(DEEMED TO BE UNIVERSITY)

ELECTRONICS & COMMUNICATION ENGINEERING

CURRICULUM & SYLLABUS

APPLICABLE FOR B.TECH. STUDENTS
ADMITTED IN A.Y. 2016-17

COURSE STRUCTURE 2016-17

HUMANITIES AND SOCIAL SCIENCE COURSES									
Sl No	**Course Code**	**Course Title**	**Type**	**Uni/Sch/Dept**	**L**	**T**	**P**	**Cr**	**CH**
1	15 EN 1101	Rudiments of Communication Skills	HSS	UNI CORE	0	0	4	2	4
2	15 EN 1202	Interpersonal Communication Skills	HSS	UNI CORE	0	0	4	2	4
3	15 EN 2103	Professional Communication Skills	HSS	UNI CORE	0	0	4	2	4
4	15 EN 2204	Employability Skills	HSS	UNI CORE	0	0	4	2	4
5	15 EN 3105	Verbal and Quantitative Reasoning	HSS	UNI CORE	0	0	4	2	4
6	15 EN 3206	Corporate Communication Skills	HSS	UNI ELEC	0	0	4	2	4
7	15 GN 1001	Ecology and Environment	HSS	UNI CORE	2	0	0	2	2
8	15 GN 1002	Human Values	HSS	UNI CORE	2	0	0	2	2
9		Management Elective	HSS	SCH ELEC	3	0	0	3	3
10	15GNXXX	Foreign/Non-Native language	HSS	UNI ELEC	3	0	0	3	3
BASIC SCIENCE COURSES									
11	15 MT 1001	Single Variable Calculus and Matrix Algebra	BS	SCH CORE	2	2	2	4	6
12	15 MT 1203	Multivariate Calculus	BS	SCH ELEC	2	2	2	4	6
13	15 MT 2005	Probability and Stochastic Models	BS	SCH CORE	2	2	2	4	6
14	15 ME 1001	Mechanics	BS	SCH ELEC	2	2	2	4	6
15	15 PH 1001	Engineering Materials	BS	SCH ELEC	2	2	2	4	6
16	15 BT 1001	Biology for Engineers	BS	SCH ELEC	2	0	0	2	2
17	15 CY 1001	Engineering Chemistry	BS	SCH ELEC	3	0	2	4	5
18	15 EE 1201	Fields & Networks	BS	SCH ELEC	2	2	2	4	6
ENGINEERING SCIENCE COURSES									
19	15 GN 1004	Introduction to Engineering	ES	SCH CORE	2	0	2	5	4
20	15 CS 1101	C Programming & Data Structures-1	ES	SCH CORE	2	4	2	5	8
21	15 CS 1201	C Programming & Data Structures-2	ES	SCH ELEC	2	4	2	5	8
21	15 ME 1002	Engineering Graphics with Auto CAD	ES	SCH ELEC	0	0	6	3	6
22	15 GN 1003	Measurements	ES	SCH ELEC	0	0	4	2	4
23	15 CS 2002	Object Oriented Programming	ES	SCH ELEC	2	2	2	4	6
24	15 EC 2002	Signal Analysis	ES	SCH ELEC	2	2	2	4	6
25	15 CS 2003	Discrete Mathematics	ES	SCH ELEC	2	2	2	4	6

PROFESSIONAL CORE COURSES									
26	15 EC 1101	Digital System Design	PC	DEPT CORE	2	2	2	4	6
27	15 EM 2001	Computer Organization and Architecture	PC	DEPT CORE	2	2	2	4	6
28	15 EC 2103	Analog Electronic Circuit Design	PC	DEPT CORE	2	4	2	5	8
29	15 EM 2202	Processors and Controllers	PC	DEPT CORE	2	2	2	4	6
30	15 EC 2204	Design with CPLD & FPGA	PC	DEPT CORE	2	2	2	4	6
31	15 EC 2205	Communication Theory-1	PC	DEPT CORE	2	2	2	4	6
32	15 EC 2206	Signal Processing	PC	DEPT CORE	2	2	2	4	6
33	15 EE 2207	Control Systems	PC	DEPT CORE	2	2	2	4	6
34	15 EC 3111	Computer Networks	PC	DEPT CORE	3	0	2	4	5
35	15 EC 3103	Embedded Systems and Applications	PC	DEPT CORE	3	0	2	4	5
36	15 EC 3107	CMOS VLSI Design	PC	DEPT CORE	2	2	2	4	6
37	15 EC 3108	Communication Theory-2	PC	DEPT CORE	2	2	2	4	6
38	15 EC 3212	Communication Theory-3	PC	DEPT CORE	2	2	2	4	6
39	15 EC 4110	Digital Image Processing	PC	DEPT CORE	2	2	2	4	6
PROFESSIONAL ELECTIVE COURSES									
40		Professional Elective Course – 1	PE	DEPT ELEC	3	0	0	3	3
41		Professional Elective Course – 2	PE	DEPT ELEC	3	0	0	3	3
42		Professional Elective Course – 3	PE	DEPT ELEC	3	0	0	3	3
43		Professional Elective Course – 4	PE	DEPT ELEC	3	0	0	3	3
44		Professional Elective Course – 5	PE	DEPT ELEC	3	0	0	3	3
OPEN ELECTIVE COURSES									
45		Open Elective Course – 1	OE	UNIV ELEC	3	0	0	3	3
46		Open Elective Course – 2	OE	UNIV ELEC	3	0	0	3	3
PROJECT/TERM PAPER/INDUSTRIAL TRAINING									
47		Industrial Training		SCH CORE	0	0	0	2	0
48	15IE3250	Term Paper		SCH CORE	0	0	4	2	4
49	15IE4049/ 15IE4048	Practice School / Project (Part - 1)		SCH CORE	0	0	12	6	12
50	15IE4049/ 15IE4050	Practice School / Project (Part - 2)		SCH CORE	0	0	12	6	12
SKILLING COURSES									
51	15TS401	Technical Skilling-1 (Lab View and MultiSim)		SCH CORE	0	0	4	2	4
52	15TS402	Technical Skilling-2(Matlab) (Communications and DSP)		SCH ELEC	0	0	4	2	4
		Total			**85**	**52**	**122**	**175**	**267**

SKILL BASED PROFESSIONAL ELECTIVES							
SIGNAL AND IMAGE PROCESSING DOMAIN							
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**CR**	**CH**
1	15EC3051	Digital Image Processing	3	0	0	3	3
2	15EC3052	Artificial neural networks	3	0	0	3	3
3	15EC3053	Fuzzy logic	3	0	0	3	3
4	15EC3054	Machine Learning	3	0	0	3	3
5	15EC3055	Computer vision & Applications	3	0	0	3	3
6	15EC3056	Pattern Recognition	3	0	0	3	3
7	15EC3057	Human Machine Interaction	3	0	0	3	3
8	15EC3058	Video Surveillance	3	0	0	3	3
9	15EC3059	Audio Signal Processing	3	0	0	3	3
10	15EC3060	Statistical Signal Processing	3	0	0	3	3
11	15EC3061	Adaptive Signal Processing	3	0	0	3	3
12	15EC4062	Bio Medical Signal Processing	3	0	0	3	3
13	15EC4063	Biomedical Imaging	3	0	0	3	3
14	15EC4064	Knowledge Based Systems	3	0	0	3	3
MOBILE AND COMMUNICATIONS DOMAIN							
1	15EC3065	Information Theory and Coding	3	0	0	3	3
2	15EC3066	Antennas and Wave Propagation	3	0	0	3	3
3	15EC3067	Microwave Engineering	3	0	0	3	3
4	15EC3068	Optical communications	3	0	0	3	3
5	15EC3069	Electronic Navigation systems	3	0	0	3	3
6	15EC3070	RF System Design	3	0	0	3	3
7	15EC3071	Satellite Communications	3	0	0	3	3
8	15EC3072	Smart Antennas	3	0	0	3	3
9	15EC4073	RADAR Engineering	3	0	0	3	3
10	15EC4074	EMI/EMC	3	0	0	3	3
VLSI DESIGN DOMAIN							
1	15EC3075	VLSI Technology	3	0	0	3	3
2	15EC3076	VLSI subsystem design	3	0	0	3	3
3	15EC3077	Digital IC Design and Applications	3	0	0	3	3
4	15EC3078	Design For Testability	3	0	0	3	3
5	15EC3079	Analog VLSI Design	3	0	0	3	3
6	15EC3080	MEMS Technology	3	0	0	3	3
7	15EC3081	Low Power VLSI	3	0	0	3	3
8	15EC3082	Nano Electronics	3	0	0	3	3
9	15EC4083	CAD for VLSI Design	3	0	0	3	3
10	15EC4084	Design of Semiconductor Memories	3	0	0	3	3

COMPUTER COMMUNICATIONS DOMAIN							
1	15EC3085	Data networks & Protocols	3	0	0	3	3
2	15EC3086	Broadband Networks	3	0	0	3	3
3	15EC3087	TCP/IP Protocol Suite	3	0	0	3	3
4	15EC3088	VOIP systems	3	0	0	3	3
5	15EC3089	5G and IOT	3	0	0	3	3
6	15EC3090	Network Architecture and Design	3	0	0	3	3
7	15EC3091	Network programming	3	0	0	3	3
8	15EC3092	Network Security	3	0	0	3	3
9	15EC4093	WLAN 802 Standards	3	0	0	3	3
10	15EC4094	IP Multimedia subsytem (IMS)	3	0	0	3	3
11	15EC4095	Emerging Technologies in Computer Communications (Cloud, IoT, NFV and SDN)	3	0	0	3	3

S.No	Course Code	Course Name	L	T	P	CR	CH
OPEN ELECTIVES							
1	15 BT 40A1	IPR & Patent Laws	3	0	0	3	3
2	15 CE 40A2	Environmental Pollution Control Methods	3	0	0	3	3
3	15 CE 40A3	Solid and Hazardous waste management	3	0	0	3	3
4	15 CE 40A4	Remote Sensing & GIS	3	0	0	3	3
5	15 CE 40A5	Disaster Management	3	0	0	3	3
6	15 CS 40A6	Fundamentals of DBMS	3	0	0	3	3
7	15 CS 40A7	Fundamentals of Software Engineering	3	0	0	3	3
8	15 CS 40A8	Fundamentals of Information Technology	3	0	0	3	3
9	15 EC 40A9	Image Processing	3	0	0	3	3
10	15 EM 40B1	Linux Programming	3	0	0	3	3
11	15 EM 40B2	E-Commerce	3	0	0	3	3
12	15 EE 40B3	Renewable Energy Sources	3	0	0	3	3
13	15 ME 40B4	Robotics	3	0	0	3	3
14	15 ME 40B5	Mechatronics	3	0	0	3	3
15	15 ME 40B6	Operations Research	3	0	0	3	3
16	15 PH 40B7	Nano Materials & Technology	3	0	0	3	3
17	15 PE 40B8	Subsea Engineering	3	0	0	3	3
18	15 PE 40B9	Oil and Gas Management	3	0	0	3	3
19	15 GN 40C1	Self-Development	3	0	0	3	3
20	15 GN 40C2	Indian Culture and History	3	0	0	3	3
21	15 GN 40C3	Emotional Intelligence	3	0	0	3	3
22	15 GN 40C4	Professional Ethics and Values	3	0	0	3	3
23	15 GN 40C5	Behavioral Sciences	3	0	0	3	3
LIST OF MANAGEMENT ELECTIVES							
1	15MB3051	Paradigms in Management thought	3	0	0	0	3
2	15MB3052	Indian Economy	3	0	0	0	3
3	15MB3053	Managing Personal Finances	3	0	0	0	3
4	15MB3054	Basics of Marketing for Engineers	3	0	0	0	3
5	15MB3055	Organization Management	3	0	0	0	3
6	15MB3056	Resources Safety and Quality Management	3	0	0	0	3

