MIMO and NOMA system technology.
- To enable students to understand various wireless protocols.
- To know the need for network security in 5G
- To know about the possible application using 5G

UNIT I	INTRODUCTION	9

Introduction to 1G/2G/3G/4G/5G Terminology - Evolution of Public Mobile Services - Motivation for IP Based Wireless Networks - Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTEA To 5G, Need for 5G, Performance Bottleneck of Universal Mobile Telecommunications System High-Speed Packet Access (UMTS/HSPA) and Long-Term Evolution (LTE) Networks.

UNIT II	WIRELESS ARCHITECTURES	9

3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context - Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain – LTE network Architecture - Roaming Architecture- Protocol Architecture - Open wireless Architecture for 5G - Network architecture changes from 3G TO 5G.

UNIT III	WIRELESS TECHNOLOGIES	9

Cellular wireless networks and systems principles - Antennas and radio propagation - Signal encoding and modulation techniques., advanced modulation and coding, medium access techniques, cognitive radio and dynamic spectrum access networks, Static and dynamic channel allocation techniques, Introduction to 5G Massive MIMO Systems Introduction to Non-Orthogonal Multiple Access (NOMA) Technology

UNIT IV	WIRELESS PROTOCOLS	9

MAC Protocols, the Mediation Device Protocol, Contention based protocols - PAMAS, Schedule based protocols – LEACH, IEEE 802.15.4 MAC protocol, Challenges and Issues in Transport layer protocol. Routing protocols - Subscription management / roaming / offloading, IP telephony.

UNIT V	NEED FOR SECURITY AND APPLICATIONS OF 4G AND 5G	9

Network Security Requirements, Issues and Challenges in Security Provisioning for 4G and 5G, Network Security Attacks , possible solutions for jamming, tampering, black hole attack, flooding attack in heterogeneous 4G and 5G networks. 4K/8K streaming, Tele-medicine, Tele-education, AR/VR, Real time interactive gaming, IoT and smart cities, Satellite Internet, SnapDragon – Case study .

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explain the basic features of 4G/5G communication technology.

CO2: The students will able to work with cellular networks and wireless protocols.

CO3: The students will able to work the principle of MIMO AMD NOMA.

CO4: The students will able to familiar with wireless protocols.

CO5: The students know the network security issues and challenges.

CO6: Explain the basic features of satellite internet, IoT and 5G smart antennas.

TEXT BOOKS:

1. Harri Holma, Antti Toskala, Takehiro Nakamura, 5G Technology :3GPP New Radio, John Wiley & Sons, 2019
2. Ayman El-Nashar, Mohamed El-saidny, Mahmoud Sherif, Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach, John Wiley & Sons, 2014

REFERENCES:

1. W. Stallings, Wireless Communications and Networks, Second Edition, Pearson Education, 2013
2. Harri Holma, Antti Toskala, WCDMA for UMTS: HSPA Evolution and LTE, Fifth Edition John Wiley & Sons, Inc. Publication, 2010.
3. Dharma Prakash Agrawal and Qing-An Zeng, Introduction to Wireless and Mobile Systems, Third Edition, Thomson, 2011.
4. T Theodore S. Rappaport, Wireless Communications -Principles Practice,Second Edition, Prentice Hall of India, New Delhi, 2010.
5. Jyh-Cheng Chen and Tao Zhang, IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols, First Edition, John Wiley & Sons, Inc. Publication, 2010.

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc22_ee56/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC916	WEARABLE DEVICES	3	0	0	3

COURSE OBJECTIVES:

- Identify the need for development of wearable devices and its implications on various sectors.
- Comprehend the development of various wearable inertial sensors and wearable bio electrodes used in healthcare applications.
- Discuss the concepts of various biochemical and gas sensors as wearable devices.
- Acquaint various wearable locomotive sensors as assistive devices for tracking and navigation.
- Acquire knowledge on challenges of using wearable devices for biomedical applications

UNIT I	INTRODUCTION TO WEARABLE DEVICES	9

Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Wearable Inertial Sensors - Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection, Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients. Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

UNIT II	WEARABLE DEVICES FOR HEALTHCARE	9

Electrode – design, geometry, material; Fabrication of inter digitated (IDE) electrodes, choice of substrate, sensing film; Wearable Bioelectric impedance devices for Galvanic skin response; Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode–Skin Interface; Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, electrodes and instrumentation.

UNIT III	WEARABLE BIOCHEMICAL AND GAS SENSORS	9

Wearable Biochemical Sensors: Parameters of interest, System Design –Textile based, Microneedle based; Types: Noninvasive Glucose Monitoring Devices, GlucoWatch® G2 Biographer, GlucoTrackTM; Pulse oximeter, Portable Pulse Oximeters, wearable pulse oximeter; Wearable capnometer for monitoring of expired carbon dioxide. Wearable gas sensors: Metal Oxide (MOS) type, electrochemical type, new materials-CNTs, graphene,Zeolites;Detection of atmospheric pollutants.

UNIT IV	WEARABLE CAMERAS AND MICROPHONES FOR NAVIGATION	9

Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials. Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist, forearmandfeet, vests and belts, head-mounted devices.

UNIT V	OTHER WEARABLE DEVICES	9

Wearable devices with Global Positioning System (GPS) integration for tracking and navigation. Wearable Optical Sensors - chemical sensors, optical glucose sensors, UV exposure indicators, speech recognition using lasers; Photoplethysmography (PPG), 3D imaging and motion capture

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Summarize the need for development of wearable devices and its influence on various sectors.

CO2: Discus the applications of various wearable inertial sensors for biomedical applications.

CO3: Comprehend various wearable bio-electrode and physiological activity monitoring devices used in healthcare applications.

CO4: Summarize the concepts of various biochemical and gas sensors as wearable devices.

CO5: Illustrate various wearable sensors used for safety, security and navigation.

CO6: Implement solutions for real time applications using wearable devices.

TEXT BOOKS:

1. Toshiyo Tamura and Wenxi Chen ,Seamless Healthcare Monitoring, , Springer 2018.
2. Edward Sazonov and Michael R. Neuman Wearable Sensors -Fundamentals, Implementation and Applications, Elsevier Inc., 2014.
3. Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay ,Wearable and Autonomous Biomedical Devices and Systems for Smart Environment, Springer 2010.

REFERENCES:

1. Subhas Chandra Mukhopadhyay ,Wearable Electronics Sensors - For Safe and Healthy Living, , Springer 2015.
2. Shantanu Bhattacharya, A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen ,Environmental, Chemical and Medical Sensors,Springer Nature Singapore Pte Ltd. 2018.
3. Mardonova and Y. Choi, Review of Wearable Device Technology and Its Applications to the Mining Industry,Energies, vol. 11, p. 547, 2018.
4. N. Luo, W. Dai, C. Li, Z. Zhou, L. Lu, C. C. Y. Poon, et al., Flexible Piezoresistive Sensor Patch Enabling Ultralow Power Cuffless Blood Pressure Measurement, Advanced Functional Materials, vol. 26, pp. 1178-1187, 2016.
5. Yang, Y.-C. Chen, L. Nicolini, P. Pasupathy, J. Sacks, B. Su, et al., Cut-and-Paste Manufacture of Multiparametric Epidermal Sensor Systems,Advanced Materials, vol. 27, pp. 6423-6430, 2015.

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc23_ge21/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC917	WIRELESS SENSOR NETWORKS	3	0	0	3

COURSE OBJECTIVES:

- To enable the student to understand the role of sensors and the networking of sensed data for different applications.
- To expose the students to the sensor node essentials and the architectural details, the medium access and routing issues and the energy constrained operational scenario.
- To enrich the student to understand the challenges in synchronization and localization of sensor networks.
- To explain topology management for effective and sustained communication
- To understand the data management and security aspects for different applications in wireless sensor networks

UNIT I	OVERVIEW OF WIRELESS SENSOR NETWORKS	9

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- case study, Enabling Technologies for Wireless Sensor Networks.

UNIT II	ARCHITECTURES	9

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, Gateway Concepts. Physical Layer and Transceiver Design Considerations

UNIT III	MAC AND ROUTING	9

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , Mediation device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing

UNIT IV	INFRASTRUCTURE ESTABLISHMENT	9

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT V	DATA MANAGEMENT AND SECURITY	9

Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1 : Understand the fundamentals of wireless sensor networks and its application

CO2 : Explain the architectures of sensor networks and its parameters

CO3 : Discuss the various protocols and routing algorithm at different layer

CO4 : Understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

CO5 : Design energy efficient sensor nodes and protocols

CO6 : Illustrate the storage ,query processing, data management and different aggregation methods for wireless sensor networks

TEXT BOOKS:

1. Holger Karl & Andreas Willig, Protocols And Architectures for Wireless Sensor Networks ,JohnWiley,2005.
2. Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach,Elsevier,2007.

REFERENCES:

1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks- Technology Protocols, And Applications, John Wiley, 2007.
2. Anna Hac, Wireless Sensor Network Designs, John Wiley, 2003.
3. Jun Zheng, Abbas Jamalipour, Wireless Sensor Networks: A Networking Perspective, John Wiley,2009.
4. Jochen Schiller, Mobile Communications, Pearson Education, 2nd Edition, 2003.
5. William Stallings, Wireless Communications and Networks , Pearson Education – 2004

NPTEL LINK:

1. https://nptel.ac.in/courses/106/105/106105160/
2. https://onlinecourses.swayam2.ac.in/arp19_ap52/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC918	ROBOTICS AND APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

- To develop knowledge in basic functioning of robot and its types.
- To realize forward and inverse kinematics equations and its general solutions.
- To study the various object recognition techniques with image processing.
- To familiarize the role of Artificial Intelligence in Robotic Applications
- To impart knowledge on recent advancements in different sectors which employs Robots

UNIT I	FUNDAMENTALS OF ROBOTICS	9

Introduction to robotics – Basic Laws of Robotics – Anatomy of a Robot – classification of a Robot – types of robots – Specifications of robot – Open kinematics vs Closed kinematics chain – degrees of Freedom – Robot configuration (PPP, RPP, RRP, RRR).

UNIT II	ROBOT KINEMATICS	9

Position Analysis – Matrix representation – forward and inverse kinematics equations (Position, Orientation) – Denavit-Hatenberg (DH) Representation of Forward Kinematic Equations – General solutions of inverse kinematic equations. Trajectory Planning – path vs trajectory – join space trajectory planning – cartesian space trajectories

UNIT III	ACTUATORS AND SENSORS	9

Actuators – Characteristics of actuating system – comparison of actuating system – hydraulic actuators – pneumatic actuators. Sensors – Characteristics of sensors – Position Sensor – Velocity sensor – Acceleration sensor – force and pressure sensor – Touch and Tactile Sensor – Proximity sensor and range finders.

UNIT IV	MACHINE VISION AND ARTIFICIAL INTELLIGENCE	9

Introduction to machine vision – sensing and digitizing function in machine vision – image processing and analysis – Training and vision system – Object recognition by features (basic features, moments, template matching, computed tomography) – Role of AI in Robots – Goals of AI Research – AI Techniques.

UNIT V	FUTURE APPLICATIONS OF ROBOT	9

Applications of Robots – Industrial Applications, medical, household, marine, defense and disaster management – Micro and Nano Robots – Future Applications – Cyber Risks in Robots

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Summarize various classification and specification of robots for the given application.

CO2: Compute position and orientation of manipulator using forward and inverse kinematics.

CO3: Identify appropriate gripper and sensor for a specific requirement

CO4: Apply suitable machine vision technique for object recognition

CO5: Infer the role of Artificial Intelligence in Robotic Applications

CO6: Discover the advancements of robotic Applications in various sectors

TEXT BOOKS:

1. Introduction to Robotics Analysis, Systems and Applications by Saeed B.Niku, 3rd edition – Wiley publications – 2019
2. Industrial Robotics Technology, Programming and Applications by Mikell P. Groover, 3rd edition - McGraw Hill Publications – 2008

REFERENCES:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, Robotics Engineering an Integrated Approach, PHI Learning., 2009.
3. Craig. J. J. Introduction to Robotics- mechanics and control, Addison- Wesley, 1999
4. Barry Leatham - Jones, Elements of industrial Robotics PITMAN Publishing, 1987.
5. Francis N. Nagy, Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
6. Fu K.S. Gonzaleaz R.C. and Lee C.S.G., Robotics Control Sensing, Vision and Intelligence, McGraw Hill International Editions, 1987.

NPTEL LINK:

https://nptel.ac.in/courses/112107289

HONORS in Internet of Things (IoT)

COURSE CODE	COURSE TITLE	L	T	P	C
21EC941	INDUSTRIAL AND MEDICAL IOT	3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Industrial IoT and its applications,
- To gain conceptual understanding of communication protocols used in IIoT deployments.
- To learn about data management and analytics in Industrial IoT.
- To understand the fundamentals of Industrial IoT, its applications.
- To understand the different IoT platforms and cloud services.

UNIT I	IIoT SYSTEM INTEGRATION AND INTEROPERABILITY	9

IOT Vs. IIOT, Integration of IIoT systems with existing industrial infrastructure - Interoperability challenges and solutions in IIoT - Standards and frameworks for IIoT system integration - Cyber-physical systems and digital twins in IIoT.

UNIT II	IIoT CONNECTIVITY AND COMMUNICATION PROTOCOL	9

IIoT communication requirements and challenges - Wired and wireless communication technologies for IIoT - Overview of common IIoT protocols: MQTT, OPC-UA, Modbus, Ethernet/IP, and more - Introduction to 5G and its role in IIoT – Network security and considerations in IIoT.