LIST OF FOREIGN LANGUAGE ELECTIVE							
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**S**	**Cr**
1	15GN3051	Arabic Language	3	0	0	0	3
2	15GN3052	Bengali Language	3	0	0	0	3
3	15GN3053	Chinese Language	3	0	0	0	3
4	15GN3054	French Language	3	0	0	0	3
5	15GN3055	German Language	3	0	0	0	3
6	15GN3056	Hindi Language	3	0	0	0	3
7	15GN3057	Italian Language	3	0	0	0	3
8	15GN3058	Japanese Language	3	0	0	0	3
9	15GN3059	Kannada Language	3	0	0	0	3
10	15GN3060	Russian Language	3	0	0	0	3
11	15GN3061	Simhali Language	3	0	0	0	3
12	15GN3062	Spanish Language	3	0	0	0	3
13	15GN3063	Tamil Language	3	0	0	0	3
14	15GN3064	Urdu Language	3	0	0	0	3

HONORS DEGREE COURSES				
1	15 EC 5206	Antenna Measurements	3-0-2	4
2	15 EC 5216	Statistical Signal Processing	3-0-2	4
3	15 EC 5109	Wavelets, Filter Banks & Applications	3-0-2	4
4	15 EC 5112	Adaptive Signal Processing	3-0-2	4
5	15 EC 5234	VLSI System Design	3-2-0	4

Minor in Electronics (Applicable for CSE, ME, CE and BT)

S.NO	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 EC 1101	Digital System Design	2-2-2	4
2	15 EC 2103	Analog Electronic Circuit Design	2-2-2	4
3	15 EC 2204	Design with CPLD & FPGA	2-2-2	4
4	15 EM 2202	Processors and Controllers	2-2-2	4
5	15 EM 3103	Embedded Systems	2-2-2	4

Minor in Communications (Applicable for CSE, ECM, EEE, ME, CE and BT)

S.NO	COURSE CODE	COURSE CODE	L-T-P	CR
1	15 EC 2205	Communication Theory-1	2-2-2	4
2	15 EC 2206	Signal Processing	2-2-2	4
3	15 CS 2208	Computer Networks	2-2-2	4
4	15 EC 3108	Communication Theory-2	2-2-2	4
5	15 EC 3209	Communication Theory-3	2-2-2	4

HUMANITIES & SOCIAL SCIENCES

RUDIMENTS OF COMMUNICATION SKILLS

Course code: 15 EN 1101 **L-T-P: 0-0-4**

Pre Requisite: NIL **Credits: 2**

Mapping of the course outcomes with student's outcomes.

CO No	Course outcome's	Mapped SO	BTL
CO 1	Remember speech sounds and apply stress and intonation rules to enhance pronunciation skills.	g	1
CO 2	Understand writing strategies and apply those by using the basic and advanced concepts of grammar.	g	1
CO 3	Understand the types of texts and tone of the author.	g	1
CO 4	Understand the importance of interpersonal skills	g	1

Syllabus:

Speaking & listening skills - Vowels in English, Diphthongs, Consonants, Word stress, Intonation, Words in Groups - English Conversation Practice, Difference between British English and American English, Received Pronunciation and Dialects, American Spelling and American Grammar , American Pronunciation, Listen and respond, Speak and Listen, Listen and Speak.

Speaking and listening exercises from Effective Speech Richard W Clark- Speaking to persuade, listening to understand.

General writing skills - Paragraph Writing: Seven 'C's of writing , Identifying & writing Topic sentences, Linkers, Coordinates, Sequencing, Letter Writing: Formal & Informal formats- Full block, Semi block, Modified block- Types & tone of letters, content & brevity, Note Making & Note Taking.

Reading skills - Reading comprehension Practice exercises (TOEFL Level) - Reading for information, Reading for specifics - Theme, Attitude, Identifying tone.

Soft skills - Introduction to soft skills, Body Language, Postures, Gestures, Eye contact, Personality styles, Grooming, Dress code, Group discussion - Format, Do s and Don'ts, scoring method

Text book:

1. Material produced by the Dept.

References Book:

1. Mark Hancock and Sylvie Donna, "English pronunciation in use: Intermediate", 2nd edition,Cambridge publication.
2. Krishna Mohan & N P Singh, "Speaking English Effective (English) 2nd Edition", Laxmi Publications-New Delhi, (2005).
3. Mr. Gopalaswamy Ramesh et al, "The Ace of Soft Skills", Pearson publishers, (2010).

4. Richard W.Clark, “Effective speech”, Glencoe Pub. Co., (1988).

INTERPERSONAL COMMUNICATION SKILLS

Course code: 15 EN 1202 **L-T-P: 0-0-4**

Pre Requisite: NIL **Credits: 2**

Mapping of Course outcomes with Student outcomes:

CO No	Course outcome’s	Mapped SO	BTL
CO 1	Understand the method of identifying the meaning of words from the context and form sentences using words.	g	1
CO 2	Understand and analyze seven types of reading techniques and improve reading speed.	g	2
CO 3	Understand and apply writing strategies for office/ formal communication.	g	2
CO 4	Understand and analyze different cultures and the importance of empathy in cross-cultural communication.	d	1

Syllabus:

Speaking skills - Interactive Skills: Group Activities taken from **keep Talking by Mary Spratt; at the chalk face Oxford word skills (Units 21-50)**

Vocabulary Skills -Basic Word List (900 words), Identifying meaning from context, Antonyms and Synonyms (Level 1)

Writing skills - Inter Office Communication and Intra Office Communication - Memo Writing, Circulars, Emails -

Netiquette, Formal and Informal Formats, Clear, concise expression, Dos and Don’ts of Email writing.

Reading skills - Types of Reading - Vertical Reading, Identifying the central idea, Speed Reading, and Seven techniques to improve reading speed.

Soft skills-II (Case Studies, Vodcasts and Role Play - ICT enabled) - Cultural sensitivity, Empathy and understanding, Diversity and Acculturation

Text Books:

1. Aruna Koneru, “Professional Communication”, Tata Mc Graw- Hill Publishing Company, New Delhi, (2008)t.

2. Asha Kaul, “Effective Business Communication”, PHI Learning Private Limited, New Delhi, (2011).

3. Sharon J. Gerson, Steven M Gerson, “Technical Writing Process and Product” (third edition), Pearson Education, Asia.

4. Frangoise Grelle, “Developing Reading Skills: A Practical Guide to Reading Comprehension Exercises”, Cambridge University Press, (1981)

5. Eric H. Glendinning, Beverly Holmström, “Study Reading: A Course in Reading Skills for Academic Purposes”, Cambridge University Press, (2004)

6. Content Area Reading: Teaching and Learning in an Age of Multiple Literacies, Video-Enhanced Pearson eText, Maureen, Pearson Education (US), (2014)

PROFESSIONAL COMMUNICATION SKILLS

Course code: 15 EN 2103 **L-T-P: 0-0-4**

Pre Requisite: NIL **Credits: 2**

Mapping of Course outcomes with Student outcomes:

CO No	Course outcome’s	Mapped SO	BTL
CO 1	Understand the concept of Group Discussion and listen and speak effectively during the discussion.	g	1
CO 2	Understand and improve learners’ competency in competitive English and apply the principles of grammar in real life contexts.	g	2
CO 3	Understand skimming & scanning, and apply the types of reasoning in comprehending the information.	g	3
CO 4	Understand the mechanics and application of presentation skills.	f	1

Syllabus:

Speaking skills - Group Discussions (Level 1) - Format of GD as used in national level recruitment boards, Rules, ambience and normal practices, Do s and Don’t s in Group Discussions, Helping to build confidence, improve on content and clarity, Practicing skills like Initiating, developing and concluding discussions

Structures and written expression (exercises) - Sentence Completion (Single blank TOEFL level), Analogies, One word substitutes, Mechanics of Grammar - Correction of Sentences, Errors in grammar and usage**,** Jumbled Sentences / Paragraph scramble, Rephrasing.

Reading skills level 2 (gre gmat cat level) - Skimming and scanning, Word Perception tests, Reading speed development (7 skill exercises), Searching for key words, Reasoning Skills - Analytical Reasoning, Critical Reasoning, Language Specific Reasoning

Soft skills III - Seminars, Presentations, Case Studies: Role Plays and Simulated Presentation.

Text Books:

1. Edgar Thorpe and Showick Thorpe, "Objective English"3rd Ed,Pearson Publishers, (2010).
2. R. S. Aggarwal, "Objective General English", S Chand Publishers, New Delhi.
3. Mortimer J. Adler, Charles Van Doren, Simon and Schuster, "How to Read a Book: The Classic Guide to Intelligent Reading" , (2014).
4. Bob Underwood, Jesse Zuck, "Philosophy Skills Book: Exercises in Philosophical Thinking, Reading, and... Chris Case", A&C Black, (2012)
5. Joanne Carlisle, "Reasoning and Reading Level 1", School Specialty Intervention, (1999)
6. Patsy Mc Carthy & Caroline Hatcher, "Presentation skills. The essential guide for students", Sage publications, (2002).

EMPLOYABILITY SKILLS

Course code: 15 EN 2204 **L-T-P: 0-0-4**

Pre Requisite: NIL **Credits: 2**

Mapping of Course outcomes with Student outcomes:

CO No	Course outcome's	Mapped SO	BTL
CO 1	Analyze one's own strength as a speaker/ Communicator and use discretion while listening.	g	2
CO 2	Apply and analyze various concepts of writing strategies in professional communication skills like, reports, resume and minutes of the meeting.	g	3

CO 3	Understand the organization of the passage and also analyze the tone, attitude and style of the author.	g	2
CO 4	Acquire knowledge of and apply people skills in various social organizational and corporate ambiences.	f	2

Syllabus :

Speaking skills - Group Discussions Level 2 Speaking and listening exercises From Effective Speech by Richard W Clark.

Know yourself as a Communicator, Communicating with others, Group Discussion, Interactive Listening.

Writing skills- Writing Proposals, Product and process description, Agenda, Minutes and Scheduling meetings, Technical Writing Skills - Report Writing, Types of reports, Formats, How to write good reports, Résumé and Job Application.

Reading skills - Reading Comprehension (GRE, GMAT Pattern) - Identifying the author's purpose, Main Idea/ Theme, Suitable Title, Specific information, not mentioned/ Negative factual information, Tone, Attitude and Style, Structure / Organization. Vocabulary in context - Signpost words, Pejorative Signals and Complimentary Signals, Continuation Signals, Contrast signals, Sentence Completion, Text completion, Sentence Equivalence (Single blank, double blank, three blank, two answer Questions)

People skills - Initiating and ending conversations, Expressing and creating interest, practicing therapeutic listening, Breaking good/bad news.

Text Books:

1. Raymond V.Leisikar et al. , "Business Communication: Connecting in a Digital World", Tata Mc Graw Hill Education, 13th Ed., (2015)
2. Mallika Nawal, "Business Communication", Cengage Learning Pvt Limited, Delhi, (2014)
3. Lisa Zimmer Hatch, Scott Hatch, "GMAT for Dummies", John Wiley & Sons, (2012)
4. Eric H. Glendinning, Beverly Holmström, "Study Reading: A Course in Reading Skills for Academic Purposes", Cambridge University Press, (2004).
5. Sunitha Mithra, "Personality Development and soft skills", OUP (2012).

VERBAL AND QUANTITATIVE REASONING

Course code: 15 EN 3105 **L-T-P: 0-0-4**

Pre Requisite: NIL **Credits: 2**

Mapping of Course outcomes with Student outcomes:

CO. No	Course outcome's	Mapped SO	BTL
CO 1	Understand the method of identifying synonyms and antonyms and analyze the meaning of a word from the context.	i	1
CO 2	Analyze issues and arguments in the process of critical reasoning and apply grammar rules to correct sentences.	i	1
CO 3	Apply the Concepts of basic Algebra and their importance while solving the problems	i	1
CO 4	Apply the short-cut methods on the concepts of different models in Calendars, Clocks, Blood relations and various types of arrangements.	i	1

Syllabus:

Verbal ability (GRE, GMAT, CAT PATTERN): Synonyms**,** Antonyms and One word substitutes.

Critical reasoning: Analyzing issues**,** Analyzing arguments and Sentence correction.

Quantitative reasoning (GRE, GMAT, CAT pattern):Arithmetic – Decimals**,** Exponents and Roots**,** Fractions**,** Integers**,** Percent**,** Ratio**,** Real Numbers. **Algebra -** Applications**,** Coordinate Geometry**,** Functions**,** Graphs of Functions**,** Operations with Algebraic Expressions**,** Rules of Exponents**,** Solving Linear Equations**,** Solving Linear Inequalities**,** Solving Quadratic Equations.

Reasoning - Clocks, Calendars**,** Binary logic, seating arrangement**,** Blood relations**,** Logical sequence**,** Assumption**,** Premise Conclusion**,** Linear and matrix arrangement.

Text Books:

1. Hari Mohan Prasad, "Objective English for Competitive Examinations (English)" 4th Ed. Tata McGraw - Hill Education, 2009.
2. RS Agarwal, "Objective General English", S Chand Publishers, New Delhi

3. P Bhardwaj , "Analytical & Logical Reasoning For CAT & Other Management Entrance Tests", Arihant Publications(I) Pvt.Ltd – Meerut, 2012 print.

4. R. S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", S.Chand, (2013).

CORPORATE COMMUNICATION SKILLS

Course code: 15 EN 3206 **L-T-P: 0-0-4**

Pre Requisite: NIL **Credits: 2**

Mapping of Course outcomes with Student outcomes:

CO. No	Course outcome's	Mapped SO	BTL
CO 1	Understand and analyze the depth of a topic and use the advanced levels in creative speaking and debating.	g	1
CO 2	Understand and analyze various strategies involved in writing an essay and apply various styles in writing.	g	2
CO 3	Understand and analyze the given text critically and answer questions on critical reasoning based on the given information.	g	3
CO 4	Acquire knowledge on various employability skills & analyze a situation and develop adaptability.	f,g	3
CO5	Apply the Concepts of basic geometry and their importance while solving the problems.	g	2

Syllabus:

Speaking skills - Speaking and listening exercises, From Effective Speech Richard W Clark, Storytelling and interpretation - Speaking to Explain, Speaking Activities - JAM, Information Gap / Creating stories, Picture Description, Debate

Writing skills - Five Types of Essays (TOEFL IBT pattern) - Agree or disagree, which you prefer and why, If / imaginary, Description / Explanation, Comparison and Contrast, **Styles in Writing: Modes of Discourse -** Narration, Description, Exposition, Argumentation/ Persuasion

Reading skills - Reading Comprehension - Critical Reading, Searching for implied meanings, Answering questions on theme, tone, point of view, title etc.

Soft skills - Interview Skills**,** Mock Interviews**,** Writing personal profile & Company profile**,** Answering unconventional HR questions**,** Dress Code**,** Dining etiquette**,** Interpersonal skills.

Quantitative reasoning -2: Geometry - Circles, Lines and Angles, Polygons, Quadrilaterals, Three-Dimensional Figures, Triangles – **Data Analysis-** Counting Methods, Data Interpretation Examples, Distributions of Data, Random Variables, and Probability Distributions, Graphical Methods for Describing Data, Numerical Methods for Describing Data, Probability.

Text Books:

1. Sanjay Kumar & Pushp Lata, "Communication Skills", Oxford University Press, (2014)
2. Akanksha Makwana, Heeral Bhatt, "IELTS Essay Booster (One Stop Destination for the Writing Module) (English)", MK Book Distributors- Ahmedabad.
3. GRE Analytical Writing: Solutions to the Real Essay Topics (English), Create space Independent Pub
4. Critical Reading: English for Academic Purposes 1st Edition, Pearson Education ESL; 1 edition, (2015)
5. Eric H. Glendinning, Beverly Holmström, "Study Reading: A Course in Reading Skills for Academic Purposes", Cambridge University Press, (2004).
6. M S Rao, "Soft Skills Enhancing Employability – Connecting campus with corporate", International Publishing Pvt Ltd, (2002).
7. R. S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S Chand Publishers, (2010).

ECOLOGY AND ENVIRONMENT

Course code: 15 GN 1001 **L-T-P: 2-0-0**

Pre Requisite: NIL **Credits: 2**

Mapping of the course outcomes with student's outcomes.

CO No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the importance of Environmental education and conservation of natural resources.	h	1
CO 2	Understand the importance of ecosystems and biodiversity.	i	1
CO 3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.	h	2

Syllabus:

The Multidisciplinary nature of Environmental Studies - Introduction to Environment, Definition,scope,importance,Multidisciplinary nature of Environmental Studies, Need for public awareness. Institutions and people in Environment. **Natural Resources**- Renewable and Non Renewable Resources **Forest resources** - Benifits,Deforestation,causes, effects and impacts, Afforestation programmes, Socio-forestry, Agro-forestry, Vanasamrakshana programmes,. **Mining its impact on environment** - mining, dams and their effects on forests and tribal people. **Water resources**- Distribution of surface and ground water, Aquifers, floods, drought, conflicts over water, dams, benefits and problems, Water conservation, rain water harvesting, watershed management, Cloud seeding **Mineral resources**- Use, exploitation, environmental effects. **Food resources**- Changes in agricultural methodologies, comparison between old and new methods of farming, Green Revolution, Environmental Impact Assessment of conversion of agricultural lands, effects of modern agriculture, Drip Irrigation, fertilizer, pesticide problems, Eutrophication, Vermicompost, water logging, Blue baby syndrome. **Energy resources** - Growing energy needs, renewable and non renewable energy sources. **Land resources**-. **Soil erosion**- Importance of soil, Types of soil erosion, Causes and effects of soil erosion. How to control soil erosion. Role of an individual in conservation of natural resources. **Ecosystems -** Concept of an ecosystem, Structure and function of an ecosystem, Energy flow in the ecosystem ,Ecological succession, Food chains, food webs and ecological pyramids. Types of ecosystem. **Biodiversity and its Conservation**- Introduction, Definition, Levels, Values of biodiversity, India as a mega diversity nation. Hotspots of biodiversity. Threats to biodiversity- Endangered and endemic species of India. Conservation of biodiversity- Assessment of Biodiversity and its impact on Environment. **Environnemental Pollution-** Définition, Causes, effects, control measures of Air pollution, Water pollution, oïl pollution, Marine pollution, Noise pollution, Thermal pollution,Nuclear hazards. **Soil waste management**. **Electronic waste management**, **Biomedical waste management -** Role of an individual in prevention of pollution. **Disaster management**–.Climate change, global warming, acid rain, ozone layer depletion. **Environmental Legislation** and objectives of Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife protection Act, Forest conservation Act, Biodiversity Act, Public awareness. **Environmental Impact Assessment Process.**

Text Book:

1. Anubha Kaushik, C.P.Kaushik, "Environmental Studies" , New Age International, (2007).
2. Benny Joseph, "Environmental Studies", Tata McGraw-Hill companies, New Delhi, (2009).

HUMAN VALUES

Course code: 15 GN 1002 **L-T-P: 2-0-0**

Pre Requisite: NIL **Credits: 2**

Mapping of the course outcomes with student's outcomes.

CO No	Course outcome's	Mapped SO	BTL
CO1	Understand and identify the basic aspiration of human beings	f	1
CO2	Envisage the roadmap to fulfill the basic aspiration of human beings.	f	2
CO3	Analyze the profession and his role in this existence.	f	2

Syllabus:

Introduction to Value Education: Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - The Basic Human Aspirations, Right Understanding, Relationship and Physical Facilities, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations.

Harmony in the Human Being: Understanding the Human Being as Co-existence of Self ('I') and Body, Discriminating between the Needs of the Self and the Body, The Body as an Instrument of 'I', Understand Harmony in the Self ('I'), Harmony of the Self ('I') with the Body, Program to Ensure Sanyam and Svasthya.

Harmony in the Family and Society: Harmony in the Family - the Basic Unit of Human Interaction, Values in Human-to-Human Relationships, 'Trust' – the Foundational Value in Relationships, 'Respect' – as the Right Evaluation, Understand Harmony in the Society, Vision for the Universal Human Order.

Harmony in the Nature (Existence): Understand Harmony in the Nature, Interconnectedness, Self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing 'Existence is Co-existence' at All Levels, The Holistic Perception of Harmony in Existence.

Implications of the Right Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models - Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Text Book:

1. R R Gaur, R Sangal and G P Bagaria, " A Foundation Course in Human Values and Professional Ethics", 1st Ed, Excel Books.

BASIC SCIENCES

SINGLE VARIABLE CALCULUS AND MATRIX ALGEBRA

Course Code : 15MT1001 **L-T-P** : 2-2-2

Pre-requisite : Nil **Credits** : 4

Mapping of Course outcomes with Student outcomes:

CO.No	Course outcome	Mapped SO	BTL
CO-1	Formulate physical laws and relations mathematically in the form of first order differential equations and identify a method for solving and interpreting the results.	e	1
CO-2	Formulate physical laws and relations mathematically in the form of second/higher order differential equations and identify a method for solving and interpreting the results.	e	1
CO-3	Provide solutions for Fourier series of periodic/non-periodic phenomenon in models involving differential equations.	e	1
CO-4	Apply numeric solution methods for a system of linear algebraic equations and application oriented matrix eigenvalue problems.	e	1
CO-5	Verify the solution of problems through MATLAB.	k	1

Syllabus:

Differential Equations: Definitions and terminology and mathematical models used in a differential equations. First-order and higher-order differential equations, along with the methods of solutions and their applications. Modeling with first and higher-order also systems of linear first-order differential equations. Solutions of first order ordinary differential equations by Numerical methods.**Fourier series**: Definitions and Fourier series for a periodic signal. Fourier series for simple functions. Fourier series of the summation of sinusoids directly from the definition by using Euler's formula. Solving particular solution to differential equation by Fourier series.**Matrix algebra**: Solving linear System of equations by Gauss-elimination, L U decomposition and Jacobi, Gauss seidal iteration methods, orthogonal, symmetric, skew-symmetric, Hermitian, Skew-Hermitian and unitary matrices, Eigen values, Eigen vectors and their properties, Cayley -Hamilton theorem (without proof) and its applications, and quadratic forms.

Text Books:

1. Erwin Kreyszig ,"Advanced engineering mathematics". JOHN WILEY Publishers , 10 th edition.

2. Green Berg ,"Advanced engineering mathematics", PHI publishers, 2 nd edition.

Reference Books:

1. Differential equations for engineers, WEI-CHAU XIE, Cambridge University Press, New York.

2. Dr. B.S. Grewal ,"Higher Engineering Mathematics',Publisher: Khanna,New Delhi.

3. S.C. Chapra ,"Advanced Numerical methods with Matlab" , Tata Mc-Graw Hill.

MULTI VARIATE CALCULUS

Course code: 15 MT 1203 **L-T-P: 2-2-2**

Pre Requisite: NIL **Credits: 4**

Mapping of Course outcomes with Student outcomes:

CO No.	Course outcome's	Mapped SO	BTL
CO 1	Determine the maximum and minimum values for the function involving two variables	e	2
CO 2	Calculate the length of the arc, area, volume of the surface of a solid revolution	e	2
CO 3	Model the given phenomena as a partial differential equations of first and second orders	k	2
CO 4	Solve the partial differential equations by analytical and finite difference methods	e	2
CO 5	Verify the solution of problems through MATLAB.	k	2

Syllabus:

Differential Calculus: Partial derivatives, Jacobian, total differentiation and their applications, chain rule, Taylor's series for function of two variables, maxima and minima of functions of two variables, Lagrange's multipliers method.