UNIT III	IIoT DATA MANAGEMENT AND ANALYTICS	9

Data acquisition, preprocessing, and storage in IIoT - Introduction to edge, fog, and cloud computing in IIoT - Data analytics techniques and tools for IIoT - Machine learning and AI for predictive maintenance and process optimization - Visualization of IIoT data and real-time monitoring.

UNIT IV	IoMT INTRODUCTION AND HEALTHCARE TECHNOLOGIES	9

Introduction to IoMT - Medical Sensors: ECG, blood pressure monitors, pulse oximeter, and glucose monitors. Communication Protocols in IoMT: Bluetooth, Wi-Fi, and Zigbee. Standards for IoMT - HIPAA, GDPR, and FDA regulations.

UNIT V	APPLICATION DESIGN & CASE STUDY	9

IoT Platforms and Cloud Services – Microsoft Azure, AWS. Application Design & Case Study: Wireless Patient Monitor system, Wearable Fitness & Activity Monitor, Design of IOT based pulse oximeter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Develop conceptual design of Medical and Industrial IoT architecture.

CO2: Apply sensors and various protocols for industry standard solutions.

CO3: Articulate privacy and security measures for industry standard solutions.

CO4: Study about Internet of Medical Things (IoMT) and its applications in healthcare industry.

CO5: Design various applications using IoT in Healthcare Technologies.

CO6: Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.

TEXT BOOKS:

1. Veneri, Giacomo, and Antonio Capasso. Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0, 1st edition, Packt Publishing Ltd, 2018.
2. Reis, Catarina I., and Marisa da Silva Maximiano, eds. Internet of Things and advanced application in healthcare, 1st edition, IGI Global, 2016.

REFERENCES:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, 1st Edition, Apress, 2017
2. Aboul Ella Hassanien, Nilanjan Dey and Sureaka Boara, Medical Big Data and Internet of Medical Things: Advances, Challenges and Applications, 1st edition, CRC Press, 2019.
3. Hamed Farhadi, Rezaul Begg, and Joarder Kamruzzaman, Internet of Medical Things (IoMT) and Analytics Handbook for Connected Healthcare, Elsevier, 2020.
4. Martin Gillet, Industrial Internet of Things: A Guide to Deploying IoT in Industrial and Manufacturing Environments, Apress,2017.
5. Arvind Kumar Bansal and Valentina E. Balas, Internet of Things for Healthcare Technologies: From Sensor to Cloud Based Systems, Springer, 2020.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105195/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC942	PROGRAMMING AND WEB TECHNOLOGIES FOR IOT	3	0	0	3

COURSE OBJECTIVES:

- To comprehend and analyze the basic concepts of web programming and internet Protocols.
- To describe how the client-server model of Internet programming works.
- To design and develop IoT applications using web technologies, such as HTML, CSS, and JavaScript.
- To learn how to integrate IoT devices with web services.
- To gain hands-on experience in programming and developing web technologies for IoT.

UNIT I	INTRODUCTION TO INTERNET	9

Internet Overview- Networks – WWW –Web Protocols — Web Organization and Addressing – Internet Service Providers, DNS Servers, Connection Types, Internet Addresses - Web Browsers and Web Servers -Security and Vulnerability-Web System Architecture – URL - Domain Name.

UNIT II	CLIENT SIDE SCRIPTING	9

HTML5 – Text tags; Graphics, Form elements, HTML 5 Input types, semantic tags, CSS3 - Selectors, Box Model, Backgrounds and Borders, Text Effects, Animations, Cascading and inheritance of style properties - Normal Flow Box Layout-Beyond the Normal Flow – Introduction to responsive design – bootstrap. JavaScript -Variables and Data Types - Statements – Operators- Literals- Functions Objects- Arrays- Built-in Objects, DOM – BOM - Regular Expression Exceptions, Event handling, Validation – Jquery.

UNIT III	DEVELOPING INTERACTIVE WEB APPLICATIONS	9

AJAX –AJAX calls - XML http – request – response – AJAX with PHP - Data Formats - AJAX with Database – Processing Server Response - AJAX Security.

UNIT IV	SERVER SIDE SCRIPTING	9

Introduction to Node.js- NPM - Events, Timers, and Callbacks in Node.js – file upload – email – Express framework – request –response –routing - templates- view engines. Introduction to Mongo DB- creating DB, collection – CRUD operations - Accessing MongoDB from Node.js. – Accessing online Mongo DB from Node JS.

UNIT V	REACT WEB FRAMEWORK	9

Introduction – Environment setup – JSX – React DOM – React Elements - Components – react state – Props – Hooks – Component life cycle. Introduction – Environment setup – JSX – React DOM – React Elements - Components – react state – Props – Hooks – Component life cycle.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Know the different web protocols and web architecture.

CO2: Apply HTML and CSS effectively to create dynamic websites.

CO3: Create event responsive webpages using AJAX and JQuery.

CO4: Implement server-side programming

CO5: Learn web data storage and transfer technologies using Angular.

CO6: Develop web applications using advanced technologies such as Node JS.

TEXT BOOKS:

1. Paul J. Deitel, Harvey Deitel, Internet and World Wide Web How To Program, 6th Edition, Pearson, 2020.
2. Vasan Subramanian, Pro MERN Stack - Full stack web app development, 2nd Edition, 2019.

REFERENCES:

1. Jessica Minnick, Responsive Web Design with HTML 5 & CSS, Cengage Learning, 2020.
2. Frank Zammetti, Modern Full-Stack Development: TypeScript, React, Node.js, 1st Edition, Apress, 2020.
3. Jennifer Niederst Robbins, Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics, O'Reilly Media, 2018.
4. Jon Duckett, JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.
5. Jon Duckett, Web Design with HTML, CSS, JavaScript and jQuery Set, Wiley, 2014.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/106/106106156/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC943	DEEP LEARNING AND ITS APPLICATION	3	0	0	3

COURSE OBJECTIVES:

- To introduce the theory and techniques of deep learning, including deep neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).
- To design and develop an application using specific deep learning models.
- To provide the practical knowledge in handling and analysing real world applications.
- To learn how to implement and train deep learning models using popular frameworks such as TensorFlow, Keras, and PyTorch.
- To explore ways to improve model performance and interpretability.

UNIT I	DEEP LEARNING ARCHITECTURES	9

Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep learning frameworks: TensorFlow, Keras, and PyTorch.

UNIT II	CONVOLUTIONAL NEURAL NETWORKS AND TRANSFER LEARNING	9

Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, AlexNet – Applications. Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet.

UNIT III	SEQUENCE MODELLING – RECURRENT AND RECURSIVE NETS	9

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short Term Memory Networks.

UNIT IV	AUTO ENCODERS AND DEEP GENERATIVE MODELS	9

Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders. Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversial Networks.

UNIT V	DEEP LEARNING WITH IOT APPLICATIONS	9

Real-time processing and optimization for camera-based applications - Developing an object detection model for IoT devices - Face detection and recognition using a pre-trained CNN model - Activity recognition using a pre-trained LSTM model - Real-time object detection using a Raspberry Pi.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Recognize the characteristics of deep learning models that are useful to solve real-world problems.

CO2: Understand different methodologies to create application using deep nets.

CO3: Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.

CO4: Implement different deep learning algorithms.

CO5: Design the test procedures to assess the efficacy of the developed model.

CO6: Combine several models in to gain better results

TEXT BOOKS:

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

REFERENCES:

1. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.
2. EthemAlpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.
3. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, Deep Learning with TensorFlow: Explore neural networks with Python, Packt Publisher, 2017.
4. Antonio Gulli, Sujit Pal, Deep Learning with Keras, Packt Publishers, 2017.
5. Francois Chollet, Deep Learning with Python, Manning Publications, 2017.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/106/106106224/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC944	ROBOT OPERATING SYSTEM	3	0	0	3

COURSE OBJECTIVES:

- To expose to the key RPA design and development strategies and methodologies
- To summarize and analyze the different types of robot sensors and actuators.
- To introduce students the criteria for selecting a sensor and actuator for a particular application.
- To understand the Robot Operating System (ROS) fundamentals.
- To introduce students the criteria for selecting a sensor and actuator for a particular ROS robotic application.

UNIT I	ROBOTIC PROCESS AUTOMATION	9

Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms.

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making.

Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events.

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV.

Case study:Build a software bot using RPA tool.

UNIT II	ROBOT OPERATING SYSTEM (ROS) AND FUNDAMENTAL	9

Robot Introduction- Seven Criteria of Defining a Robot, Robot Controllers-Major Components, Robot Vocabularies- Robotics Middleware Basics.

ROS Basics-ROS Equation, History of ROS, Sensors and Robots Supporting ROS, ROS Architecture and Concepts, ROS Filesystem Level, ROS Computation Graph Level, ROS Community Level.

Ubuntu Linux for Robotics-Ubuntu Graphical User Interface, Shell Commands, C++ and Python for Robotic Programming- Basic Concepts with Examples.

UNIT III	ROS PROGRAMMING	9

Creating ROS Workspace and Package, Using ROS Client Libraries, Programming Embedded Board using ROS-Interfacing Arduino with ROS, ROS on a Raspberry Pi.

UNIT IV	ROBOTIC PROJECTS USING ROS	9

Introduction to Wheeled Robots, Building Robot Hardware-Block Diagram and Assembling Robot Hardware, Programming Robot Firmware.

UNIT V	ROS NAVIGATION	9

Localizing the robot in a map, ROS Navigation Stack-hardware requirement-navigation packages, path planning, motion planning of robot – software requirement and configuration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: To learn to deploy and maintain the software bot

CO2: Comprehend, classify and analyze the behavior of different types of sensors and actuators.

CO3: Understand the ROS fundamentals

CO4: Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.

CO5: Design robotic applications using ROS.

CO6: Design products by suitable integration of Arduino and Raspberry Pi boards with ROS.

TEXT BOOKS:

1. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018.
2. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018

REFERENCES:

1. Hughes, C. and Hughes, T., Robot programming: a guide to controlling autonomous robots. Que Publishing, 2016
2. Quigley, M., Gerkey, B. and Smart, W.D., Programming Robots with ROS: a practical introduction to the Robot Operating System, O'Reilly Media, 2015.
3. Anil Mahtani, Luis Sanchez, Enrique Fernandez, Aaron Martinez, Lentin Joseph. ROS Programming: Building Powerful Robots. Packt Publishing, 2018.
4. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.
5. Tom Taulli, The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems, Apress publications, 2020.

NPTEL LINK:

https://archive.nptel.ac.in/courses/112/105/112105249/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC945	DESIGN OF SMART CITIES	3	0	0	3

COURSE OBJECTIVES:

- To understand the concept of smart city and associated challenges.
- To understand latest technologies used in intelligent building.
- To understand process of planning and drafting a plan for smart city.
- To understand the importance of different smart system.
- To analyze the benefits and challenges of Smart Cities

UNIT I	INTRODUCTION TO SMART CITY AND URBAN PLANNING	9

Introduction, Smart City, Complexities of Smart Cities, Urban Network, Sensor Network, Role of Urban Networks, Trends in Urban Development, Community Resource Sensing. Urban Planning, Databases, Principles of Urban Planning, Data Organization, Role of Planning in Smart Cities, Case Studies.

UNIT II	ENERGY SUSTAINABILITY, SECURITY AND THREATS IN SMART CITIES	9

Energy, Decision Making, Energy as a catalyst for Sustainable Transformation, Cohesion and efficiency of smart cities.

Security challenges in Internet of Things, Security threats in IoT, IoT related safety measures for a safer smart city.

UNIT III	SMART CITIES PLANNING AND DEVELOPMENT	9

City Planning, Understanding Smart Cities, Dimensions of Smart Cities, Global standards and performance benchmark of smart cities, Financing smart cities development, Governance of smart cities.

UNIT IV	PROJECT MANAGEMENT IN SMART CITIES	9

Philosophy and project management, Phases and Stages of Project, Work Breakdown Structure, Project Organization Structure, Planning, Scheduling, Case studies on project management of smart cities – web application and mobile based implementation

UNIT V	PROCESS CONTROL AND STABILIZATION IN SMART CITIES, IOV, ITS	9

Structural concept, Specific applications, Structural health monitoring-Process control and stabilization, Internet of Vehicle (IoV) Importance, Applications, Perspectives on Intelligent Transport Systems (ITS), ITS Highway safety perspective, Environmental aspects of ITS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Acquaint knowledge on smart cities planning and development.

CO2: Develop work break down structure, scheduling and project management of smart cities.

CO3: Work out the most energy efficient technique.

CO4: Understand technologies, infrastructure, and concept of planning and latest methodology.

CO5: Understand process of planning and drafting a plan for smart city

CO6: Understand the importance of different smart system

TEXT BOOKS:

1. Paola Pucci, Smart Cities: A Spatialised Intelligence, Taylor & Francis Group, 2019.
2. Javier Gil Quesada, Francisco Javier Nieto, and José M. de Fuentes, Smart Cities and Communities: Enabling Technologies and Data Governance, Springer, 2021.

REFERENCES:

1. William J. V. Neill, Urban Planning and cultural identity, Routledge, 2004.
2. Anthony M. Townsend, Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company, 2013.
3. Massimo Bertoncini and Alessandra De Paola, The Internet of Things and Smart Cities: Technologies, Applications and Challenges, Springer 2018.
4. Houbing Song, Ravi Srinivasan, Tamim Sookoor, and Sabrina Tahsin, Smart Cities: Foundations, Principles, and Applications, Wiley, 2019.
5. Jason M. Pittman, The Future of Smart Cities: Rise of Automation, 5G, and Digital Twinning, CRC Press, 2020.

NPTEL LINK:

http://www.nitttrc.edu.in/nptel/courses/video/124107007/L43.html

COURSE CODE	COURSE TITLE	L	T	P	C
21EC946	IMAGE AND VIDEO ANALYTICS	3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the basic principles and concepts in digital image and video processing.
- To explore and demonstrate real time image and video analytics in solving practical problems of commercial and scientific interests.
- To develop algorithms and techniques to analyse and interpret the visible world around us.
- To Understand the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis visual geometric modelling, stochastic optimization etc.
- To explore and contribute to research and further developments in the field of Image and Video Analytics.

UNIT I	IMAGE PROCESSING	9

Basic steps of Image Processing System. Image Segmentation –Detection of Discontinuities. - Edge Linking and Boundary Detection. - Thresholding. Region-Based Segmentation. Image Compression – Encoder-Decoder model, Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, JPEG, JPEG 2000. Colour Image Processing – Colour Models, Color Transformations, Color Image Smoothing and Sharpening, Color Noise Reduction, Color-Based Image Segmentation. Transformation: Orthogonal, Euclidean, Projective. Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

UNIT II	FEATURE EXTRACTION AND TEXTURE ANALYSIS	9

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Texture Analysis - Concepts and classification, statistical, structural and spectral analysis.

UNIT III	OBJECT RECOGNITION AND IMAGE RETRIEVAL	9

Basics of object recognition and image search, Object Recognition -Patterns and pattern class, Bayes' Parametric classification, Feature Selection and Boosting, Template- Matching. Content Based Image Retrieval - Feature based image retrieval, Object Based Retrieval.

UNIT IV	IMAGE ANALYSIS USING MACHINE LEARNING	9

Convolutional image processing; Basic architecture of a convolutional neural network for machine vision applications. Introduction to PyTorch. Training, activation, normalization, ensembles, data augmentation for Detection and segmentation in images. Processing video for motion estimation, and human action recognition.

UNIT V	VIDEO PROCESSING	9

Digital Video, Sampling of video signal, Video Enhancement and Noise Reduction- Rate control and buffering, MPEG, H.264, Inter frame Filtering Techniques, Fundamentals of Motion Estimation and Motion Compensation. Change Detection, Background modelling, Motion Segmentation, Simultaneous Motion Estimation and Segmentation, Motion Tracking, Multi-target/Multi-camera tracking

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the requirements of image processing

CO2: Illustrate the principles and techniques of digital image in applications related to digital imaging system.

CO3: Demonstrate the image recognition and motion recognition.

CO4: Understand the fundamentals of digital video processing.

CO5: Illustrate the motion estimation, segmentation and modelling.

CO6: Design and Analysis of video processing in application.

TEXT BOOKS:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Third Ed., Prentice-Hall, 2008.
2. A. Murat Tekalp, Digital Video Processing, Second Edition, Prentice Hall, 2015.

REFERENCES:

1. Oge Marques, Practical Image and Video Processing Using MATLAB, Wiley-IEEE Press, 2011.
2. Yu Jin Zhang, Image Engineering: Processing, Analysis and Understanding, Tsinghua University Press, 2009.
3. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.
4. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.
5. Boguslaw Cyganek, Object Detection and Recognition in Digital Images: Theory and Practice, Wiley, 2013.

NPTEL LINK:

https://nptel.ac.in/courses/108103174

HONORS in VLSI

COURSE CODE	COURSE TITLE	L	T	P	C
21EC947	SEMICONDUCTOR DEVICES AND FABRICATION PROCESSES	3	0	0	3

COURSE OBJECTIVES:

- To acquire fundamental knowledge and to be exposed to the field of semiconductor theory, devices and their applications.
- To understand the semiconductor device modelling aspects, designing devices for electronic applications.
- To gain fundamental knowledge of different semiconductor device modelling aspects.
- To understand the short channel effects of MOSFET.
- To gain knowledge on VLSI technology.

UNIT I	MOS CAPACITORS	9

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

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.

UNIT III	ANALYSIS OF SHORT CHANNEL EFFECTS	9

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 IV	CMOS DEVICE DESIGN	9

CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Non Uniform 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 V	VLSI TECHNOLOGY	9

Material properties and crystal growth-Diffusion and Ion Implantation - Oxidation, Isolation and Epitaxy - Diffusion, Etching and Lithography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explore the properties of MOS capacitors.

CO2: Analyze the various characteristics of MOSFET devices.

CO3: Analyze the short channel effects of MOSFET.

CO4: Describe the various CMOS design parameters.

CO5: Explain the impact of design parameters on performance of the device.

CO6: Explore the concepts of fabrication process.

TEXT BOOKS:

1. Yuan Taur and Tak H.Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 2016.
2. Sze S.M., VLSI Technology, Tata McGraw Hill, 2013.

REFERENCES:

1. A.B. Bhattacharyya, Compact MOSFET Models for VLSI Design, John Wiley & Sons Ltd, 2009.
2. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th Edition, PHI Private Limited, 2011.
3. Behzad Razavi, Fundamentals of Microelectronics, Wiley Student Edition, 2nd Edition, 2014.
4. S.M.Sze, Kwok.K. NG, Physics of Semiconductor devices, Springer, 2006.
5. M. Lundstrom,Fundamentals of Carrier Transport, Cambridge University Press, 2000.

NPTEL LINK:

http://nptel.ac.in/courses/117106033

COURSE CODE	COURSE TITLE	L	T	P	C
21EC948	RFIC DESIGN	3	0	0	3

COURSE OBJECTIVES:

- To study the various impedance matching techniques used in RF circuit design.
- To study amplifier design.
- To analyze oscillators performance.
- To understand the functional design aspects of LNAs, Mixers, PLLs and VCOs.
- To understand frequency synthesis.

UNIT I	IMPEDANCE MATCHING IN AMPLIFIERS	7

Characteristics of passive IC components at RF frequencies – Definition of 'Q', Series Parallel Transformations of Lossy Circuits, Impedance Matching Using 'L', 'Pi' and T Networks, Integrated Inductors, Resistors, Capacitors, Tunable Inductors, Transformers

UNIT II	HIGH FREQUENCY AMPLIFIER DESIGN	10

High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, fTdoublers, Low noise amplifier design – LNA topologies, impedance matching, power constrained noise optimization, linearity and large signal performance.

UNIT III	ACTIVE AND PASSIVE MIXERS	10

Mixers – fundamentals of mixers, multiplier-based mixers, sub sampling mixers, diode-ring mixers.

UNIT IV	OSCILLATORS	9

Oscillators– Feedback View of Oscillators, Colpitts oscillator, Hartley oscillator, describing functions, tuned oscillators, negative resistance oscillators.

UNIT V	PLL AND FREQUENCY SYNTHESIZERS	9

Phase Detector/Charge Pump, Analog Phase Detectors, Digital Phase Detectors, Frequency Dividers, Loop Filter Design, Phase Locked Loops, Phase Noise in PLL, Loop Bandwidth, Basic Integer-N Frequency Synthesizer, Basic Fractional-N Frequency Synthesizer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: To understand the principles of operation of an RF receiver front end.

CO2: To design and apply constraints for LNAs, Mixers and frequency synthesizers.

CO3: To analyze and design mixers.

CO4: To design different types of oscillators and perform noise analysis.

CO5: To design PLL and frequency synthesizer.

CO6: To understand passive components at RF frequencies and required circuit theory.

TEXT BOOKS:

1. Thomas H. Lee, Cambridge, The Design of CMOS Radio-Frequency Integrated Circuits, UK: Cambridge University Press, 2004.
2. Phillip E. Allen and Douglas R. Holberg- CMOS Analog Circuit Design Oxford University Press - 3rd Ed., -2011.

REFERENCES:

1. Behzad Razavi, RF Microelectronics, Prentice Hall, 1998.
2. Ludwig, Rf Circuit Design, 2nd Ed., Pearson,2011.
3. Bosco H Leung VLSI for Wireless Communication, Pearson Education, 2002.
4. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Mcgraw-Hill, 1999.
5. Jia-Sheng Hong, Microstrip Filters for RF/Microwave Applications, Wiley, 2001.

NPTEL LINK:

https://nptel.ac.in/courses/117102012

COURSE CODE	COURSE TITLE	L	T	P	C
21EC949	VLSI ALGORITHMS AND ARCHITECTURES	3	0	0	3

COURSE OBJECTIVES:

- To discuss the algorithms for logic synthesis and verification.
- To discuss the design tradeoff in various partitioning algorithms, placement, floor planning and pin assignment of VLSI design automation.
- To analyze the different global routing algorithms.
- To describe the basics of 7 series FPGA Architecture.
- To discuss the various implementation strategies with FPGA.

UNIT I	LOGIC SYNTHESIS & VERIFICATION	7

Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High - level synthesis, Introduction to Circuit Simulation - Co – Simulation.

UNIT II	PARTITIONING, PLACEMENT, FLOOR PLANNING & PIN ASSIGNMENT	10

Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms, simulation base placement algorithms, other placement algorithms, constraint-based floor planning, floor planning algorithms for mixed block & cell design. General & channel pin assignment.

UNIT III	GLOBAL ROUTING	10

Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches Detailed Routing: problem formulation, classification of routing algorithms, single layer routing algorithms, two-layer channel routing algorithms, three-layer channel routing algorithms,

and switchbox routing algorithms Over The Cell Routing & Via Minimization: two layers over the cell routers, constrained & unconstrained via minimization.

UNIT IV	INTRODUCTION TO FPGA ARCHITECTURES	9

Logic blocks, routing architecture, Design flow –Strengths and Weaknesses of FPGA, Application and computational Characteristics and Performance in Xilinx Virtex-7, Spartan-7 FPGAs

UNIT V	IMPLEMENTING APPLICATIONS WITH FPGA	9

General Implementation Strategies for FPGA-based Systems - Configure-once Runtime Reconfiguration Design Flow –. Implementing Arithmetic - Fixed-point, Floating- point, Block Floating Point Number Representation - CORDIC Architectures for FPGA Computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze the algorithms needed for synthesis.

CO2: Explore the partitioning, placement and floorplanning algorithm.

CO3: Describe the various global routing algorithm.

CO4: Analyze the classification of channel routing algorithm.

CO5: Describe the routing architecture of FPGA.

CO6: Implement application with FPGA.

TEXT BOOKS:

1. Naveed Shervani, Algorithms for VLSI physical design Automation, Kluwer Academic Publisher, Third Edition,2017.
2. P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall (Pte), 1994.

REFERENCES:

1. Trimburger, Introduction to CAD for VLSI, Kluwer Academic publisher, 2002.
2. Sabih H.Gerez, Algorithms for VLSI Design Automation, John Wiley & Sons, 2007.
3. J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley & Sons, New York, 1995.
4. Christophn Meinel & Thorsten Theobold, Algorithm and Data Structures for VLSI Design, Kluwer Academic publisher, 2002.
5. 7 series FPGA's Data sheets of Artix-7, Kintex-7, Virtex-7 -xilinx-2020.

NPTEL LINK:

https://nptel.ac.in/courses/108105118

COURSE CODE	COURSE TITLE	L	T	P	C
21EC950	VLSI DESIGN TESTING AND VERIFICATION	3	0	0	3

COURSE OBJECTIVES:

- Model and simulate different types of faults in digital circuits at the gate level.
- Establish equivalence and dominance relationships of faults in a circuit.
- compare automatic test pattern generation algorithms with respect to search space, speed, fault coverage and other criteria.
- Handle design complexity, ensure reliable operation, and achieve short time-to-market using various testing methodologies.
- To study Fault Diagnosis.

UNIT I	FAULT MODELING	9

Importance of Testing - Testing during the VLSI Lifecycle - Challenges in the VLSI Testing: Test Generation - Fault Models - Levels of Abstraction in VLSI Testing - Historical Review of VLSI Test Technology - Functional Versus Structural Testing - Levels of Fault Models – Fault Equivalence - Fault Dominance - Fault Collapsing - Check point Theorem - Delay Fault.

UNIT II	FAULT SIMULATION AND TEST GENERATION	9

Fault Simulation: Serial, Parallel, Deductive, Concurrent - Combinational Test Generations - ATPG for Combinational Circuits - D-Algorithm - Testability Analysis - SCOAP measures for Combinational Circuits.

UNIT III	SCAN BASED TESTING	9

Design for Testability Basics - Ad Hoc Approach - Structured Approach - Scan Cell Designs - Scan Architectures - Scan Design Rules - Scan Design Flow – Special Purpose Scan Designs -RTL Design for Testability.

UNIT IV	BUILT IN SELF TEST	9

BIST Design Rules - Test Pattern Generation - Exhaustive Testing - Pseudo-Random Testing - Pseudo-Exhaustive Testing - Delay Fault Testing - Output Response Analysis - Logic BIST Architectures - BIST Architectures for Circuits with and without Scan Chains.

UNIT V	FAULT DIAGNOSIS	9

Introduction and Basic Definitions-Fault Models for Diagnosis-Generation of Vectors for Diagnosis-Combinational Logic Diagnosis-Scan Chain Diagnosis-Logic BIST Diagnosis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Model different fault models.

CO2: Simulate faults and generate test patterns for combinational circuits.

CO3: Apply scan-based testing.

CO4: Recognize the BIST techniques for improving testability.

CO5: Understand boundary scan-based test architectures.

CO6: Perform Fault Diagnosis.

TEXT BOOKS:

1. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003.
2. P. K. Lala, Digital Circuit Testing and Testability, Academic Press,1997.

REFERENCES:

1. M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning about systems, Cambridge University Press, 2nd Edition, 2004.
2. Michael L. Bushnell and Vishwani D. Agrawal, Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits, Kluwer Academic Publishers, 2017.
3. Niraj K. Jha and Sandeep Gupta, Testing of Digital Systems, Cambridge University Press, 2017.
4. Laung-Terng Wang, Cheng-Wen Wu and Xiaoqing Wen, VLSI Test Principles and Architectures, Elsevier, 2017.
5. Zainalabedin Navabi, Digital System Test and Testable Design: Using HDL Models and Architectures, Springer,2011.