Integral Calculus: Line integrals- length of the arc, double and triple integrals and applications to area, volume, mass & moment of inertia. Change of order of integration, change of variables in polar, cylindrical and spherical polar coordinates.

Vector Calculus: Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of a vector point function. Line, surface and volume integrals, Green's, Gauss divergence and Stoke's theorems and their applications

Modeling with partial differential equations: Formation of partial differential equations, solutions of first order linear and nonlinear PDEs by Lagrange and Charpit's methods, solution of second order PDEs by method of separation of variables i.e., one dimensional wave and heat equations, Laplace equation in two dimensions. Solving Laplace equation by Finite difference method.

Text Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, , John Wiley &Sons, Inc, Newyork .(2015)
2. Nakhle H Asmar, "Partial differential equations with Fourier series and boundary value problems", Second edition Pearson Pub.

Reference Books:

1. Michael Greenberg, Advanced Engineering Mathematics. 2nd Ed, **Prentice Hall, USA.**
2. Zafar Ahsan, Differential equations and their applications, 2nd Ed., PHI

PROBABILITY AND STOCHASTIC MODELS

Course Code : 15MT2005 **L-T-P :2-2-2**
Pre-requisite :NIL **Credits : 4**
Mapping of course outcomes with student outcomes:

CO.No	Course outcome	Mapped SO	BTL
1	Construct the probability distribution of a random variable, based on a real-world situation, and use it to compute expectation and variance	**e**	**2**
2	Predict the relationship between two variables and construct the linear and non-linear regression lines for the given data	**e**	**2**
3	Model the Single and multi server markovian queuing models with finite and infinite capacity.	**k**	**2**
4	Verify and validate the simulation models.	**k**	2
5	Verify the solution of problems through	**k**	**2**

	MATLAB/MINITAB.		

Syllabus:

Probability and Random variables: Definitions of probability, Sample space, Axioms of probability, Conditional probability, Addition, Multiplication and Bayes' theorem. Random variables, Joint and marginal probabilities, Mathematical expectation.

Standard discrete and continuous distributions: Definitions and simple properties of Binomial, Poisson, Geometric, Hyper-Geometric, Uniform, Exponential, Weibull and Normal distributions, Applications of the above distributions.

Correlation and Regression: Correlation coefficient for grouped and ungrouped data, Rank correlation. Linear and Non-Linear Regression.

Stochastic Processes: Discrete-Time Markov Chains, Continuous- Time Markov Chains.

Queueing models: Single and multi server markovian queuing models with finite and infinite capacity. Networks of queues.

Simulation: Introduction to simulation, simulation examples, general principles, statistical models in simulation. Verification and validation of simulation models.

Text Books

1. Ronald E. Walpole, Sharon L. Myers and Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson.
2. Kishore S Trivedi, "Probability& Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, Wiley India, 2009.

Reference Books

1. Richard A Johnson , Miller & Freund's Probability and Statistics for Engineers, 11th Edition PHI, New Delhi.
2. Jerry Banks, John S Carson, Barry L Nelson, David M Nicol, Discrete- Event System Simulation, 4th Edition, Pearson
3. Jay L. Devore, Probability and Statistics for Engineers, CENAGE learning.
4. S C Gupta and V K Kapoor , Fundamentals of Mathematical Statistics, 11th Edition, S Chand & Sons, New Delhi.

MECHANICS

Course code: 15 ME 1001 **L-T-P: 2-2-2**

Pre Requisite: NIL **Credits: 4**

Mapping of Course outcomes with Student outcomes:

CO No	Course outcome's	Mapped SO	BTL
CO 1	Apply the concept of forces, governing static equations and analyze planer system of forces. Apply different analytical methods on spatial system of forces and analyzing them	a	2
CO 2	Understanding the concepts of planar and non-planar system of parallel forces and analyzing them. estimate moment of inertia of lamina and material bodies	a	2
CO 3	Analyzing the rigid bodies under translation and rotation with and without considering forces.	e	1
CO 4	Understanding the engineering mechanics physical systems prepare and demonstrate the models with the help of mechanics concepts to solve the engineering problems	e	1
CO5	Apply the concepts of mechanics and carryout different experiments and analyze the results	b	2

Syllabus:

Vectors, Units, Dimensions and conversions

Two Dimensional Force Systems: Basic concepts, Laws of motion, Principle of Transmissibility of forces, Transfer of a force to parallel position , Resultant of a force system, Simplest Resultant of Two dimensional concurrent and Non-concurrent Force systems, Free body diagrams, Equilibrium and Equations of Equilibrium, Applications, Forces in space, Truss-Method of joints and sections.

Properties of areas and volumes: Centroids, centre of gravity, Moment of inertia- Area and Mass

Friction: Introduction, Laws of Coulomb Friction, Equilibrium of Bodies involving Dry-friction, Application.

Kinematics of Rigid Body: Introduction, Plane Motion of Rigid Body, Velocity and Acceleration under Translation and Rotational Motion.

Kinetics of Rigid Body: Introduction, Force, Mass and Acceleration, Work and Energy, Impulse and Momentum, D'Alembert's Principles and Dynamic Equilibrium.

Text Books:

1. Stephen Timoshenko, D. Young, J Rao, "Engineering Mechanics" Revised Fourth Edition (in SI Units) (special Indian Edition) , Tata McGraw Hill,

Reference Books:

1. Irving H. Shames "Engineering Mechanics", Prentice-Hall.
2. F.P. Beer and E.R. Johnston "Vector Mechanics for Engineers (in SI units) Statics & Dynamics" – Mc Graw Hill Publications.

ENGINEERING MATERIALS

Course code: 15 PH 1001 **L-T-P : 2-2-2**

Pre Requisite: NIL **Credits: 4**

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapped SO	BTL
CO 1	Understand the concepts of crystallography and crystalline imperfections in order to determine crystal structures and to identify defects in crystals	c	1
CO 2	Understand electrical and optical properties of materials and apply them to know various mechanisms involved in electrical, electronic, optical, optoelectronic devices.	c	1
CO 3	Understand mechanical and thermal properties of materials and apprehend their importance in identification of materials for specific engineering applications	c	1
CO 4	Understand magnetic properties of materials and apply them to know various mechanisms involved in magnetic memory devices and transformers.	c	1
CO 5	Understand various properties of materials and apply the knowledge to execute the related experiments to get hands on experience and also to develop some inter disciplinary projects.	c	1

Syllabus:

Crystallography: Bonding in materials, Space lattice, basis, unit cell, Seven Crystal systems, Bravais lattice system, Reciprocal lattice, Crystal directions, Miller Indices, problems, Diffraction of Crystals, Bragg's Law, XRD, Laue, Rotating Crystal and powder XRD Techniques, Problems.

Crystal Imperfections: Point Defects, Line Defects, Surface Defects, Volume Defects, Effects of Defects on Crystalline Properties.

Electrical Properties: Free Electron Model (Postulates of Classical and Quantum models and their Failures), Bloch theorem (qualitative analysis only), Kronig- Penny model (qualitative analysis only), Brillouin Zones, Energy band theory, Band structures in Conductors, Semi conductors and Insulators, Electrical properties of conductors- Ohms, Mathiessen rule, conductivity, Mobility, Electrical properties of Semi conductors, Factors effecting the carrier concentration , Conductivity and Mobility of charge carriers. Electric properties of Insulator-Dielectrics- Types of Dielectrics, Dielectric Constant, Polarization, Types of Polarizations, Frequency Dependence of Polarization, Ferro, Piezo Electrics.

Optical properties: Optical reflectance, Optical Absorption, Exciton Binding Energy, Raman Effects in Crystals, Energy Loss of Fast Particles in Solids.

Thermal properties: Crystal vibrations with Mono atomic basis, Phonon Momentum, Heat capacity , Thermal Expansion and Thermal Conductivity in Metals, Ceramics and Polymers, Heat treatment of Materials, Hardening, Tempering, Quenching and Nitriding.

Mechanical Properties: Stress, Strain, Hooke's Law, Elasticity, Plasticity, Creep, Ductility, Brittle, Hardness, Strength, Modulus of Elasticity, Fracture, Fatigue, Stress- Strain Behavior of Ductile and Brittle Materials, Hardness Tests- Vickers, Rockwell and Brinell.

Magnetic properties: Origin of Magnetic Moment, Dia, Para, Ferro, Antiferro and Ferri Magnetism, Domain theory and Hysteresis Effect of Ferro and Ferri Magnetism, Soft and Hard Magnetic Materials.

Text Books:

1. William D. Callister,Jr. "Materials Science and Engineering: An Introduction" 6th edition, Wiley India Pvt.Ltd, (2007)
2. Charles Kittel, "Introduction to Solid State Physics" 8th edition, Wiley India Pvt.Ltd,(2012).

Reference Books:

1. Adrianus J. Dekker, *"Solid State Physics"* 1st Edition, Macmillan India Ltd, (*2002).*

ENGINEERING CHEMISTRY

Course Code: 15CY1001 L-T-P : 2-2-2

Pre-requisite: NIL Credits : 4

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapped SO	BTL
CO-1	Predict potential complications from combining various chemicals or metals in an engineering setting.	**c**	**1**
CO-2	Discuss fundamental aspects of electrochemistry and materials science relevant to corrosion phenomena.	**c**	**1**
CO-3	Examine water quality and select appropriate purification technique for intended problem.	**c**	**1**
CO-4	Apply phase rule, polymers, conducting polymers and nano chemistry to engineering processes.	**b**	**1**
CO-5	An ability to analyze & generate experimental skills.	**b**	**1**

Syllabus:

ENERGY SOURCES: Chemical Energy: Basic concepts of electrochemistry – electrode potential, origin of single electrode potential, Galvanic cells, Reference electrodes- Determination of pH using glass electrode. Chemistry, construction and engineering aspects of Primary (zinc-carbon cell) and secondary (lead-Acid cell, Ni-Cd cell, Lithium cells) and fuel cells– Hydrogen–Oxygen fuel cell, advantages of fuel cell. Nuclear Energy: Fission and fusion– power rectors– Atomic pile applications. Solar Energy: Methods of utilization– thermal conversion– Liquid Flat– Plate collector, photovoltaic conversion- solar cell and

Applications. Thermal Energy: Fuels, classification– Solid fuels – coal – Liquid fuels – primary – petroleum – cracking, knocking, synthetic petrol, gaseous fuels– natural gas, calorific value of fuel– HCV, LCV. CORROSION AND ITS CORROSION CONTROL: Introduction, causes and different types of corrosion and effects of corrosion. Theories of corrosion– Chemical, Electrochemical corrosion and corrosion reactions; Factors affecting corrosion– Nature of metal, galvanic series, over voltage, purity of metal, nature of oxide film, nature of corrosion product. Nature of environment- effect of temperature, effect of pH, Humidity, effect of oxidant. Control Methods – Cathodic protection, sacrificial anode, impressed current cathode. Surface coatings: methods of application on metals- hot dipping, galvanizing, tinning, cladding, electroplating; Organic surface coatings– paints constituents and functions. WATER TREATMENT: Introduction, Hardness: Causes, expression of hardness – units – types of hardness, estimation of temporary and permanent hardness of water, numerical problems. Alkalinity and estimation of alkalinity of water, numerical problems. Boiler troubles – Scale & sludge formation, caustic embrittlement, corrosion, priming & foaming. Softening of water: Internal and external treatments -Lime soda, Ion exchange process and Numerical problems. Desalination-reverse osmosis and electro dialysis - domestic water treatment POLYMERS AND PLASTICS: Definition – Types of polymerization – Mechanisms of polymerization. Effect of polymer structure on properties. Plastics – Thermoplastic resins and Thermosetting resins - Compounding of plastics – Fabrication of plastics. Preparation, properties and engineering applications of: polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde . Conducting Polymers: Poly acetylene, polyaniline, conduction, doping, applications. Liquid Crystal polymers: Characteristics and uses. Nano-Chemistry: Introduction, types of Nano materials, General methods of preparation of Nano materials, Applications. PHASE RULE: Definitions – phase, component, degree of freedom, phase rule equation. Phase diagrams – one component system: water system. Two component system lead - silver system, heat treatment based on iro-carbon phase diagram, hardening, annealing.