NPTEL LINK:

https://archive.nptel.ac.in/courses/117/103/117103125/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC951	SoC AND LOW POWER VLSI DESIGN	3	0	0	3

COURSE OBJECTIVES:

- To identify sources of power in an IC.
- To understand basic principle of System on Chip design.
- To learn optimization of power in combinational and sequential logic machines for SoC Design.
- To identify suitable techniques to reduce the power dissipation and design circuits with low power dissipation.
- To understand Back End Process and Various Floor planning methods.

UNIT I	POWER CONSUMPTION IN CMOS	9

Physics of power dissipation in CMOS FET devices – Hierarchy of limits of power – Sources of power consumption – Static Power Dissipation, Active Power Dissipation - Designing for Low Power, Circuit Techniques for Leakage Power Reduction - Basic principle of low power design, Logic level power optimization – Circuit level low power design.

UNIT II	SYSTEM-ON-CHIP DESIGN	9

System-on-Chip Concept, Design Principles in SoC Architecture, SoC Design Flow, Platform based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

UNIT III	POWER OPTIMIZATION OF COMBINATIONAL AND SEQUENTIAL LOGIC MACHINES FOR SOC	9

Introduction to Standard Cell-Based Layout – Simulation - Combinational Network Delay - Logic and interconnect Design - Power Optimization - Switch Logic Networks. Introduction - Latches and Flip-Flops - Sequential Systems and Clocking Disciplines - Sequential System Design - Power Optimization - Design Validation - Sequential Testing.

UNIT IV	DESIGN OF LOW POWER CIRCUITS FOR SUB SYSTEM ON A SoC	9

Subsystem Design Principles - Combinational Shifters – Adders – ALUs – Multipliers – High Density Memory – Field Programmable Gate Arrays - Programmable Logic Arrays - Computer arithmetic techniques for low power system – low voltage low power static Random access and dynamic Random-access memories, low power clock, Inter connect and layout design.

UNIT V	FLOOR PLANNING	9

Floor-planning Methods – Block Placement & Channel Definition - Global Routing - switchbox Routing - Power Distribution - Clock Distributions - Floor-planning Tips - Design Validation – Off Chip Connections – Packages, The I/O Architecture - PAD Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understanding various sources of power dissipation.

CO2: Analyze low-power VLSI circuits using different circuit technologies for system on chip design.

CO3: Design low-power VLSI circuits using different circuit technologies for system on chip design.

CO4: Design of low power circuits for sub system on a SoC.

CO5: Understanding various Floor planning Techniques.

CO6: Understand Design validation steps for digital design.

TEXT BOOKS:

1. J.Rabaey, Low Power Design Essentials (Integrated Circuits and Systems), Springer, 2009.
2. Wayne Wolf, Modern VLSI Design – System – on – Chip Design‖, Prentice Hall, 3rd Edition, 2008.

REFERENCES:

1. J.B.Kuo & J.H.Lou, Low-voltage CMOS VLSI Circuit, Wiley, 1999.
2. A.Bellaowar & M.I.Elmasry, Low power Digital VLSI Design, Circuits and Systems, Kluwer, 1996.
3. Swarup Bhunia, Sandip Ray and Susmita Sur-kolay, Fundamentals of IP and SoC Security:Design Verification and Debug, Springer 2017.
4. Amr M Fahim, Clock Generators for SOC Processors: Circuits and Architectures, Kluwer Academic Publishers 2005.
5. Furber S, ARM System on Chip Architecture, springer 2010.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105034/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC952	RECONFIGURABLE ARCHITECTURES	3	0	0	3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of sequential system design, synchronous and Asynchronous circuits.
- To understand Various advanced architectural techniques.
- To summarize different concepts of Low power FPGA architecture.
- To introduce basics of Reconfigurable processors.
- To familiarize the Network on Chip for any embedded applications.

UNIT I	INTRODUCTION TO ADVANCED DIGITAL SYSTEM DESIGN	9

Modeling of Clocked Synchronous Sequential Network (CSSN), Design of CSSN, Design of Asynchronous Sequential Circuits (ASC), Designing Vending Machine Controller, Races in ASC, Static and Dynamic Hazards, Essential Hazards, Designing Hazard free circuits.

UNIT II	ADVANCED ARCHITECTURAL TECHNIQUES	9

Tree based FPGA Routing architectures: Interconnect description, Interconnect depopulation, Rent's Rule based model – Configuration flow, 2D Physical Design – wirelength optimization – Performance improvements.

UNIT III	ARCHITECTURES FOR LOW POWER FPGA'S	9

Power consumption in FPGAs – power and clock gating in FPGAs – Multi V_{DD} architectures – Power reduction in FPGA Routing Structures – Glitch Reduction – Ultra Low power FPGAs.

UNIT IV	RECONFIGURABLE PROCESSORS	9

Reconfigurable Hardware architectures – MPSoC and NoCs – Reconfigurable architecture management – Partially reconfigurable Processors – Reconfigurable architecture modeling – exploration and implementation flow.

UNIT V	NETWORKS ON CHIP	9

Introduction – Challenges in FPGA Interconnection – architecting Embedded NoCs on FPGA – Fabric Port – Future Prospects of Embedded NoCs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the design flow of modeling advanced digital systems.

CO2: Analyze various hazards in the digital systems.

CO3: Summarize various architectural techniques for advanced applications.

CO4: Contrast the architectural needs for modeling Low power FPGAs.

CO5: Discuss various reconfigurable processors.

CO6: Illustrate the steps in architecting NoCs for any given embedded applications.

TEXT BOOKS:

1. Donald G. Givone, Digital principles and Design, Tata McGraw Hill, 2002.
2. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications, 1st Edition, CRC Press, 2015.

REFERENCES:

1. Charles H. Roth Jr., Fundamentals of Logic design, Thomson Learning, 2004.
2. Joao Cardoso, Michael Hübner, Reconfigurable Computing: From FPGAs to Hardware/Software Codesign, Springer, 2011.
3. William J. Dally / Curtis Harting / Tor M. Aamodt, Digital Design Using VHDL: A Systems Approach, Cambridge University Press,2015.
4. Christian de Schryver & Henning Marxen & Stefan Weithoffer & Norbert Wehn (auth.) & Wim Vanderbauwhede & Khaled Benkrid (eds.) , High-Performance Computing Using FPGAs, Springer, 2013.
5. Gaillardon & Pierre-Emmanuel, Reconfigurable logic: architecture, tools, and applications, Taylor & Francis Group, 2018.

NPTEL LINK:

https://archive.nptel.ac.in/courses/108/105/108105118/

HONOURS in HIGH SPEED COMMUNICATION

COURSE CODE	COURSE TITLE	L	T	P	C
21EC953	ADVANCED WIRELESS COMMUNICATION	3	0	0	3

COURSE OBJECTIVES:

- To understand the importance of improving capacity of wireless channel using MIMO
- To study the characteristics of wireless channels.
- To analyze the channel impairment mitigation using space-time block codes.
- To analyze the channel impairment mitigation using Trellis codes.
- To learn the advanced MIMO system like layered space time codes

UNIT I	INTRODUCTION	9

The crowded spectrum, need for high data rate, MIMO systems – Array Gain, Diversity Gain, Data Pipes, Spatial MUX, MIMO System Model. MIMO System Capacity – channel known at the TX, Channel unknown to the TX – capacity of deterministic channels, Random channels and frequency selective channels.

UNIT II	RADIO WAVE PROPAGATION	9

Radio wave propagation – Macroscopic fading- free space and out door, small scale fading –Fading measurements – Direct pulse measurements, spread spectrum correlation channel sounding frequency domain channel sounding, Antenna Diversity – Diversity combining methods.

UNIT III	SPACE TIME BLOCK CODES	9

Delay Diversity scheme, Alamouti space time code – Maximum likelihood decoding maximum ratio combining. Transmit diversity space time block codes for real signal constellation and complex signal constellation - decoding of STBC.

UNIT IV	SPACE TIME TRELLIS CODES	9

Space time coded systems, space time code word design criteria, design of space time T C on slow fading channels, design of STTC on Fast Fading channels, performance analysis in slow and fast fading channels, effect of imperfect channel estimation and Antenna correlation on performance, comparison of STBC & STTC.

UNIT V	LAYERED SPACE TIME CODES	9

LST transmitter – Horizontal and Vertical LST receiver – ML Rx, Zero forcing Rx; MMSE Rx, SIC Rx, ZF V-blast Rx- MMSE V-blast Rx, Iterative Rx - capacity of MIMO – OFDM systems – capacity of MIMO multi user systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the importance of MIMO in today's communication

CO2: Identify different effects of radio propagation in Wireless Channel.

CO3: Evaluate the channel impairment mitigation techniques using Block codes.

CO4: Evaluate the channel impairment mitigation techniques using Trellis Codes

CO5: Understand and differentiate various Layered Space Time Codes.

CO6: Identify the various methods for improving the data rate of wireless communication system

TEXT BOOKS:

1. Mohinder Jankiraman, Space Time Codes and MIMO Systems", Artech House, Boston, London . www.artech house.com, 2004.
2. Paulraj Rohit Nabar, Dhananjay Gore, Introduction of Space Time Wireless Communication Systems, Cambridge University Press, 2003.

REFERENCES:

1. David Tse and PramodViswanath, Fundamentals of Wireless Communication, CambridgeUniversity Press, 2005.
2. Sergio Verdu Multi User Detection, Cambridge University Press, 1998.
3. Andre Viterbi, Principles of Spread Spectrum Techniques, Addison Wesley 1995
4. Volker Kuhn, Wireless communication over MIMO channels, John Wiley and Sons Ltd., 2006.
5. Franco De Flaviis, Lluis Jofre, Jordi Romeu, Alfred Grau, Multiantenna Systems for MIMO Communications, Morgan & Claypool Publishers, First Edition, 2008.

NPTEL LINK:

https://archive.nptel.ac.in/courses/117/105/117105132/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC954	ADVANCED WIRELESS NETWORKS	3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge about the digital cellular systems
- To build an understanding of the concepts and performance of IEEE 802.16 standard.
- To build knowledge on LTE specific signalling protocols and procedures.
- To understand Wireless local and personal area network setup & its security
- To comprehend the concepts of cognitive radio technologies

UNIT I	3G MOBILE CELLULAR TECHNOLOGIES	9

CDMA2000-Operational Advantages, General Architecture, Airlink Design, Data Throughput, Forward Link Scheduling, Reverse Link, CDMA2000 1xEV Signaling, Handoffs, CDMA2000 1xEV-DO, CDMA2000 1xEV-DV. WCDMA-ETSI UMTS versus ARIB WCDMA, UMTS Cell and Network Structure, UMTS Radio Interface, UMTS, UTRA Channels, UTRA Multiplexing and Frame Structure, Spreading and Carrier Modulations, Packet Data, Power Control Handovers.

UNIT II	WiMAX	9

Background on IEEE 802.16 and WiMAX, Salient Features of WiMAX, WiMAX Physical Layer, MAC-Layer Overview, Advanced Features for Performance Enhancements, Reference Network Architecture, Performance Characterization

UNIT III	LTE AND LTE-ADVANCED NETWORKS	9

Overview of LTE Networks, The Radio Protocol Architecture, The Interfaces, Support for Home eNBs (Femtocells), Air Interface, Frame Structure, UE States and State Transitions, Quality of Service and Bandwidth Reservation, Mobility Management, Security, Frame Structure in LTE, Frame-Structure in LTE-Advanced, LTE Identification, Naming and Addressing.

UNIT IV	WIRELESS DATA NETWORKS	9

IEEE 802.11 Standards for Wireless Networks, IEEE 802.11a Supplement to 802.11 Standards, IEEE 802.11 Security, IEEE 802.15 WPAN Standards, ETSI HIPERLAN and ETSI HIPERLAN/2 Standards, Bluetooth Technologies.

UNIT V	COGNITIVE RADIO TECHNOLOGY & 5G	9

Definitions of Cognitive Radio, Basic Cognitive Algorithms, Conceptual Classifications of Cognitive Radios, Cognitive Radio for WPANs, Cognitive Radio for WLANs, Cognitive Radio for WMANs, Cognitive Radio for WWANs, Cognitive Radio for WRANs: IEEE 802.22, Challenges to Implement Cognitive Radio.5G system concept, Concept overview, Extreme mobile broadband, Massive machine-type communication, Ultra-reliable machine-type communication-The 5G architecture-NFV and SDN-Basics about RAN architecture, D2D standardization: 4G LTE D2D, New relaying Techniques for 5G.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1 : Apply Digital cellular concepts in the design of Cellular networks

CO2: Build and Design the wireless networks based on the IEEE 802.16 standard

CO3: Explain the LTE related components and its functions
CO4: Demonstrate advanced knowledge of networking and performance of data networks and define performance metrics
CO5: Explain the concepts behind the cognitive wireless networks and next generation Networks
CO6: Explain the concept of new relaying techniques for 5G.

TEXT BOOKS:

1. William Stallings; Foundations of Modern Networking, 1st Ed.; Pearson Education India,2016
2. Hsiao-Hwa Chen and Mohsen Guizani, Next Generation Wireless Systems and Networks, John Wiley & Sons Ltd, 2006.

REFERENCES:

1. Abd-Elhamid M Taha, Hossam S Hassanein and Najah Abu Ali, LTE, LTE-Advanced and WiMAX towards IMT-Advanced Networks, John Wiley & Sons, Ltd, 2012.
2. Jeffrey G Andrews, Arunabha Ghosha and Rias Muhamed, Fundamentals of WiMAX
3. Fazel K and Kaiser S, Multi-Carrier and Spread Spectrum Systems-From OFDM and MC-CDMA to LTE and WiMAX, John Wiley & Sons, Second Edition, 2008.
4. Steve Rackley, Wireless Networking Technology from Principles to Successful Implementation, Elsevier, 2007.
5. Paul Goransson, Chuck Black, Software Defined Networks: A Comprehensive Approach,1st Edition, 2006

NPTEL LINK: http://www.nitttrc.edu.in/nptel/courses/video/106105160

COURSE CODE	COURSE TITLE	L	T	P	C
21EC955	SOFTWARE DEFINED NETWORKS	3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of software defined networks
- To understand the separation of the data plane and the control plane.
- To study about the data center concepts in SDN
- To understand the programming in SDN and network function virtualization concept
- To build an SDN framework and understand the concept of data center orchestration

UNIT I	INTRODUCTION TO SDN	9

History of Software Defined Networking (SDN) – Modern Data Center – Traditional Switch Architecture – Why SDN – Evolution of SDN – How SDN Works – Centralized and Distributed Control and Date Planes

UNIT II	OPEN FLOW AND SDN CONTROLLERS	9

Open Flow Specification – Drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor- Based Overlays – SDN via Opening up the Device – SDN Controllers – General Concept

UNIT III	DATA CENTER CONCEPTS	9

Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE

UNIT IV	NETWORK FUNCTION VIRTUALIZATION	9

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

UNIT V	BUILDING AN SDN FRAMEWORK	9

Juniper SDN Framework – IETF SDN Framework – Open Daylight Controller – Floodlight Controller – Bandwidth Calendaring – Data Center Orchestration

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyze the evolution of software defined networks

CO2: Express the various components of SDN and their uses

CO3: Explain the use of SDN in the current networking scenario

CO4: Design and develop various applications of SDN

CO5: Apply the concept in building SDN framework

CO6: Discuss the use cases.

TEXT BOOKS:

1. Paul Goransson and Chuck Black, Software Defined Networks: A Comprehensive Approach, First Edition, Morgan Kaufmann, 2014.
2. Thomas D. Nadeau, Ken Gray, SDN: Software Defined Networks, O'Reilly Media, 2013.

REFERENCES:

1. Oswald Coker, Siamak Azodolmolky, Software-Defined Networking with OpenFlow, 2nd Edition, O'Reilly Media, 2017
2. Vivek Tiwari, SDN and Open Flow for Beginners, Amazon Digital Services, Inc., 2013.
3. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud, Pearson Education, 1st Edition, 2015
4. Fei Hu, Network Innovation through OpenFlow and SDN: Principles and Design, 1st Edition, CRC Press, 2014
5. Ken Gray, Thomas D. Nadeau, Network Function Virtualization, Morgan Kauffman, 2016

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc21_cs18/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC956	SATELLITE COMMUNICATION & NAVIGATION SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

- To learn the basic parameters in satellite communication.
- Learn M2M developments and satellite applications.
- Understand Satellite Communication In IPv6 Environment.
- Learn the concepts of GPS Working and its application.
- Understand the concepts of Deep Space Networks and Inter Planetary Mission.

UNIT I	OVERVIEW OF SATELLITE COMMUNICATION	9

Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

UNIT II	M2M DEVELOPMENTS AND SATELLITE APPLICATIONS	9

Overview of the Internet of Things and M2M- M2M Applications Examples and Satellite Support- Satellite Roles Context and Applications- Antennas for Satellite M2M Applications- M2M Market Opportunities for Satellite Operators

UNIT III	SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT	9

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence-Implementation scenarios and support- Preparations for IPv6 in Satellite communication- Satellite specific Protocol issues in IPv6 – Impact of IPv6 on Satellite Network architecture and services.

UNIT IV	SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM	9

Overview of Radio and Satellite Navigation, GPS Principles, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data, GPS Receiver Operation and Differential GPS.

UNIT V	DEEP SPACE NETWORKS AND INTER PLANETARY MISSION	9

Introduction – Functional description - Design procedure and performance criterion-Mars exploration Rover-Mission and spacecraft summary-Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance Telecom subsystem Hardware and software Chandrayaan-1 Mission - Mission and spacecraft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Discuss Satellite navigation and global positioning system

CO2: Understand deep space networks and inter planetary missions

CO3: Demonstrate an understanding of the different interferences and attenuation mechanisms affecting the satellite link design.

CO4: Demonstrate an understanding of the different communication, sensing and navigational applications of satellite.

CO5: Familiar with the implementation aspects of existing satellite based systems.

CO6:Understand the CHANDRAYAN mission and its working

TEXT BOOKS:

1. Anil K. Maini, Varsha Agrawal, 'Satellite Technology: Principles and Applications', Third Edition, Wiley, 2014.
2. Daniel Minoli, Satellite Systems Engineering in an IPv6 Environment, CRC Press, First Edition, 2009.

REFERENCES:

1. Daniel Minoli' Innovations in Satellite Communication and Satellite Technology Wiley,2015
2. Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, Global Navigational Satellite Systems Springer-Verlag, 2008.
3. Adimurthy.V, Concept design and planning of India's first interplanetary mission Current Science, VOL. 109, NO. 6, 1054 25 SEPTEMBER 2015.
4. Jim Taylor,Deep Space Communications John Wiley & Sons, 2016
5. Louis J. Ippolito, Jr. Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance, Second Edition, 2017

NPTEL LINK:

https://archive.nptel.ac.in/courses/117/105/117105131/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC957	INFORMATION STORAGE AND CLOUD COMPUTING	3	0	0	3

COURSE OBJECTIVES:

- To learn the concept of cloud computing.
- To understand the trade-off between deploying applications in the cloud over local infrastructure.
- To identify different storage virtualization technologies and their benefits.
- To understand and articulate business continuity solutions including backup and recovery technologies, local and remote replication solutions.
- To learn various Storage security and Management.

UNIT I	INTRODUCTION	9

Distributed Computing and Enabling Technologies, Cloud Fundamentals: Cloud Definition, Evolution, Architecture, Applications, Deployment models and service models. Virtualization: Issues with virtualization, Virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, Virtualization of data centers and Issues with Multi-tenancy.

UNIT II	IMPLEMENTATION	9

Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine and Microsoft Azure, Build Private/Hybrid Cloud using open source tools, Deployment of Web Services from inside and outside a Cloud Architecture, Map Reduce and its extensions to Cloud Computing, HDFS and GFS.

UNIT III	STORAGE VIRTUALIZATION	9

Fixed Content and Archives, Types, Features, Benefits, CAS Architecture, Object storage and retrieval, Examples: Storage Virtualization-forms of virtualization, SNIA Taxonomy – Storage virtualization configurations, Challenges, Types of storage virtualization - Business Continuity- Overview of emerging technologies such as Cloud storage, Virtual provisioning, Unified Storage, FCOE, FAST.

UNIT IV	BUSINESS CONTINUITY AND RECOVERY	9

Information Availability, BC Terminology, Life cycle, Failure analysis: Backup and Recovery- Backup purpose, considerations, Backup Granularity, Recovery considerations- Backup methods, Process, backup and restore operations, Overview of emerging technologies: Duplication, Off site backup.

UNIT V	STORAGE SECURITY AND MANAGEMENT	9

Storage security framework, Securing the Storage infrastructure, Risk triad: Managing the storage infrastructure, Monitoring the storage infrastructure, identify key parameters and components to monitor in a storage infrastructure, List key management activities and examples, Define storage management standards and initiative-Industry trend.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: To understand the key dimensions of the challenge of Cloud Computing.

CO2: To assess the economics, financial and technological implications for selecting cloud computing for organization.

CO3: To describe and apply storage technologies.

CO4: To identify leading storage technologies that provide cost-effective IT solutions for medium to large scale businesses and data centres.

CO5: To describe important storage technology features such as availability, replication, scalability and performance.

CO6: To describe and apply storage security and management technique

TEXT BOOKS:

1. Barrie Sosinsky, Cloud Computing Bible, Wiley Publishers 2010.
2. Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly 2010.

REFERENCES:

1. EMC Corporation, Information Storage and Management, 1st Edition, Wiley India 2009
2. Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, Mastering Cloud Computing , McGraw Hill, 2013
3. IBM, Introduction to Storage Area Networks and System Networking, 5th Edition, November 2012.
4. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing - A Practical Approach‖, Tata Mcgraw Hill, 2009.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)‖, O'Reilly, 2009.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105167/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC958	CRYPTOGRAPHY AND NETWORK SECURITY	3	0	0	3

COURSE OBJECTIVES:

- To learn security mechanisms and techniques to provide security services.
- To be exposed to symmetric & asymmetric key algorithms.
- To be exposed to key management aspects
- To be aware of the need for Firewalls and Web security
- To learn Wireless Network Security.

UNIT I	SECURITY SERVICES AND MECHANISMS	9

Security Goals, Types of Attacks: Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability. Security services – Confidentiality, Integrity, Authentication, Nonrepudiation& Access control and Mechanisms- Encipherment, Data Integrity, Digital Signature, Authentication Exchange, Traffic Padding, Routing Control , Notarization & Access Control, Techniques: Cryptography, Steganography , Revision on Mathematics for Cryptography.

UNIT II	SYMMETRIC & ASYMMETRIC KEY ALGORITHMS	9

Substitutional Ciphers, Transposition Ciphers, Stream and Block Ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, Principle of Asymmetric key algorithms, RSA Cryptosystem.

UNIT III	INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT	9

Message Integrity, Hash functions: SHA, Digital signatures: Digital signature standards, Authentication: Entity Authentication: Biometrics, Key management Techniques.

UNIT IV	NETWORK SECURITY, FIREWALLS AND WEB SECURITY	9

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature.

UNIT V	WIRELESS NETWORK SECURITY	9

Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. WEP for Wi-Fi network, Security for 4G networks: Secure Ad hoc Network, Secure Sensor Network.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify and differentiate security attacks

CO2: Apply various Encryption Algorithms.

CO3: Apply various Authentication and Digital Signature Algorithms.

CO4: Configure firewalls based on the security requirements and secure the perimeter

CO5: Deal with different general purpose and application specific Security Protocols and Techniques

CO6: Provide security services at different layers for various network architectures.

TEXT BOOKS:

1. Behrouz A. Forouzan ,Debdeep Mukhopadhyay, Cryptography and Network security, Tata McGraw-Hill, Second Edition, 2011.
2. William Stallings, Cryptography and Network security: Principles and Practice, Prentice Hall of India, New Delhi, Sixth Edition, 2013.

REFERENCES:

1. AtulKahate , Cryptography and Network security, Tata McGraw- Hill, Third Edition, 2008
2. R.K.Nichols and P.C. Lekkas , Wireless Security Models, Threats and Solutions, Tata McGraw- Hill, First Edition, 2006.
3. H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution , IEEE Wireless Communications,Feb. 2004.
4. L. Zhou and Z. J. Haas , Securing Ad Hoc Networks, IEEE Network Magazine, vol. 13, no. 6, pp. 24-30, December 1999.
5. David Boyle and Thomas Newe, Securing Wireless Sensor Networks – Security Architecture, Journal of networks, Vol.3. No. 1. pp. 65 -76, Jan 2008

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105162/

MINOR DEGREE IoT

COURSE CODE	COURSE TITLE	L	T	P	C
21EC901	INTRODUCTION TO INTERNET OF THINGS	3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To learn about the IoT architecture
- To familiarize various IoT Protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real-world scenario.

UNIT I	INTRODUCTION TO IoT	9

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M.

UNIT II	IoT ARCHITECTURE	9

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture.

UNIT III	IoT PROTOCOLS	9

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – Zigbee Architecture – 6LowPAN – CoAP.

UNIT IV	BUILDING IoT WITH RASPBERRY PI & ARDUINO	9

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces - Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V	CASE STUDIES AND REAL-WORLD APPLICATIONS	9

Real world design constraints – Applications - Industrial automation, smart grid, Commercial building automation - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify IoT enabling technologies.

CO2: Discover different IoT Architecture.

CO3: Understand communication, network and security protocols

CO4: Develop IoT based applications with Raspberry Pi

CO5: Infer the applications of IoT in Real-world scenario.

CO6: Discover the advancements of IoT in various sectors

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015

2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.

REFERENCES:

1. Honbo Zhou, ―The Internet of Things in the Cloud: A Middleware Perspective‖, CRC Press, 2012.
2. Jan Holler, Vlasios Tsiatsis, 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. Olivier Hersent, David Boswarthick, Omar Elloumi, ―The Internet of Things – Key applications and Protocols‖, Wiley, 2012
4. David E. Goldberg, - IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017.
5. Maciej Kranz - Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry, John Wiley & Son, 2016.

NPTEL LINK:

https://archive.nptel.ac.in/courses/106/105/106105166/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC907	SENSORS AND ACTUATOR DEVICES	3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental principles and operating mechanisms of sensors and actuator devices.
- To familiarize the basic electronic circuits and systems used to interface sensors and actuator devices.
- To acquire the skills to create, construct, and validate basic sensor and actuator devices.
- To analyze, troubleshoot, and debug sensor and actuator systems.
- To develop real-time IoT based applications with sensors and actuators.

UNIT I	SENSORS AND ACTUATORS	9

Introduction to Sensors and Actuator- Sensor and Actuator Characteristics- Types of sensors and actuators - Calibration, accuracy, and precision of sensors - Signal conditioning and amplification of sensor signals.

UNIT II	SEVEN GENERATIONS OF IOT SENSORS	9

Introduction to IoT Sensors - First-generation sensors: temperature, light, and motion sensors - Second-generation sensors: proximity sensors, pressure sensors, and gas sensors - Third-generation sensors: biosensors, chemical sensors, and magnetic sensors - Fourth-generation sensors: intelligent sensors, microelectromechanical systems (MEMS) - Fifth-generation sensors: nanosensors, biometric sensors - Sixth-generation sensors: printed sensors, flexible sensors - Seventh-generation sensors: quantum sensors, carbon nanotube sensors, and neural sensors.