Text Book:

1. J C Kuriacose & J Rajaram ,"Chemistry in Engineering and Technology", Volume 2, , TMH, New Delhi.

2. Shashi Chawla, " text book of Engineering Chemistry," Dhanpat Rai , New Delhi.

Reference Books:

1. O G Palanna, ,"Engineering Chemistry", TMH, New Delhi.

2. B. Sivasankar," Engineering Chemistry", TMH, New Delhi.

3. Jain & Jain ,"Engineering Chemistry," , Dhanpat Rai Publishing Company. New Delhi.

4. C Parameswara Murthy, C V Agarwal and Andra Naidu ,"Engineering Chemistry", , B S Publications.

BIOLOGY FOR ENGINEERS

Course Code: 15BT1001 L-T-P : 2-0-0

Pre-requisite: Nil Credits : 2

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapping of SO	BTL

CO-1	Acquire the Knowledge of basic biology	h,j	1,2
CO-2	Acquire the Knowledge of Human Biological Systems	h,j	1,2
CO-3	Acquire Knowledge on Microorganisms and Biosensors	h,j	1,2

Syllabus:

Basic Biology : Introduction, Living organisms, Cell structure and Organelles, Organogenesis, Human Anatomy,

Systems of Life: Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking and coordination and Defense,

Diet and Nutrition: Macro (Carbohydrates, proteins, lipids) - and Micronutrients (vitamins), Essential minerals and their role; deficiency symptoms; and their role; deficiency symptoms.
Micro organisms: Classification of Microorganisms, beneficial and harmful effects of Bacteria, Fungi and Viruses.

Biosensors, biomechanics and Medical Imaging technology, Applications of Biosensor in Food and Agriculture.

Text Books:

1. Dr RC Dubey ,"Advanced Biotechnology", S Chand Publications.
2. P K Gupta ,"Elements of Biotechnology", RASTOGI Publications.

FIELDS & NETWORKS

Course code :15 EE 1201 **L – T – P : 2-2-2**

Pre Requisite :NIL **Credits : 4**

Mapping of Course outcomes with student outcomes

C.O. No.	Course outcome	Mapped SO	BTL
1	Understand the circuit elements, kirchhoff's law and theorems to solve the networks	a,k	1
2	Apply the procedure to determine form factor and peak factor to different symmetrical & unsymmetrical waves.	a	2
3	Apply vector algebra to field fundamentals to analyze electric and magnetic field distributions	a	2
4	Apply Maxwell's equations for static and time varying fields	a	2
5	Test and Analyze the concepts learned in fields and networks by conducting experiments or by any simulation softwares	a	2

Syllabus:

Circuit Concept, R, L, C parameters, voltage and current sources, specifications of Active and Passive elements, voltage – current relationship for passive elements Kirchoff's Laws, Mesh and Nodal methods of analysis of networks.

Network theorems- (without proof): Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer. Star/delta transformation, source transformation,.

AC Circuits- RMS and average values and form factor of different periodic wave forms (Sinusoidal, rectangular, triangle and saw-tooth), steady state analysis of R, L and C (in series, parallel and series parallel combinations) with sinusoidal excitation, concept of reactance, impedance, susceptance and Admittance, Phase and Phase difference, concept of power factor, Real and Reactive powers, j-notation, complex and polar forms of representations, complex power. Vector Algebra: Co-ordinate systems, Del operator, Gradient of a scalar, Divergence of a vector, Curl of a vector. Electrostatics: Coulomb's Law, Electric Field Intensity – Fields due to Different Charge Distributions, Electric Flux Density, Gauss Law and Applications, Electric Potential, Relations Between E and V. Poisson's and Laplace's Equations; Capacitance calculations, related Problems. Magneto Statics: Biot-Savart Law and its applications, Ampere's Circuit Law and Applications, Inconsistency of Ampere's Law, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Lorentz Force Equation, Inductances calculations, related Problems. Time Varying Fields: Faraday's Law, Maxwell's Equations in Different Final Forms and Word Statements. Conditions at a Boundary Surface: Dielectric-Dielectric and Dielectric-Conductor Interfaces.

Text Books :

1. W.H.Hayt and J.E.Kimmerly "Engineering circuit analysis", McGraw Hill, 5th Edition, 1993.
2. Mathew NO Sadiku, Elements of Electromagnetics, Oxford University Press,2011.

INTRODUCTION TO ENGINEERING

Course Code: 15GN1004 **L-T-P :2-0-2**

Pre-requisite: Nil **Credits: 3**

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapped SO	BTL
CO-1	Understand the basic principles of engineering design	h	1
CO-2	Understand the aspects of critical thinking and problem solving in engineering	h	2
CO-3	Apply to knowledge of critical thinking to frame real-world problems and provide basic solution approach to such problems from engineering perspective	h	2
CO-4	Understand and analyze the possible career options in Engineering and develop strategic plan, career targets and mechanism to achieve the same.	f	3

Syllabus:

History Of Engineering, What is Engineering, Fields of Specialization in Engineering, **Engineering Design Process, Types of Engineering Design, Societal considerations in Engineering Design, The Engineer as a Professional:** Characteristics And Responsibilities - Ideals And Obligations Of Professional Engineers - Engineering Ethics - Codes Of Engineering Ethics - Case Studies In Ethics, **Career Paths for Engineers -** Initial Career Profiles, **Engineering Communication and Presentations:** Brief Overview

LAB COMPONENT: **MS Office- MS WORD, MS PPT, MS XCEL**

Text Book:

1. George E Dieter and Linda C Schimidt ,"Engineering Design" , Mc Graw Hill Publications

C PROGRAMMING & DATA STRUCTURES - 1

Course Code: 15CS1101 **L-T-P :**2-4-2

Pre-requisite : Nil **Credits : 5**

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapping of SO	BTL
CO-1	Illustrate how problems are solved using computers and programming.	a,e	2
CO-2	Interpret & Illustrate user defined C functions and different operations on list of data.	a,e	2

CO-3	Implement Linear Data Structures and compare them.	a,e	2
CO-4	Implement Binary Trees.	b	2
CO-5	Apply the knowledge obtained by the course to solve real world problems.	a,b,e	2

Syllabus:-

Problem Solving Approach, Algorithms and Algorithm Analysis, Program Development

Steps, Structure of C Program, Pre-Processor Directives, Formatted I/O,C Tokens, Data Types:

Primitive, Extended and Derived Including Pointers, Operators, Precedence, Associativity ,

Redirecting I/O : Files and File Operations , Control Flow Statements, Functions, Recursion,

Scope of Variables and Storage classes, Arrays, 2-DimensionalArrays, Dynamic Memory

Allocation, Searching: Linear Search and Binary Search, Sorting: Bubble Sort, Strings,

Structures and Unions, Introduction to Stacks-Implementation using array, Introduction to

Queues - Linear Queue-Implementation using array, Introduction to Lists: Single Linked ListInsertion, Deletion, Display, Introduction to Trees- Binary tree, Definition, Terminology.

Text Books:

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.
2. E. Balagurusamy , **"**Programming in ANSI C" 4th ed., Tata McGraw-Hill Education, 2008 .
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

Reference Books:-

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education.
2. Horowitz, Sahni, Anderson Freed, "Fundamentals of Datastructures in C", 2nd Edition-2007.
3. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
4. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
5. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.
6. Jean Paul Trembly Paul G.Sorenson, "An Introduction To Data Structures with applications", 2nd Edition.

C PROGRAMMING & DATA STRUCTURES - 1

Course Code: 15CS1201 **L-T-P :**2-4-2

Pre-requisite : 15CS1101 **Credits : 5**

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapping of SO	BTL
CO-1	Solve typical problems using computers and programming.	a,e	2
CO-2	Apply linear data structures in solving problems	a,e	2
CO-3	Implement non Linear Data Structures	a,e	2
CO-4	Implement Height balanced trees & Hashing	b	2
CO-5	Apply the knowledge obtained by the course to solve real world problems.	a,b,e	2

Syllabus:-

Problem solving on **Arrays**, Array of **Structures**, Nested Structures, **Queues:** DE Queue, Circular Queue and Priority Queues, **Lists:** Operations on Single Linked List, Double Linked List - Operations on DLL, **Problem Solving on Strings,** Circular Linked List, **Applications** of
Stacks and Queues, Implementation of Stacks and Queues using Linked List, Constructing **Recursion, Heaps, Sorting:** Merge Sort, Quick Sort, Heap Sort, Insertion Sort and Shell Sort, Trees: Binary Tree, Expression Tree, Binary Search **Tree:** Implementation- Insertion, Deletion,
Tree Traversals, AVL Tree and Splay Tree, **Hashing:** Hash Function, Separate Chaining, Open
Addressing, Re-Hashing and Extendible Hashing.

Text Books:

4. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.

5. E. Balagurusamy , **"**Programming in ANSI C" 4th ed., Tata McGraw-Hill Education, 2008 .

6. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

Reference Books:-

7. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education.

8. Horowitz, Sahni, Anderson Freed, "Fundamentals of Datastructures in C", 2nd Edition-2007.

9. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.

10. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.

11. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.

12. Jean Paul Trembly Paul G.Sorenson, "An Introduction To Data Structures with applications", 2nd Edition.

ENGINEERING GRAPHICS

Course Code: 15ME1002 **L-T-P :** 0-0-6

Pre-requisites : Nil **Credits :** 3

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapping of SO	BTL
CO-1	Draft orthographic Projections, Isometric views ,projection of planes, Manually and prepare Models in workshop by using drawings.	k	**2**
CO-2	Draftorhtographic projections ,isometric views , projection of planes using Autocad. Draft projection of solids Manually and by using AutoCAD and prepare Models in workshop by using different workshop trades	k	**2**
CO-3	Draft Development of surfaces of solid and sections of solid Manually	k	**2**
CO-4	Practicing house wiring through Auto Cad	k	**2**
CO-5	Develop 2D & 3D components using Auto Cad Software	b	**2**

Syllabus:

Introduction To Computer Aided Drafting: Commands, Tool Bars, Layout of Drawing sheet, Dimensions, Point Style and Text.

Projections Of Points: Theory of Projection, Elements of projection, Planes of projection, Quadrants, Projection of points in four (4) Quadrants and Conclusions.

Projections Of Planes: Different Planes, Projections of planes in various positions w.r.t planes of projection (Use First Angle Projection).

Projections Of Solids: Types of Solids, Names and Nomenclature of Solids, Projection of solids in simple position, Projections of solids with axis inclined to one reference plane and parallel to the other reference plane (Use First Angle Projection).

Orthographic Views: Projection, Orthographic projection, Importance of Front view, Position of Top view and side views w.r.t Front view, Difference between First Angle Projection and Third Angle Projection, Symbol indicating the Angle of Projection.

Sectional Views: Purpose of Sectioning, Types of sections, Importance of Hatching.

Development Of Surfaces: Principle of Development of Surfaces, Methods of Development of Surfaces, Practical Applications of Development of Surfaces.

Isometric Views: Principle of Isometric Projection, Isometric Axes, Isometric lines, Non-Isometric lines, Isometric Planes, Non-Isometric Planes, Isometric scale, Difference between Isometric drawing and Isometric Projection.