UNIT III	ACTUATORS AND ADVANCED SENSING TECHNIQUES	9

Electromechanical and electrothermal actuators: differences, characteristics, and use cases - Types of actuators: motors, solenoids, relays, and others - Control of actuator devices: DC, AC, and stepper motor control - H-bridge motor driver circuits.

UNIT IV	SENSORS FOR AUTOMOTIVE AND SMART CITIES	9

Introduction to automotive sensors and their applications - Types of automotive sensors: temperature, pressure, speed, position - Sensor requirements for automotive applications: reliability, durability, and accuracy. Introduction to sensors for smart city applications - Types of smart city sensors: air quality, noise, traffic, weather, and others - Sensor requirements for smart city applications: energy efficiency, data accuracy, and real-time monitoring.

UNIT V	DEVELOPING AN IOT BASED APPLICATIONS	9

Smart Energy Monitor Based on IoT, Develop a Face Recognizing Robot, Build an IoT based Smart Home System, IoT Based Air Quality Index Monitoring, IoT Based Contactless Body Temperature Monitor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Build schematic for IoT solutions with sensors.

CO2: Design and develop IoT based sensor systems.

CO3: Select the appropriate sensors for various industrial applications

CO4: Evaluate the wireless sensor technologies for IoT.

CO5: Design and develop an IoT Prototype project

CO6: Identify the IoT networking components with respect to sensors.

TEXT BOOKS:

1. D. Patranabis, Sensors and Transducers, 1st edition, PHI Learning Private Limited, 2013.
2. Maggie Lin and Qiang Lin., Internet of Things Ecosystem: 2nd Edition, 2021.

REFERENCES:

1. Timothy Chou, - Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA, 2020
2. Ravindra P. Singh and Narayan C. Kar, Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, CRC Press, 2014.
3. A.J. Siti Shafrah, R. Badlishah Ahmad, and I.A. Halim, Sensors and Actuators: Control System Instrumentation, Penerbit UTM Press, 2018
4. Sanjay Sharma, Sensors and Actuators: Engineering System Instrumentation, Second Edition, CRC Press, 2015.
5. Clarence W. de Silva, Intelligent Autonomous Systems 13: Proceedings of the 13th International Conference IAS-13, Springer, 2014.

NPTEL LINK:

https://archive.nptel.ac.in/courses/108/108/108108147/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC959	IMAGE AND VIDEO ANALYTICS	3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the basic principles and concepts in digital image and video processing.
- To explore and demonstrate real time image and video analytics in solving practical problems of commercial and scientific interests.
- To develop algorithms and techniques to analyse and interpret the visible world around us.
- To Understand the fundamental concepts related to feature extraction, pattern analysis visual geometric modelling etc.
- To explore and contribute to research and further developments in the field of Image and Video Analytics.

UNIT I	IMAGE PROCESSING	9

Basic steps of Image Processing System. Image Segmentation - Color-Based Image Segmentation. Transformation: Orthogonal, Euclidean, Projective. Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

UNIT II	FEATURE EXTRACTION AND TEXTURE ANALYSIS	9

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF - Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

UNIT III	OBJECT RECOGNITION AND IMAGE RETRIEVAL	9

Basics of object recognition and image search, Object Recognition - Patterns and pattern class, Bayes' Parametric classification, Feature Selection and Boosting, Template- Matching. Content Based Image Retrieval - Feature based image retrieval, Object Based Retrieval.

UNIT IV	IMAGE ANALYSIS USING MACHINE LEARNING	9

Convolutional image processing; Basic architecture of a convolutional neural network for machine vision applications. Introduction to PyTorch. Training, activation, normalization, ensembles, data augmentation for Detection and segmentation in images. Processing video for motion estimation, and human action recognition.

UNIT V	VIDEO PROCESSING	9

Digital Video, Sampling of video signal, Video Enhancement and Noise Reduction- Rate control and buffering, MPEG, H.264, Inter frame Filtering Techniques, Fundamentals of Motion Estimation and Motion Compensation. Change Detection, Background modelling, Motion Segmentation, Motion Tracking.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the requirements of image processing

CO2: Illustrate the principles and techniques of digital image in applications related to digital imaging system.

CO3: Demonstrate the image recognition and motion recognition.

CO4: Understand the fundamentals of digital video processing.

CO5: Illustrate the motion estimation, segmentation and modelling.

CO6: Design and Analysis of video processing in application.

TEXT BOOKS:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Third Ed., Prentice-Hall, 2008.
2. A. Murat Tekalp, Digital Video Processing, Second Edition, Prentice Hall, 2015.

REFERENCES:

1. Oge Marques, Practical Image and Video Processing Using MATLAB, Wiley-IEEE Press, 2011.
2. Yu Jin Zhang, Image Engineering: Processing, Analysis and Understanding, Tsinghua University Press, 2009.
3. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.
4. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.
5. Boguslaw Cyganek, Object Detection and Recognition in Digital Images: Theory and Practice, Wiley, 2013.

NPTEL LINK:

https://nptel.ac.in/courses/108103174

COURSE CODE	COURSE TITLE	L	T	P	C
21EC960	ROBOT OPERATING SYSTEM	3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamentals of robotic programming
- To summarize and analyze the different types of robot sensors and actuators.
- To introduce students the criteria for selecting a sensor and actuator for a particular application.
- To understand the Robot Operating System (ROS) fundamentals.
- To introduce students the criteria for selecting a sensor and actuator for a particular ROS robotic application.

UNIT I	ROBOTICS OPERATING SYSTEM (ROS)	9

Robot Introduction- Seven Criteria of Defining a Robot, Robot Controllers-Major Components, History of ROS, Sensors and Robots Supporting ROS, ROS Architecture and Concepts, ROS Filesystem Level.

UNIT II	ROS FUNDAMENTAL	9

Ubuntu Linux for Robotics-Ubuntu Graphical User Interface, Shell Commands, C++ and Python for Robotic Programming- Basic Concepts with Examples.

UNIT III	ROS PROGRAMMING	9

Creating ROS Workspace and Package, Using ROS Client Libraries, ROS Nodes and Topics – ROS command line tools – rosnode, rostopic.

UNIT IV	ROBOTIC PROJECTS USING ROS	9

Introduction to Wheeled Robots, Building Robot Hardware-Block Diagram and Assembling Robot Hardware, Programming Robot Firmware.

UNIT V	ROS NAVIGATION	9

Localizing the robot in a map, ROS Navigation Stack-hardware requirement-navigation packages, path planning, motion planning of robot.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the robotics design and implementation.

CO2: Comprehend, classify and analyze the behavior of different types of sensors and actuators.

CO3: Understand the ROS fundamentals

CO4: Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.

CO5: Design robotic applications using ROS.

CO6: Design Robots with Localization.

TEXT BOOKS:

1. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018.

2. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.

REFERENCES:

1. Hughes, C. and Hughes, T., Robot programming: a guide to controlling autonomous robots. Que Publishing, 2016.
2. Quigley, M., Gerkey, B. and Smart, W.D., Programming Robots with ROS: a practical introduction to the Robot Operating System, O'Reilly Media, 2015.
3. Anil Mahtani, Luis Sanchez, Enrique Fernandez, Aaron Martinez, Lentin Joseph. ROS Programming: Building Powerful Robots. Packt Publishing, 2018.
4. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.

NPTEL LINK:

https://archive.nptel.ac.in/courses/112/105/112105249/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC961	CAPSTONE PROJECT	0	0	12	6

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of IoT technologies, including sensors, actuators, and image and video analytics, and how they can be integrated into practical solutions.
- To enable students to design and develop IoT systems using the Robot Operating System (ROS), a widely used open-source robotics middleware platform.
- To give students hands-on experience with IoT technologies through the development of a Capstone project that addresses a real-world problem or meets a specific need in the industry, healthcare, agriculture, or smart homes.
- To foster teamwork, creativity, and communication skills by working collaboratively on a Capstone project that involves industry partners, stakeholders, or end-users.
- To prepare students for a successful career in the rapidly growing field of IoT by enhancing their problem-solving skills, critical thinking, and adaptability to new technologies and challenges.

STRATEGY:

- A student or a group of students (maximum 4) has to identify a topic of interest in consultation with faculty supervisor.
- They review the literature and gather information pertaining to the chosen topic and state the objectives and develop a methodology to achieve the objectives.
- Based on the topic, experimental investigation/ software analysis/ analytical modelling will be carried out.
- The results will be analyzed with a concluding remark to correlate the objectives.
- A comprehensive report will be prepared after completing the project.
- Evaluation will be done based on the performance in the periodic reviews, project report and viva voce examination.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Demonstrate a comprehensive understanding of IoT technologies, including sensors, actuators, and image and video analytics, and their applications in practical solutions.

CO2: Demonstrate a comprehensive understanding of IoT technologies, including sensors, actuators, and image and video analytics, and their applications in practical solutions.

CO3: Analyze and evaluate IoT solutions using a systematic approach, including the use of appropriate sensors, actuators, and analytics algorithms.

CO4: Collaborate effectively with industry partners, stakeholders, or end-users to develop a Capstone project that addresses a real-world problem or meets a specific need in the industry, healthcare, agriculture, or smart homes.

CO5: Communicate and present complex technical information effectively to both technical and non-technical audiences.

CO6: Continuously adapt to new technologies and challenges in the rapidly evolving field of IoT and demonstrate the ability to learn and apply new skills to real-world problems.

OPEN ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
21EC001	PCB DESIGN	3	0	0	3

COURSE OBJECTIVES:

- To explore the concept of PCB design and electronic components.
- To examine the rules for designing Analog and Digital Circuits.
- To apply advance techniques, skills and modern tools for designing and fabrication of PCBs.
- To understand the PCB production techniques.
- To familiarize the techniques for fabricating Multilayer, SMT and HDI PCB.

UNIT I	INTRODUCTION TO PRINTED CIRCUIT BOARD	9

Fundamental of electronic components – passive electronic components – Resistors, Thermistors, Capacitors, Inductors; active electronic components - Diode, Transistor, MOSFET, LED, IC's. PCB advantages, basic electronic circuits, Basics of printed circuit board designing: Layout planning, general rules and parameters, ground conductor considerations, thermal issues, check and inspection of art work.

UNIT II	DESIGN RULES FOR PCB	9

PCB layout design, Prototype Designing, PCB Making, Assembly of components, PCB Layers: Electrical Layers, Mechanical, Documentation Layers; Heat sinks and Package Density, Footprint, pad stack, Vias, Track. Design rules for Digital circuit PCBs, Analog circuit PCBs, High frequency and fast pulse applications, Power electronic applications, Microwave applications

UNIT III	INTRODUCTION TO ELECTRONIC DESIGN AUTOMATION (EDA) TOOLS FOR PCB DESIGNING	9

Brief Introduction of various simulators, SPICE and PSPICE Environment, Selecting the Components Footprints as per design, Making New Footprints, Assigning Footprint to components, Net listing, PCB Layout Designing, Auto routing and manual routing. Assigning specific text to design, Creating report of design, Creating manufacturing data (GERBER) for design.

UNIT IV	PRINTED CIRCUIT BOARD PRODUCTION TECHNIQUES	9

Photo printing, film master production, reprographic camera, basic process for double sided PCBs photo resists, Screen printing process, plating,Relative performance and quality control, Etching machines, Solders alloys,fluxes, soldering techniques, Mechanical operations.

UNIT V	PCB TECHNOLOGY TRENDS AND DESIGN FOR EMI/EMC	9

Multilayer PCBs, Multiwire PCB, Flexible PCBs, Surface mount PCBs, Reflow soldering, Introduction to High-Density Interconnection (HDI) Technology. Subsystem/PCB Placement in an enclosure, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Electronic waste; Printed circuit boards Recycling techniques, Introduction to Integrated Circuit Packaging and footprints, NEMA and IPC standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify the various types of Electronic components for PCB design

CO2: Apply the appropriate design rules for designing application based PCB circuits

CO3: Design and Develop a PCB layout using modern tools

CO4: Identify and select the appropriate PCB manufacturing technology.

CO5: Select the appropriate PCB technology for EMI/EMC design

CO6: Design and Evaluate the PCB circuits for real time applications

TEXT BOOKS:

1. R.S Khandpur, Printed Circuit Boards - Design, Fabrication, Assembly and Testing,1st Edition, TMH, 2017
2. Xing Chang Wei, Modeling and Design of Electromagnetic Compatibility for High Speed Printed Circuit Boards and Packaging, CRC Press, 2017.

REFERENCES:

1. Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, 2nd Edition, Academic Press, 2019.
2. Clyde F. Coombs, Jr, Happy T., Printed Circuits Handbook, Sixth Edition, Holden Publisher McGraw-Hill Education, 2016
3. Mark I. Montrose, Printed Circuit Board Design Techniques for EMC Compliance: A handbook for designers, 2nd ed., Wiley, 2015.
4. Bruce R. Archambeault, James Drewniak, PCB Design for Real-World EMI Control, Volume 696 of The Springer International Series in Engineering and Computer Science, Springer Science & Business Media, 2013.
5. Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, Newnes / Elsevier, 2009

NPTEL LINK:
https://nptel.ac.in/courses/112105267

COURSE CODE	COURSE TITLE	L	T	P	C
21EC002	EMBEDDED SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

- To describe the build process of Embedded System and the components of embedded systems.
- To discuss various Embedded Development Strategies.
- To outline different bus communication in processors and I/O interfacing.
- To impart knowledge in RTOS and various scheduling algorithms.
- To discuss specific embedded system application.