Perspective Views: Principle of perspective projection, Definitions of Perspective elements, Methods of Drawing Perspective view(s).

MEASUREMENTS

Course Code: 15GN1003 **L-T-P :0-0-4**

Pre-requisite: Nil **Credits : 2**

Mapping of Course outcomes with Student outcomes:

CO No.	Course Outcome	Mapped SO	BTL
CO-1	Understand and apply the fundamentals of a measurement system, characteristics, and metrology using simulation and experimentation tools.	a,b	2
CO-2	Understand various electrical & computer parameters, and apply different measuring techniques on various electrical parameters using simulation and experimentation tools.	a,b	2
CO-3	Understand electronic & electro-physiological parameters, and apply measuring techniques on electronic parameters using simulation and experimentation tools.	a,b	2
CO-4	Understand and apply different measuring techniques on civil and mechanical parameters using simulation	a,b	2

	and experimentation tools.		
CO-5	Apply the theoretical concepts to measure different parameters	b	2

Syllabus:

Fundamentals of Measurements: Introduction, significance, types, GMS, Static & Dynamic characteristics, Error – types, sources and remedies, Statistical & Regression analysis of data, Transducers – classification.**Metrology:** Definition, types, linear metrology, angular metrology. Straightness, flatness, squareness, parallelism, roundness and cylindricity measurements. Applications and advanced measurement techniques.**Measurement of Electrical & Computer parameters:** Definition, Representation and analogy of Current, Voltage, Power, Energy, Power factor and R – L – C components. Analog meters: Types, connections, Selection & Extension of range, applications. Electrical Bridge circuits for R, L, and C. Computer terms: Units of digital information, memory measurement, measurement of RAM, Processor speed, internet transfer speed, network connection speed, baud rate. **Measurement of Electronic & Electrophysiological parameters:** DSO – front panel controls, connectivity, measurement of Amplitude and Time period, Phase and Frequency using lissajuous patterns. Applications and advanced measurement techniques. Metric system, Electrophysiological measurements (EEG, ECG, EMG, ERG), tilt measurement, acceleration in human body (jumps), Arm flexion and rotation angle, stability of hand muscles and breathing muscles contraction, pulse rate, blood pressure, oxygen content in exhaled air, registration of algal rest and action bio potentials. Biomedical applications and advanced measurement techniques.**Measurement of Civil & Mechanical parameters:** Definition and representation of Displacement (Linear/Angular), Speed, Force, Torque, Stress/Strain, Flow, Temperature, Humidity, Viscosity. Measurement of angles and distances (height, area, distance between two elevations), Water and waste water analysis (Spectrophotometry/ Chromatography), Liquid Level using Direct and Indirect methods, Hardness of a given material sample using Brinell/Rockwell hardness testing machine, Modulus of Elasticity of a specimen using tension test, measurement analysis of air pollution. Industrial applications and advanced measurement techniques.**NI MyDAQ/ LabVIEW:**

Introduction, Hardware/Software overview, Getting started with MyDAQ (Signal connections), applying the MyDAQ as DMM, DVM, DAM, Oscilloscope, Function Generator, Real-time signal capturing, interfacing of sensors (Thermistor/LM35/Thermocouple/Opto-coupler).

Text books & References:

1. JP Holman ,"Experimental methods for engineers",McGraw Hill Ltd.
2. Thomas G Beckwith ,"Mechanical measurements", 6/E, Pearson
3. Martin U Reissland ,"Electrical measurements"New Age Int.
4. A course in Electrical, Electronic Measurement and Instrumentation- AK Sawhney-Dhanpat Rai & Co.
5. Bewoor ,"Metrology & Measuremen",McGraw Hill Ltd.
6. NI MyDAQ User Manual

OBJECT ORIENTED PROGRAMMING

Course code : 15 CS 2002 L–T–P : 2-2-2

Pre Requisite : NIL Credits : 4

Mapping of Course outcomes with Student outcomes

CO.NO.	Course outcome's	Mapped SO	BTL
CO1	Understand Basic Concepts of OOP, introduction to classes and objects through Java Language and apply.	e	2
CO2	Understand the concepts of constructors, Overloading, parameter passing, access control, Inheritance and apply.	e	2
CO3	Understand Packages, Interfaces, and Exception Handling and apply.	e	2
CO4	Understand I/O Streams & apply and understand Basic Concepts of Multi -Threading	k	3
CO5	Apply OOP concepts for developing an application	k	3

Syllabus:

Introduction: Object-Oriented Programming, OOP Principles, Encapsulation, Inheritance and Polymorphism Java as a OOPs & Internet Enabled language, The Byte code, Data types, Variables, Dynamic initialization, scope and life time of variables, Arrays, Operators, Control statements, Type Conversion and Casting, Compiling and running of simple Java program. Classes and Objects: Concepts of classes and objects, Declaring objects, Assigning Object Reference Variables, Methods, Constructors, Access Control, Garbage Collection, Usage of static with data and methods, usage of final with data, Overloading methods and constructors, parameter passing - call by value, recursion, Nested classes. Inheritance: Inheritance Basics, member access rules, Usage of super key word, forms of inheritance, Method Overriding, Abstract classes, Dynamic method dispatch, Using final with inheritance, The Object class. Packages and Interfaces: Packages, Classpath, Importing packages, differences between classes and interfaces, Implementing & Applying interface. I/O Streams- file, byte streams, character streams, Exception Handling: Exception Handling fundamentals, Types of Exceptions, Usage of try and catch, throw, throws and finally keywords, Multithreading.

Text Books:

1. Herbert Schildt, "The Complete Reference Java2", 7th edition TMH,(2002).
2. Timothy A. Budd, "An Introduction to Object-Oriented Programming", 3/E, Pearson, (2008).

Reference Books:

1. Jim Keogh, "The Complete Reference J2EE", TMH, (2006).
2. Deitel & Deitel, "'JAVA – How to program", 6th edition, PHI,(2007).

3. Cay.S.Horstmann and Gary Cornell “Core Java 2, Vol 1, Fundamentals”, Seventh Edition, Pearson Education.

SIGNAL ANALYSIS

Course Code: 15 EC 2002 **L–T–P : 2-2-2**

Pre Requisite : NIL **Credits : 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO 1	Demonstrate signals and their Spectra	**a**	**2**
CO 2	Analyze discrete time systems	**a**	**2**
CO 3	Design filters to cater signal analysis needs	**k**	**2**
CO 4	Analyze non stationary signals in time	**k**	**2**
CO 5	Analyze non stationary signals in frequency domains	**k**	**2**

Syllabus

Introduction to signal and system, Elementary signals, Signal properties and operations, Orthogonal signal space, Signal approximation using orthogonal functions, Orthogonal Properties of Sinusoidal functions

Exponential and trigonometric Fourier series, Complex Fourier spectrum, Fourier Transform, Properties of Fourier Transform, Fourier transform of Periodic Signals, Case studies

Sampling of continuous time signals, sampling theorem, DTFT, DFT, FFT, Z-Transform, Properties of Z-Transform, Case studies.

DT Systems, Classification of DT systems, System Function, Impulse Response, Response for an arbitrary input, Causality and stability of LTI systems ,case studies

Realization of discrete time systems, Design of Butterworth IIR low pass filter, FIR low pass filter using windows, Case studies

Time frequency analysis: STFT, Wavelet transform and applications, Case studies

Text books

1. Simon Haykin and Barry Van Veen, “Signals and systems”, Wiley, (2003).
2. J G Proakis and D G Manolakis, “Digital Signal Processing”, Pearson Education, (2007).
3. V. Oppenheim, R.W.Schafer and J R Buck, “Digital Signal Processing”, Pearson Education, (2007).
4. M. Vetterli and J. Kovacevic, “Wavelets and Sub band Coding”, Prentice Hall, (1995).

Reference Books

1. Alan. V. Oppenheim, Alan.V.Willsky, "Signals and systems", Prentice-Hall signal processing series.
2. Raghuveerrao and AjitS.Bopardikar, "Wavelet transforms: Introduction, Theory and applications", Pearson Education Asia, (2000).
3. Stark, "Wavelets and signal processing: An application based introduction", Springer, (2005).
4. Dimitris G. Manalakis and Vinay Ingle, "Applied Digital Signal Processing, theory, and practice", Cambridge University Press, New York, (2011).
5. S. Mallat, "A Wavelet Tour of Signal Processing", 2nd edition, Academic Press, (1999).

Simulation Books

1. Vinay, Ingle, John G Proakis, "Digital Signal Processing Using Matlab", Pearson Education.
2. Nasser Kehtarnavaz, Namjin Kim, "Digital Signal Processing System Level Design using LabVIEW", Elsevier.
3. E. S. Gopi, "Mathematical Summary for Digital Signal Processing Applications with Matlab", Springer.

DISCRETE MATHEMATICS

Course code : 15 CS 2003 L–T–P: 2-2-2

Pre Requisite :NIL Credits: 4

Mapping of Course outcomes with Student outcomes

CO.NO.	Course outcome's	Mapped SO	BTL
CO1	Understand sets, relations, functions and discrete structures , Count discrete event occurrences	**a**	**2**
CO2	Apply Propositional logic and First order logic to solve problems	**a**	**2**
CO3	Formulate and solve recurrence relations, apply algebraic structures and lattices.	**k**	**2**
CO4	To identify the basic properties of graphs and trees and model simple applications	**k**	**2**
CO5	Relate practical examples to the appropriate set,function or relation model and interpret the associated operations and terminology in context	**k**	**2**

Syllabus:

The Foundations: Logic and Proofs: Propositional Logic, Applications of Propositional, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of

Inference, Introduction to Proofs, Proof Methods and Strategy . **Basic Structures: Sets, Functions, Sequences, Sums, and Matrices:** Sets , Set Operations , Functions, Sequences and Summations, Cardinality of Sets, Matrices. **Induction and Recursion** Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness. **Counting:** The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients and Identities, Generalized, Permutations and Combinations, Generating Permutations and Combinations. **Advanced Counting Techniques:** Applications of Recurrence Relations, Solving Linear Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion–Exclusion , Applications of Inclusion–Exclusion. **Relations:** Relations and Their Properties, *n*-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings,Lattices. **Graphs:** Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. **Trees:** Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. **Algebraic Structures:** Algebraic Systems-Semi Groups, Monoids-Groups-Subgroups and Homomorphisms- Cosets and Lagrange's Theorem- Ring and Fields (Definitions and Examples).

Text Books:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Special Indian Edition, 7th Edition, Tata Mcgraw-Hill Publisher, New Delhi.
2. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics: An Applied Introduction", 4th Edition, Pearson Education Asia, Delhi, (2002).

Reference Books:

1. Joe L. Mott, Abraham Kandel, Theodare P. Baker ,"Discrete mathematics for computer scientists and mathematicians" Second Edition, PHI.
2. Tremplay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Publishing Company Limited, New Delhi, (2007).

Thomas Koshy., "Discrete Mathematics with Applications", Elsevier Publications, (2006).

THERMODYNAMICS

Course code : 15 ME 1003 L – T – P : 2- 2- 2

Pre Requisite : Nil Credits : 4

Mapping of course outcomes with student outcomes

C.O. No.	Course outcome	Mapped SO	BTL
CO-1	Understand the fundamentals of thermodynamic systems and processes	a	2
CO-2	Apply laws of the thermodynamics and principle of entropy to engineering devices.	a	2

CO-3	Analyze various air standard cycles and their performance.	a	2
CO-4	Evaluate the performance of fuels and combustion to various engines.	k	1
CO 5	Apply the theoretical concepts to conduct various experiments of thermodynamics practically and analyze the data.	b	2

Syllabus:

FUNDAMENTAL CONCEPTS AND DEFINITIONS: Thermodynamic system and control volume, Macroscopic and Microscopic points of view. Thermodynamic properties, Thermodynamic equilibrium, Quasi-static process, Reversible and Irreversible processes, Zeroth law, concept of temperature, work, work done at the moving boundary of system, work done in various non-flow processes, heat, comparison of heat and work.

LAWS OF THERMODYNAMICS: First law of thermodynamics for flow and non-flow processes, energy-a property of system, internal energy and enthalpy, specific heat at constant volume and constant pressure, PMM1, steady flow energy equation and applications. Second law of thermodynamics, thermal reservoirs, Kelvin-Plank and Clausius statements, Equivalence of Kelvin-Plank and Clausius statements, Carnot cycle, Reversed heat engine, Carnot's theorem and corollaries, Absolute thermodynamic temperature scale.

ENTROPY: Clausius theorem, temperature-entropy plot, inequality of Clausius, entropy change in reversible and irreversible process, principle of increase of entropy, applications, entropy change of an ideal gas, availability and irreversibility.

AIR STANDARD CYCLES: Otto, Diesel, Dual and Brayton cycles, performance evaluation and calculation of mean effective pressure, reversed Carnot cycle and Bell Coleman cycle.

FUELS AND COMBUSTION: Types of fuels, exothermic and endothermic combustion equation, stoichiometry combustion analysis by mass and volume, conversion of gravimetric to volumetric analysis and vice versa, exhaust gas analysis, excess air, combustion problem by mole method.

TEXT BOOKS:

1. Younus A Cengel & Michael Boles, "Thermodynamics, An Engineering Approach" - (6E) Tata McGraw Hill, New Delhi.
2. P.K.Nag, "Engineering Thermodynamics*"* - (4E) Tata McGraw Hill, New Delhi.

REFERENCE BOOKS:

1. G.J. Van Wylen., Sonntag (6E) "Fundamentals of Thermodynamics ", Wiley India publications.
2. Coheand Rogers "Engineering Thermodynamics" (5 E)-Pearson education India limited.

Zemansky *"*Heat and Thermodynamics"-, Mc Graw Hill (5E)

DIGITAL SYSTEM DESIGN

Course Code : 15 EC 1101 **L–T–P: 2-2-2**

Pre Requisite : NIL **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	Understand numerical and character representations in digital logic, number system, data codes and the corresponding design of arithmetic circuitry.	**e**	**2**
CO2	Understanding Logic gates, Logic theorems, Boolean algebra and SOP/POS expressions.	**e**	**2**
CO3	Combinational and sequential systems design using standard gates and filp-flops and minimization methods	**e,k**	**2**
CO4	Verilog HDL design for logic gates, combinational and sequential Logic Functions.	**e,k**	**2**
CO5	Concepts of Programmable Logic devices.	**e,k**	**2**

SYLLABUS:

Basic Principles of Digital Systems: Digital Versus Analog Electronics, Digital Logic Levels, Review of Number systems, Digital Waveforms, Classification of codes. **Logic Functions and Gates:** Basic Logic Functions, Derived Logic Functions, DeMorgan's Theorems and Gate Equivalence, Enable and Inhibit Properties of Logic Gates, Integrated Circuit Logic Gates.

Boolean Algebra: Boolean Expressions, Logic Diagrams and Truth Tables, Sum of Products and Product of Sums Forms, Theorems of Boolean Algerba, Simplifying SOP and POS Expressions, Simplification by the Karnaugh Map Method, Simplification by DeMorgan Equivalent Gates, Universal Property of NAND/NOR Gates. Multilevel Circuits Conversions. **Verilog Constructions to Logic Gates.**

Combinational Logic Functions: Decoders, Endoders, Multiplexers, Demultiplexers, Magnitude Comparators, Parity Generators and Checkers, Adder and Substractor. **Sequential Logic Functions:** Latches, NAND/NOR Latches Gated Latches, Edge- Triggered Flip-flops. **Registers and Counters**: Shift register, Register with parallel load, Bidirectional shift register with parallel load. Ripple counter, Synchronous Counters, up-down counter, Ring counter, Johnson Counter, Modulus counter. **Finite State machines:** Mealy and Moore machines, state diagram, Introduction to ASM charts. **Verilog HDL design for Combinational and Sequential Logic Functions.**

Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Programming of PLAs and PALs, Complex Programmable Logic Devices, Fild-Programmable Gate Arrays, Using CAD Tools to Implement Circuits in CPLDs and FPGAs, Applications of CPLDs and FPGAs, Custom chips, Standard Cells, and Gate Arrays.

Text Books

1.Stephen Brown and Zvonko Vrane "Fundamentals of Digital Logic with Verilog Design" Second Edition, McGraw-Hill.

2.Robert K. Dueck, "Digital Design" Cengage Learning-India Edition.

3.M. Morris Mano, “Digital Logic and Computer Design”, Pearson

Reference Books

1.R. P. Jain, “Modern Digital Electronics”, McGraw-Hill

2.J. Bhasker , “Verilog HDL Synthesis, A Practical Primer”, Star Galaxy Publishing.

3.ZviKohavi, “Switching and Finite Automata Theory”, 2nd Edition, TMH

ANALOG ELECTRONIC CIRCUIT DESIGN

Course Code : 15 EC 2103 **L–T–P: 2-4-2**

Pre Requisite : NIL **Credits: 5**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	Understand the industrial processes and organizations connected with the profession and relate classroom learning with real life situation by taking into the consideration of various design concepts	**c**	**3**
CO2	Understanding the concepts of various diodes and their applications.	**c**	**3**
CO3	BJT concepts as operation, biasing and frequency response	**c,k**	**3**
CO4	FET concepts as operation, biasing and frequency response	**c,k**	**3**
CO5	Feedback concepts and their analysis	**c,k**	**3**
CO6	Concepts of various oscillators and applications.	**c,k**	**3**

SYLLABUS

P-N Junctions: Diode theory, forward and reverse-biased junctions, reverse-bias breakdown, load line analysis, diode applications - Limiters, clippers, clampers, voltage multipliers, half wave & full wave rectification, Capacitor filters, π-section filter, ripple factor, Special purpose diodes - Zener diode, Varactor, light emitting diodes, Laser diodes. Regulators: Series and shunt voltage regulator, percentage regulation, Concept of SMPS.

Transistor biasing & stability: Q point, Self-Bias-CE, Compensation techniques, h-model of Transistor, Expression of voltage gain, current gain, input & output impedance, Trans-resistance & Trans-conductance, Emitter follower circuits, High frequency model of Transistor, FET fundamentals, Configurations, current-voltage characteristics, parameters of JFET, Biasing of JFET, Biasing of MOSFET.

Transistor amplifiers: RC coupled amplifier, Function of all components, Equivalent circuit, derivation of voltage gain, Current gain, Input impedance & output impedance, Frequency response characteristics, Lower & upper frequencies, Bandwidth, Concept of Wide band amplifier, FET small signal model, Common drain common gate configurations.

Operational amplifiers: Ideal OPAMP, Differential amplifier, Constant current source, CMRR, Open & closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers, Voltage follower circuits.

Application of Operational amplifiers: Adder, Integrator & Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Log & Antilog amplifier, Trans-conductance multiplier, Precision rectifier, Voltage to current & Current to voltage converter.

Filter Circuits: Analysis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier.

Feedback amplifier & Oscillators: Concept of Feedback, Negative & Positive feedback, Voltage/Current, Series/Shunt feedback, Berkhausen criterion, Colpit , Hartley's, Phase shift, Wien bridge, & Crystal oscillators.

Power amplifiers: Class A, B, AB, C, Conversion efficiency, Distortion.

Multivibrators: Monostable, Bistable multivibrators, Monostable & Astable operation using 555 timer.

Special function circuits: VCO & PLL

Text Books:

1.Muhammad H. Rashid, "Microelectronic Circuit Analysis and Design", Oxford Press.

2.Sedra & Smith, "Micro-Electronic Circuits theory and applications" 2nd edition, Cengage Learning.

Reference Books:

1.Jacob Millman & Christos C. Halkias, "Integrated Electronics", Tata -McGraw Hill, 2nd Edition, (2010).

2.Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", PHI. 9th Edition.

DESIGN WITH CPLD AND FPGA

Course Code : 15 EC 2204 **L–T–P: 2-2-2**

Pre Requisite : 15 EC 1101 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	Study and design of combinational and sequential circuits using PLDs and state machines.	**c**	**2**

CO 2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.	**c,k**	**2**
CO 3	To study PLD structures and design process	**c**	**2**
CO 4	Study of different CPLD and FPGA architectures	**c**	**2**
CO 5	To understand different physical process.	**c,k**	**2**

SYLLABUS:

Programmable Logic Design: Combinational circuit realization using: PLDs – ROM, PLA and PAL. Analysis of Clocked Sequential Circuits: State table, State diagram, State Equation, State reduction, state Assignment. Flip Flop Excitation Tables, Design Procedure.

ASIC Design: Full Custom Design; Semicustom Design; Standard Cell Based ASIC, Gate Array Based ASIC, Programmable Logic Devices, CPLDs, FPGA, ASIC Design Flow, Economics of ASICs, ASIC Cell Library. Programmable ASICs: The Antifuse, Static RAM, EPROM and EEPROM.

Programmable Logic Devices: MOS Programmable Logic Device (PLD); Sequential PLD; Complex PLD; Field Programmable Gate Array (FPGA); Xilinx SRAM-Based FPGA; Comparison between FPGA, ASIC and CPLD; FPGA based system design.

Complex Programmable Logic Devices (CPLDs): PAL16L8, PAL20P8, PAL20R8, PALCE16V8, GAL22V10, Altera Series- MAX 7000S, FLEX 10K architectures.

Field Programmable Gate Arrays (FPGAs): Xilinx – XC2000, XC3000, XC4000, Altera – FLEX 8000, Actel – ACT – 1, 2, 3 architectures.

Computer Aided Design Tools: Synthesis: Netlist Generation, Gate Optimization, Technology Mapping. Physical Design: Placement, Routing, Static Timing Analysis.

Text Books

1. Michael John Sebasatian Smith, "Appliction Specific Integrated Circuits" Pearson Education.

2. M. Morris Mano, "Digital Logic and Computer Design", Pearson.

3. Stephen M. Trimberger, "Field-Programmable Gate Array Technology", Springer.

4. Stephen Brown and Zvonko Vranesic "Fundamentals of Digital Logic with Verilog Design" McGraw-Hill.

Reference Books

1.Pak K. Chan, Samiha Mourad, "Digital Design Using Field Programmable Gate Array", Pearson Education (2009).

2.Parag K. Lala, "Digital System Design Programmable Logic Devices", B S Publications

3.Debaprasad Das, "VLSI Design", Oxford (2011).

4.Robert K. Dueck, "Digital Design with CPLD Applications and VHDL", Thomson – Delemar Learning.

COMMUNICATION THEORY-I

Course Code : 15 EC 2205 **L–T–P: 2-2-2**

Pre Requisite: 15 EC 2103 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	have a good understanding of both time and frequency domain representations of signals;	**b,k**	**2**
CO2	have a good understanding of analog modulation and demodulation techniques;	b,k	**2**
CO3	have a good understanding of digital modulation and demodulation techniques; and	**b,k**	**2**
CO4	Understanding pulse modulation systems	**b,k**	**2**
CO5	Understand and be able to implement noise and error analysis of an analogue system.	**b,k**	**2**
CO6	Understand and be able to implement noise and error analysis of an analogue or digital telecommunication system.	**b,k**	**2**

SYLLABUS:

Fundamentals of Communication systems: Introduction, Energy-power and their spectral densities, spectral characteristics of periodic signals, random signals and noise, probability distribution functions, mean, correlation and covariance functions and correlation and spectral densities.