UNIT I	INTRODUCTION TO EMBEDDED SYSTEMS	9

Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, Selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT II	EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT	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 Model.

UNIT III	EMBEDDED NETWORKING	9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols – RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI)
– Inter Integrated Circuits (I2C) – Need for device drivers.

UNIT IV	RTOS BASED EMBEDDED SYSTEMS	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 inversion.

UNIT V	EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT	9

Case Study of Washing Machine – Automotive Application – Smart card system Application – ATM machine – Digital Camera.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Elaborate the build process of embedded systems.

CO2: Summarize the concepts of embedded system development life cycle.

CO3: Interpret the various embedded networking protocols and I/O interfacing.

CO4: Describe RTOS, multiprocessing and multitasking.

CO5: Illustrate the different scheduling algorithms used for embedded systems.

CO6: Implement embedded system design methods to a specific application.

TEXT BOOKS:

1. Rajkamal, Embedded System-Architecture, Programming, Design, Mc Graw Hill Third edition 2017.
2. Peckol, Embedded systems A contemporary design tool, Wiley, 2014.

REFERENCES:

1. LylaB. Das, Embedded Systems: An Integrated Approach Pearson Education, 2013.
2. Tammy Noergaard, Embedded Systems Architecture, Elsevier,2nd Edition,2017.
3. Rajib Mall ,Real-Time systems Theory and Practice,Pearson Education,1st Edition,2006.
4. Sriram V Iyer, Pankaj Gupta, Embedded Real Time Systems Programming, Tata McGraw Hill, 2017.
5. JonathanW.V alvano, Embedded Microcomputer Systems Real Time Interfacing, Second Edition Cengage Learning,2012

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc21_cs08/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC003	PRINCIPLES OF ANALOG AND DIGITAL COMMUNICATION	3	0	0	3

COURSE OBJECTIVES:

- To discuss the concepts of various Amplitude Modulation schemes and compare their performance.
- To describe the concept of Angle Modulation and demodulation.
- To explain the transmitter and receiver blocks of various waveform coding techniques.
- To describe the various digital modulation schemes.
- To familiarize the fundamentals of Source coding Techniques.

UNIT I	AMPLITUDE MODULATION	9

Need for Modulation - Amplitude modulation, Frequency spectrum of AM, Representation of AM, Amplitude Modulation Index, Power relations in AM, Generation of AM, Collector Modulator-Theory of Double-sideband suppressed carrier (DSBSC) - Single sideband (SSB) modulation techniques – AM Demodulation, Envelope Detector-VSB - Comparison of AM, DSBSC, SSB and VSB modulation - Superheterodyne receiver.

UNIT II	ANGLE MODULATION	9

Principles of Angle Modulation - Definition of Frequency Modulation, Mathematical representation of FM - Narrowband and Wideband FM-Generation of FM, Varactor diode modulator and Armstrong Modulator - PLL FM Demodulator-Phase Modulation, Definition of PM, Relationship between FM and PM, Comparison of AM, FM and PM.

UNIT III	PULSE MODULATION SYSTEMS	9

Block Diagram of Digital communication system, Sampling – Quantization – Pulse Code Modulation (PCM) - Differential pulse code modulation-Delta modulation and Adaptive Delta Modulation (Block Diagram and Explanation).

UNIT IV	DIGITAL MODULATION TECHNIQUES	9

Design Features of Digital Modulation, BASK, BFSK, BPSK, QPSK and comparison of all digital Modulation Techniques.

UNIT V	INFORMATION THEORY AND SOURCE CODING	9

Definition of - Discrete Memoryless source, Information, Entropy - Source coding theorem

-Shannon Fano & Huffman codes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe the concepts of various Amplitude Modulation Techniques.

CO2: Summarize the concepts of Angle Modulation Systems.

CO3: Explain the performance of various Pulse code modulation Techniques.

CO4: Illustrate the different digital modulation schemes.

CO5: Compare the analog and digital modulation techniques.

CO6: Illustrate the different source coding schemes.

TEXT BOOKS:

1. George Kennedy, Bernard Davis, Electronic Communication Systems, 2009, Mc Graw Hill.
2. Wayne Tomasi, Advanced Electronic Communications Systems, 2014, 6th Edition, Pearson New International Edition, Noida, India.

REFERENCES:

1. Herbert Taub and Donald Schilling, Principles of Communication Systems, ,Mc Graw Hill, 4th edition, 2017
2. T L Singal, Analog and Digital Communications, McGRaw-Hill, 2012.
3. Sanjay Sharma, Communication Systems (Analog and digital), , S.K. Kataria & Sons Reprint edition, 2016
4. Roddy and Coolen, Electronic Communication, Pearson Education, Noida, India, 4th Edition, 2014.
5. B. P. Lathi , Zhi Ding Modern Digital and Analog Communication Systems, Oxford University Press, 2010.

NPTEL LINK:

https://nptel.ac.in/courses/108104091
https://nptel.ac.in/courses/108104098

COURSE CODE	COURSE TITLE	L	T	P	C
21EC004	SENSORS AND INSTRUMENTATION	3	0	0	3

COURSE OBJECTIVES:

- To categorize the sensors according to their needs.
- To analyze different type of bio inspired and life inspired sensors.
- To examine the sensors used in robotic system.
- To interpret the data acquired by the sensing system.
- To illustrate the working of detectors for human occupancy.

UNIT I	INTRODUCTION TO SENSORS	9

Basic Sensor Classification, Basic Sensor Types- Mechanical Sensors, Thermal Sensors, Electrical Sensors, Magnetic Sensors, Radiant Sensors, Chemical Sensors, Signal Processing and Decision Making, Sensor Fusion, Sensors in Manufacturing – Introduction, Signal Processing and Conversion

UNIT II	BIO-INSPIRED AND LIFE - INSPIRED SENSORS	9

Introduction, Bio-inspired Systems, Life-inspired Systems, Semiconductor Sensors, Biomedical and Biological Sensors, Advanced Biosensors, Biomimetic Sensors, Signal Processing, Bio-inspired Sensors in industry.

UNIT III	ROBOTICS AND SENSORS - ENVIRONMENTAL APPLICATIONS	9

Introduction, Sensors for General Robotic Systems, Sensors for a Humanoid Robot, Anthropomorphic Robotic Arm for plant health monitoring using RGB Color Sensor, Sensors for Mobile Robotic Platforms in Environmental applications, Biomimetic Sensor design

UNIT IV	DATA ACQUISITION SYSTEMS	9

Introduction, Signals, Plug-in DAQ Boards, Types of ADCs, Analog input architecture, Data Acquisition software, Scanning, Factors influencing the accuracy of measurements

UNIT V	HUMAN OCCUPANCY DETECTORS	9

Introduction, Ultrasonic Detectors, Microwave Motion Detectors, Capacitive Occupancy Detectors, Triboelectric Detectors, Optoelectronic Motion Detectors, Optical Presence Sensors, Pressure-Gradient Sensors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Identify the sensor according to the specific requirement.

CO2: Summarize the sensors that are bio inspired.

CO3: Use the sensors in robotic system.

CO4: Acquire the data obtained by the sensors.

CO5: Analyze the data acquired from the sensing system.

CO6: Contrast the detectors based upon their working principle.

TEXT BOOKS:

1. John G. Webster, Halit Eren, Measurement, Instrumentation, and Sensors Handbook, 2nd Edition, Taylor & Francis, 2014.
2. H.K. Tönshoff, I. Inasaki, Sensors in Manufacturing, Wiley, 2001.

REFERENCES:

1. Princeton Brown, Sensors and Actuators: Technology and Applications, Library Press, 2017.
2. Ian R. Sinclair, Sensors and Transducers, 3rd Edition, Newnes, 2001.
3. Sawney A K and Puneet Sawney, A Course in Mechanical Measurements and Instrumentation and Control, 12th edition Dhanpat Rai & Co, 2013.
4. Patranabis D, Sensors and Transducers, 2nd Edition, PHI, New Delhi, 2011.
5. DVS Murthy, Transducers and Instrumentation, 2nd Edition, PHI, 2013.

NPTEL LINK:

https://nptel.ac.in/courses/108108147

COURSE CODE	COURSE TITLE	L	T	P	C
21EC005	AUTOMATIVE ELECTRONICS	3	0	0	3

COURSE OBJECTIVES:

- To learn about automotive electronics trends and its evolution.
- To understand the basic principles and fundamentals of ignition and injection systems.
- To describe about various actuators used in automobiles.
- To impart knowledge on the diagnostic systems used in Modern Automobiles.
- To interpret the basics of Chassis and safety control Systems

UNIT I	INTRODUCTION	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	IGNITION AND INJECTION SYSTEMS	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	SENSORS AND ACTUATORS	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, vacuum operated actuator.

UNIT IV	ENGINE CONTROL SYSTEMS	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

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: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe the concept of automotive electronics trends and its evolution.

CO2: Interpret the basic principles and fundamentals of ignition and injection systems.

CO3: List out the different types of sensors and define its working principle.

CO4: Classify and demonstrate various types of actuators used in automobiles.

CO5: Summarize the ignition control methodologies used in Modern Automobiles.

CO6: Define the basics of Chassis and safety control Systems.

TEXT BOOKS:

1. William B. Ribbens, Understanding Automotive Electronics, 6th Edition, Publishing.2002.
2. Robert Bosch Gmbh (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems Elsevier and Components, Networking and Hybrid Drive, 5th edition, John Wiley& Sons Inc., 2007.

REFERENCES:

1. Tom Denton, Automobile Electrical and Electronics Systems, Edward Arnold Publishers, 2000.
2. William B. Ribbens, Understanding Automotive Electronics, 5th edition, Newnes Publishing, 2000.
3. Barry Hollembeak, Automotive Electricity, Electronics & Computer Controls, Delmar Publishers, 2001.
4. Richard K. Dupuy ,Alan Ahlstrand , Kalton C. Lahue ,Fuel System and Emission controls, Check Chart Publication, 2000.
5. Ronald. K. Jurgon, “Automotive Electronics Handbook”, McGraw-Hill, 1999

NPTEL LINK:

https://nptel.ac.in/courses/112107289

COURSE CODE	COURSE TITLE	L	T	P	C
21EC006	ROBOTICS SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To familiarize students with the concepts of Robot Kinematics
- To impart Knowledge in Robot Programming
- To learn Robot safety issues and economics.

UNIT I	FUNDAMENTALS OF ROBOT	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

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

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, Analog 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

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 Effector commands and simple Programs.

UNIT V	IMPLEMENTATION AND ROBOT ECONOMICS	9

RGV, AGV- Implementation of Robots in Industries - Various Steps - Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the basic concepts of a Robot

CO2: Explain the use of various types of End of Effectors

CO3: Explain the use of Various types of Sensors

CO4: Explain the Concepts of Robot Kinematics

CO5: Demonstrate the Robot Programming

CO6: Understand the Robot safety issues and economics

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.

REFERENCES:

1. Craig J.J., Introduction to Robotics Mechanics and Control, Pearson Education, 2008
2. Mikell P. Groover, Industrial Robotics Technology, Programming and Applications - McGraw Hill Publications -3rd edition 2008
3. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009.

4. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, Robotics Engineering an Integrated Approach, PHI Learning., 2009.
5. Saeed B.Niku ,Introduction to Robotics Analysis, Systems and Applications ,3rd edition – Wiley publications – 2019.

NPTEL LINK:

https://nptel.ac.in/courses/112107289

COURSE CODE	COURSE TITLE	L	T	P	C
21EC007	CONSUMER ELECTRONICS	3	0	0	3

COURSE OBJECTIVES:

- To understand working principles of various audio systems.
- To identify the working principles of various video systems and display operations.
- To study the various technical specifications and facilities of the domestic & consumer appliances used on day to day basis.
- To learn how to maintain the products by using preventive power supplies
- To understand how to select the product by comparing commercially available products on the basis of electrical safety

UNIT I	AUDIO SYSTEMS	9

Audio System : Microphones, loudspeakers baffle and enclosure, Acoustics, mono, stereo, Quad, Amplifying System, Equalizers and Mixers Synthesizers, Commercial Sound, Theater Sound System.

UNIT II	VIDEO SYSTEMS AND TELEVISON	9

Video Systems and Displays: Monochrome, Color TV standards, TFT, Plasma, HDTV,LCD, LED TV, Direct-To- Home (DTH- Set Top Box), Video Telephone and Video Conferencing.

UNIT III	DOMESTIC & CONSUMER APPLIANCES	9

Domestic & Consumer Appliances: Washing machines, Microwave ovens, Air-conditioners and Refrigerators, Computers office System, Telephone & Mobile Radio System

UNIT IV	POWER SUPPLIES AND OTHER SYSTEMS	9

Power Supplies SMPS/UPS and Preventive Maintenance and others systems such as Remote controls, Bar codes, RFID, Scanners, Printers, Photocopier

UNIT V	PRODUCT COMPLIANCE AND PRODUCT SAFETY	9

Product Compliance: Product safety and liability issues; standards related to electrical safety and fire hazards, EMI/EMC requirements, design techniques for ESD, RF interference and Immunity, line current harmonics and mains voltage surge.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO2: Identify the need of preventive maintenance in various electronic appliances.

CO3: Use different product safety, compliance standards and techniques associated with electronic products.

CO4: Evaluate and analyze different electronic products and systems based on specifications

CO5: Manage multi-faceted and multi-disciplinary projects with significant technical considerations using a broad systems perspective.

CO6: Foster a desire to continue life-long learning.

TEXT BOOKS:

1. R.P.Bali, Consumer Electronics, Pearson Education ,2008
2. R.G.Gupta, Audio and video System, Tata McGraw Hill,2008

REFERENCES:

1. Douglas Kinney ,A Beginners Guide to Consumer Electronics Repair: Hand Book and Tutorial , iUniverse Publishers ,2006
2. Dr J S Chitode, Consumer Electronics - A Conceptual Approach by, Technical Publications Pune,2008.
3. H Davidson,Troubleshooting Consumer Electronics Audio Circuits , Prompt publications,2001
4. Gulati.R.R,Modern Television Practice:Transmission,reception,Applications,New Age International,2015
5. Dhake A.M,Television and Video Engineering, Tata McGraw Hill,2006

NPTEL LINK

https://archive.nptel.ac.in/courses/108/106/108106138/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC008	HEALTH CARE ELECTRONICS	3	0	0	3

COURSE OBJECTIVES:

- To familiarize the essentials of Telemedicine.
- To explain the technologies and Communication infrastructure in telemedicine.
- To describe the concepts of real time telemedicine standards
- To disseminate the concepts of picture archiving and communication system
- To discuss m-health and its applications

UNIT I	TELEMEDICINE AND HEALTH	9

History and Evolution of telemedicine, Functional diagram of telemedicine system, Tele- consultation, Tele health, Organs of Telemedicine, Global and Indian scenario, International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Cyber laws related to telemedicine - Patient Rights

UNIT II	TELEMEDICAL TECHNOLOGY	9

Principles of Multimedia: Text, Audio, Video, data - Data communications and networks, Internet, Body centric wireless communication: Wireless Body Area Networks (WBAN), Wireless Sensor Networks (WSN) and Wireless Personal Area Networks (WPAN) and their design concepts Antenna design considerations for in-body and on-body electronics - Communication infrastructure for Telemedicine - Telemedicine through world wide web

UNIT III	TELEMEDICAL STANDARDS	9

Real-time Telemedicine integrating doctors / Hospitals, Access to health care services – Health education and self-care, Telesurgery, Teleradiology, Telecardiology, Teleoncology, Telemedicine in neurosciences, Telepathology, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care, Home Telehealth Protocols and Procedure

UNIT IV	PICTURE ARCHIVING AND COMMUNCIATION SYSTEM	9

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication, Computer aided diagnosis (CAD), Hospital information system - Doctors, paramedics, facilities available. Pharmaceutical information system

UNIT V	m-HEALTH	9

Mobile Devices : Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – mHealth technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support – m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe the key principles for telemedicine and health.

CO2: Discuss the technologies and Communication infrastructure in telemedicine applications.

CO3: Develop real time telemedicine systems.

CO4: Describe the concepts of picture archiving and communication system.

CO5: Discuss recent trends in m-Health.

CO6: Develop m-Health platforms for telemedicine applications.

TEXT BOOKS:

1. Norris, A.C. Essentials of Telemedicine and Tele care, Wiley, 2002
2. Wootton R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine,Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006

REFERENCES:

1. David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008
2. Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers series, USA, 2006
3. Simpson, W. Video over IP. A practical guide to technology and applications. Focal PressElsevier,2006.
4. Bemmel, J.H. van, Musen, M.A. (Eds.) Handbook of Medical Informatics. Heidelberg, Germany:Springer,1997
5. Mohan Bansal " Medical Informatics", Tata McGraw-Hill, 2004.

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc23_hs67/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC009	SEMICONDUCTOR PHYSICS	3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of basic semiconductor physics which includes the Electronic materials, Semiconductors
- To understand the carrier transport and properties of semiconductors
- To be familiar with light semiconductor
- To provide problem solving experience and learning of concepts through it in Semiconductor Physics.
- To deliver complex problem solving through electrical measurements and nanomaterial's.

UNIT I	ELECTRONIC MATERIALS	9

Classical Free Electron Theory- Energy Bands in solids - Kronig Penny model - Direct & Indirect Band gaps -Brillouin Zone - Energy band structure in Semiconductors - Concept of Effective mass - Classification of Electronic materials - Fermi level - Probability of Occupation - Influence of donorsand acceptors in semiconductors - Non equilibrium properties of carriers. .

UNIT II	CARRIER TRANSPORT AND SEMICONDUCTORS	9

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for opto electronic devices.

UNIT III	LIGHT-SEMICONDUCTOR INTERACTION	9

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Density of states for photons, Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model. Laser, Amplification of light by population inversion, different types of lasers: gas laser(He-Ne, CO_2), Solid state laser (Ruby, Neodymium), Dye laser, Applications of laser in science and medicines.

UNIT IV	ELECTRICAL MEASUREMENTS	9

Electrical Measurements – Two point probe technique- Four point probe technique-Linear method - Four point probe technique- Vander Paw method - Significance of carrier density, Resistivity & hall mobility - Hot point probe measurements - Extraction of parameters in a diode - I-V characteristics of a diode - Deep level transient spectroscopy - (DLTS)

UNIT V	NANOMATERIALS	9

Density of states in 2D - Density of states in 1D & 0D - Introduction to low dimensional systems, Quantum well, Quantum wire & do - CNT – Properties & synthesis CVD – Fabrication Technique PVD- Characterization techniques for low dimensional system- XRD powder method - Principle of electron microscopy –SEM - AFM - Hetero junctions -Band diagram of hetero junctions

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand fundamentals of energy band theory in semiconducting materials.

CO2: Understand the basic of Intrinsic and Extrinsic Semiconductors.

CO3: Understand the concepts of light interaction with matter and its applications.

CO4: Analyze and apply the elementary understanding of the measurement techniques for semiconductor.

CO5: Summarize the concepts of hetero junctions with band diagram

CO6 : Analyze the fabrication techniques involved in semiconductors

TEXT BOOKS:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc.,1995.
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc.,2007.

REFERENCES:

1.A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York ,2007

2. P. Bhattacharya,Semiconductor Optoelectronic Devices, Prentice Hall of India, 1997.

3. Mishra, Umesh K. and Singh, Jaspreet, Semiconductor Device Physics and Design, Springer, 2008.

4. Pierret, R.F., Semiconductor Device Fundamentals, Pearson Education Inc., 2006.

5. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley ,2008.

NPTEL LINK:

https://nptel.ac.in/courses/108108122

COURSE CODE	COURSE TITLE	L	T	P	C
21EC010	BIOMEDICAL INSTRUMENTATION	3	0	0	3

COURSE OBJECTIVES:

- To study about the different bio potentials and its propagation
- To understand the different types of electrodes and their placement for various recordings
- To study the design of bio amplifier for various physiological recording
- To learn the different measurement techniques for non-physiological parameters.
- To be familiar with chemical measurement techniques.

UNIT I	BIO POTENTIAL GENERATION AND ELECTRODES TYPES	9

Origin of bio potential and its propagation. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes

UNIT II	BIOSIGNAL CHARACTERISTICS AND ELECTRODE CONFIGURATIONS	9

Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode.

UNIT III	SIGNAL CONDITIONING CIRCUITS	9

Need for bio-amplifier - differential bio-amplifier, Impedance matching circuit, isolation amplifiers, Power line interference, Right leg driven ECG amplifier, Band pass filtering

UNIT IV	MEASUREMENT OF NON-ELECTRICAL PARAMETERS	9

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods -Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement.

UNIT V	BIO-CHEMICAL MEASUREMENT	9

Blood gas analyzers and Non-Invasive monitoring, colorimeter, Sodium Potassium Analyzer, Spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the different bio potential and its propagation.

CO2: Summarize the bio signal characteristics

CO3: Summarize the different electrode placement for various physiological recording

CO4: Design bio amplifier for various physiological recording

CO5: Understand various technique non electrical physiological measurements

CO6: Understand the different biochemical measurements

TEXT BOOKS:

1. Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice hall of India, New Delhi, 2007.
2. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 2004.

REFERENCES:

1. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 2003.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
4. Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.
5. M. Arumugam, Bio-Medical Instrumentation, Anuradha Agencies, 2003.

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc22_bt56/preview

COURSE CODE	COURSE TITLE	L	T	P	C
21EC011	MATLAB PROGRAMMING	3	0	0	

COURSE OBJECTIVES:

- To learn features of MATLAB for program solving.
- To promote new teaching model that will help to develop programming skills and technique to solve mathematical problems
- To understand MATLAB graphic feature and its applications
- To develop programs in MATLAB language for engineering applications.
- To use MATLAB as a simulation tool

UNIT I	INTRODUCTION	9

The MATLAB Environment - MATLAB Basics – Variables, Numbers, Operators, Expressions, Input and output - Vectors, Arrays – Matrices

UNIT II	SAMPLE CONTENT	9

Built-in Functions - User defined Functions – Function Creation – Argument Definitions – Scope variables and Generate Names – Error handling

UNIT III	GRAPHICS WITH MATLAB	9

Files and File Management – Import/Export - Basic 2D, 3D plots - Graphic handling - Formatting and Annotation – Printing and Saving – Graphics Objects – Graphics Performance

UNIT IV	PROGRAMMING WITH MATLAB	9

Conditional Statements, Loops - MATLAB Programs – Programming and Debugging - Applications of MATLAB Programming

UNIT V	MATHEMATICAL COMPUTING WITH MATLAB	9

Algebraic equations - Basic Symbolic Calculus and Differential equations - Numerical Techniques and Transforms

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Learn features of MATLAB as a programming tool.

CO2: Promote new teaching model that will help to develop programming skills and technique to solve mathematical problems.

CO3: Understand MATLAB graphic feature and its applications

CO4: Use MATLAB as a simulation tool

CO5: Learn the MATLAB Library

CO6: Know about recent trends in MATLAB

TEXT BOOKS:

1. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB – for Beginners and Experienced Users, 2nd Ed., Cambridge University Press, 2006
2. Stephen J. Chapman, Cengage Learning,Essentials of MATLAB Programming, 2nd Ed. 2009.

REFERENCES:

1. David McMahon,MATLAB Demystified,The McGraw-Hill Companies, 2007.
2. Holly Moore,MATLAB® for Engineers,3rd Ed, Pearson Education, Inc.,2012.
3. David M. Smith,Engineering computation with MATLAB, 2nd Ed., Pearson Education, Inc.2010
4. Brian Hahn and Daniel T. Valentine,Essential MATLAB for Engineers and Scientists, 7th Edition, Apress, 2018.
5. Michael Paluszek, Stephanie Thomas,Practical MATLAB Deep Learning: A Project-Based Approach, Apress,4th Edition, 2016

NPTEL LINK:

https://nptel.ac.in/courses/103/106/103106118/

COURSE CODE	COURSE TITLE	L	T	P	C
21EC012	INDUSTRIAL IoT APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

- To introduce how IoT has become a game changer in the new economy where the customers are looking for integrated value.
- To get insights over the architecture and protocols of IIoT
- To know the various sensors and interfacing used in IIoT.
- To bring the IoT perspective in thinking and building solutions.
- To understand the different IoT platforms and cloud services

UNIT I	INTRODUCTION	9

Introduction to IOT, What is IIOT? IOT Vs. IIOT, History of IIOT, Components of IIOT - Sensors, Interface, Networks, People Process, Hype cycle, IOT Market, Trends, future Real life examples, Key terms – IOT Platform, Interfaces, API, clouds, Data Management Analytics, Mining Manipulation, Thinking about Prototyping – Costs versus ease of prototyping, prototyping and Production, open source versus Closed Source, Role of IIOT in Manufacturing Processes, Use of IIOT in plant maintenance practices, Sustainability through Business excellence tools Challenges, Benefits in implementing IIOT

UNIT II	ARCHITECTURE AND PROTOCOLS	9

Overview of IOT components; Various Architectures of IOT and IIOT, Advantages &disadvantages, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT; Need for protocols, Wi-Fi, Zigbee, Bacnet, IIOT protocols –COAP, MQTT, 6LoWPAN, LWM2M, AMPQ

UNIT III	SENSORS AND INTERFACING	9

Introduction to sensors, Transducers, Classification, Roles of sensors in IIOT , Various types of sensors , Design of sensors, sensor architecture, special requirements for IIOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial,Parallel, Ethernet, BACNet , Current, M2M, Prototyping online Components – Getting Started with an API, Writing a New API, Real Time Reactions.

UNIT IV	CLOUD, SECURITY AND GOVERNANCE	9

IIOT cloud platforms: Overview of cots cloud platforms, predix, thingworks, azure,. Data analytics, cloud services, Business models: Saas, Paas, Iaas; Introduction to web security, Conventional web technology and relationship with IIOT, Vulnerabilities of IoT, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity; Management aspects of cyber security.

UNIT V	IOT ANALYTICS AND APPLICATIONS	9

IOT Analytics : Role of Analytics in IOT, Data visualization Techniques, Statistical Methods; IOT Applications : Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Plant Automation, Real life examples of IIOT in Manufacturing Sector**.**

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe IOT, IIOT

CO2: Understand various IoT Layers and their relative importance

CO3: Interpret the requirements of IIOT sensors and understand the role of actuators.

CO4: Study various IoT platforms and Security

CO5: Realize the importance of Data Analytics in IoT

CO6: Design various applications using IIoT in manufacturing sector.

TEXT BOOKS:

1. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications,1st Edition, Wiley Publications, 2013
2. Dieter Uckelmann , Mark Harrison, Florian Michahelles, Architecting the Internet of Things, Springer-Verlag Berlin Heidelberg 2011 Industry 4.0: The Industrial Internet of Things

REFERENCES:

1. Hakima Chaouchi,The Internet of Things Connecting Objects to the Web Willy Publications.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, 2nd Edition,Wiley Publications

3. Internet of Things - From Research and Innovation to Market Deployment; by OvidiuVermesan & Peter Friess; River Publishers Series,2014
4. How Protocol Conversion Addresses IIoT Challenges:White Paper By RedLion.
5. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things,First edition,Kindle edition

NPTEL LINK:

https://onlinecourses.nptel.ac.in/noc20_cs69/preview