Analog Modulation Systems: Need for Modulation, Frequency Translation methods. L**inear Modulation techniques**: AM, DSB-SC, SSB and VSB modulation techniques. **Demodulators:** Synchronous, and envelope detectors **Superhetrodyne AM Receiver**. AM systems in the presence of noise. **Angle Modulation**: Phase and Frequency Modulation techniques. Narrow Band FM and Wide Band FM, Carson s Rule, Indirect and direct methods of Frequency Modulation. **FM receivers, FM** systems in the presence of noise. Pre emphasis and De-emphasis, **Basic of PLL:** AM and FM demodulation using PLL.

Pulse modulation Systems: PAM, PWM and PPM

Digital Modulation Systems: Pulse Modulation: Baseband signals. Sampling process; Quantization Process; Quantization Noise; Pulse-Code Modulation; Noise Considerations in PCM Systems; Differential Pulse-Code Modulation; Amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Multiple Access Techniques: TDMA, FDMA and CDMA

Information theory and Error Coding: Measure of information – Entropy – Source coding theorem – Channel capacity – Shannon-Hartley law – Shannon's limit-Error, control Codes – Linear codes, Cyclic codes, Convolution Coding.

Text Books:

1.Lathi, "Modern Digital & Analog Communications Systems", 2e,Oxford University Press

2.Simon Haykin and Michael Moher, "An Introduction to Analog & Digital Communications", 2nd Ed., Wiley, (2007).

3.Loen W. Couch, "Modern Communication Systems: Principles & Applications", Prentice Hall, (P621.382/84), (1995)

4.Tomasi, Wayne, "Electronics Communication Systems- Fundamentals through advanced", 4th Edition.

Reference Books:

1.H Taub & D. Schilling, Gautam Sahe, "Principles of Communication Systems", TMH, 3rd Edition, (2007).

2.Bruce Carlson, Paul B. Crilly and Janet C. Rutledge, "Communication Systems: An Introduction to Signals and Noise in Electrical Communications", 4th Edition, McGraw-Hill, (2002).

3.Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, (2001).

4.Nevio Benvenuto, Roberto Corvaja, Tomaso Erseghe, and Nicola Laurenti, "Communication Systems: Fundamentals and Design Methods", John Wiley & Sons, (2006).

5.Andrew J. Viterbi & Jim K. O, "Principles of Digital Communication and Coding", McGraw-Hill Book Company.

6.Bernard Sklar, "Digital Communications - Fundamentals and Applications", 2E, Prentice Hall.

7.Sam Shanmugam, K, "Digital and Analog Communication Systems", Wiley publisher (2006).

SIGNAL PROCESSING

Course Code : 15 EC 2206 **L–T–P: 2-2-2**

Pre Requisite : 15 EC 2002 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	Understand various signals and model physical process using them.	e	2

CO2	Acquaint with various a transformation methods and their potential for applicability in various signal analysis conditions	**e**	**2**
CO3	Demonstrate sampling and its potential applications in communications, discrete signal acquisition etc.,.	**e**	**2**
CO4	Evaluate discrete system behavior and its response to facilitate system design.	**e**	**2**
CO5	Design a low pass discrete time system to meet noise elimination like applications	**e, k**	**2,3**
CO6	Analyze non stationary signals and analyze them in both time frequency domains.	**e, k**	**2,3**

SYLLABUS:

Multi-rate Digital Signal Processing: Decimation by A factor D- Interpolation by a Factor I - Sampling Rate Conversion by a Rational Factor I/D Filter Design and Implementation for sampling rate Conversion: Direct form FIR filter structures – Poly-phase filter structures - Time Variant filter structure, Multistage Implementation of Sampling Rate Conversion, Perfect Reconstruction and Aliasing Removal.

Matrix Analysis: Toeplitz Matrices and Fast Algorithms.

Wavelet Transform: Pyramid and Cascade Algorithms, Daubechies Wavelets, Orthogonal and Biorthogonal Wavelets, Smoothness, Approximation, Boundary Filters and Wavelets, Time-Frequency and Time-Scale Analysis, Second-Generation Wavelets.

Design Methods: Spectral Factorization, Cosine-Modulated Filter Banks, Lattice Structure, Ladder Structure (Lifting.)

Applications: Audio and Image Compression, Quantization Effects, Digital Communication and Multicarrier Modulation, Trans-multiplexers, Text-Image Compression: Lossy and Lossless, Medical Imaging and Scientific Visualization, Edge Detection and Feature Extraction, Seismic Signal Analysis, Geometric Modeling, Matrix Preconditioning, Multiscale Methods for Partial Differential Equations and Integral Equations.

Simulation Software: MATLAB® Wavelet Toolbox, Software for Filter Design, Signal Analysis, Image Compression, PDEs, and Wavelet Transforms on Complex Geometrical Shapes.

Text Books:

1. Strang, and Nguyen. “Wavelets and Filter Banks”, Wellesley-Cambridge Press, (1997).

2. M. Vetterli and J. Kovacevic, “Wavelets and Subband Coding”, Prentice Hall-PTR, (1995).

CMOS VLSI DESIGN

Course Code : 15 EC 3107 **L–T–P: 2-2-2**

Pre Requisite : 15 EC 1101 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	To understand the VLSI fabrication process and to be able to interact with integrated circuit process engineers	**b**	**2**
CO2	To analysis the theory and CV characteristics of MOS transistor	**b**	**2**
CO3	To analysis MOS gate static and switching characteristics	**b**	**2**
CO4	To design and layout MOS logic circuits	**k**	**3**
CO5	Circuit Characterization and Performance Estimation and scaling	**k**	**3**
CO6	Logic and Fault Testing	**b,k**	**2,3**

SYLLABUS:

Technology Introduction: Introduction to IC Technology – MOS, PMOS, NMOS and CMOS Technologies. VLSI Fabrication, Oxidation, Lithography, Diffusion, Ion Implantation, Metallization. **MOS Theory Analysis:** Basic Electrical Properties of MOS Circuits: **Ids-Vds** Relationships, MOS Transistor Threshold Voltage **Vth**, **gm**, **gds**, Figure of Merit **ωo**, Short Channel and Narrow Channel Width Effects. Pass Transistor, Transmission Gate, NMOS Inverter, Various Pull-ups, CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits. **CMOS Circuits and Logic Design Rules:** MOS Layers, Stick Diagrams, Layout, Design Rules, Rules for Vias and Contacts, Stick Diagrams and Simple Symbolic Encodings for NMOS, CMOS and BiCMOS Logic Gates. Scaling of MOS Circuits. **CMOS Circuit Charactersation and Performance Estimation:** Delay Estimation, Power Dissipation, Interconnect, Design Margin, Reliability. **Logic and Fault Testing:** Logic verification, Fault Models, Scan Design Test, Built-in Self Test.

Text Books

1.Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” PHI, EEE, (2005) Edition.

2.Neil H. E. Weste and David, Harris Ayan Banerjee, “CMOS VLSI Design” Pearson Education, (1999).

References Books

1.Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits”, TMH (2003).

2. Jan M. Rabaey, “Digital Integrated Circuits” Pearson Education, (2003)

3. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall, (1998).

Simulation Text Books

1. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, (2005).

COMMUNICATION THEORY-II

Course Code : 15 EC 3108 **L–T–P: 2-2-2**

Pre Requisite: 15 EC 2205 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO.No.	Course Outcome	Mapped SO	BTL
CO1	Understand the principles behind microwave transmissions, impedance matching and waveguides	**b**	**2**
CO2	Identify different antennas and their parameters	**b**	**2**
CO3	Analyze the antenna measurement techniques	**b,k**	**2**
CO4	Analyze the microwave components	**b,k**	**2**
CO5	Examine the microwave measurements using VNA and SA	**b,k**	**2**

SYLLABUS:

Transmission lines-General Solution, Physical Significance, infinite line, wavelength, propagation, Reflection Coefficient, Open and short circuited lines, Insertion loss, standing wave ratio, input impedance of open and short circuited lines, power and impedance measurement on lines, Impedance matching–single and double-stub matching, smith chart and its applications, Transmission of TM, TE and TEM waves between parallel planes, characteristic impedance, Attenuators, Rectangular and Circular Waveguides

Antenna Types: Design considerations of Resonant Antennas, Dipole antenna, Folded Dipole antenna, Yagi –Uda Antenna, Horn antenna, Slot antenna, Log periodic antenna, Microstrip antenna , Types of feeds, antenna parameters-Radiation Patterns, Radiation Intensity, Radiation Power Density, Beam Width, Beam Area, Beam Efficiency, Directivity, Gain, Radiation Resistance, Main Lobe, Polarization, Antenna efficiency, Half Power Beam width, Effective Length and Effective Area, Antenna Arrays- Two Element Arrays, N-Element Linear Arrays, Uniform spacing, mutual coupling effects, Antenna Measurements: Introduction, Impedance/VSWR measurements, Radiation Pattern measurements, Gain Measurements

Microwave Components Microwave Passive Devices: Impedance transformer filters, adapters, matched loads, variable attenuators, Cavity Resonators, phase shifters, Microwave Bends, Twists, Transitions, S-Parameters, E-Plane, H-Plane and Hybrid Tee, directional couplers, Isolators, circulators, frequency and wave meters, Microwave diodes-Schottky, PIN, Tunnel, Gunn, Reflex klystrons, Microwave measurements using Spectrum analyzers and Vector Network analyzers

Text Books

1.John D Ryder , “Netwotk Lines and fields”, 2nd Edition, PHI

2.E.C.Jordan and Balmain, “Electro Magnetic Waves and Radiating Systems”, PHI, (1968), Reprint (2003).

3.Balanis,

Communication Theory-3

Code : 15 EC 3212 **L–T–P: 2-2-2**

Pre Requisite: 15 EC 3108 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	Describe the types and advantages of spread spectrum modulation formats	**b**	**2**
CO2	Identify the radio signal propagation mechanism and different fading concepts	**b**	**2**
CO3	Illustrate the growth of communication satellites	**b,k**	**2,1**
CO4	Identify the different phases of cellular communication concepts	**b,k**	**2,1**
CO5	Understand the optical communication transmission media and principles of operation	**b,k**	**2,1**

SYLLABUS:

Spread Spectrum Techniques: Introduction, Pseudo random sequences, a notion of spectrum, direct sequence spread spectrum with coherent BPSK. Signal-space dimensionality and processing gain.

Radio Signal Propagation mechanism: Reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading concepts: multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and RMS delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

Satellite Communications: Evolution and growth of communication satellites, Kepler's laws of motion, orbits and altitude control.

Cellular Communication concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3G cellular standards.

Optical communications: Characteristics of optical transmission media, optical fibers - preparation and transmission characteristics, loss and dispersion mechanisms, optical sources - principles of operation.

Introduction to Signal Detection: Integrated and dump filter, Optimum filter and Matched filter, Correlator, Error probabilities of base band signals.

Text Books:

1.Tomasi, Wayne, “Electronic Communication Systems- Fundamentals through advanced”, 4th Edition.

2.T. S. Rappaport, "Wireless digital communications: Principles and practice", 2nd ed., Prentice Hall India, (2007).

3.G. Keiser, "Optical Fiber Communication".

Reference Books

1.Lathi, "Modern Digital & Analog Communications Systems", 2ed, Oxford University Press.

2.Simon Haykin and Michael Moher, "An Introduction to Analog & Digital Communications", 2nd Ed., Wiley, (2007).

3.Loen W. Couch, "Modern Communication Systems: Principles & Applications", Prentice Hall, (1995).

DIGITAL IMAGE PROCESSING

Course Code : 15 EC 4110 **L–T–P: 2-2-2**

Pre Requisite : 15 EC 2206 **Credits: 4**

Mapping of the Course Outcomes with Student Outcomes

CO. No.	Course Outcome	Mapped SO	BTL
CO1	Acquire the fundamental concepts of a digital image processing system	**b**	**3**
CO2	Identify and exploit analogies between the mathematical tools used for 1Dand 2D signal analysis and processing by analysing 2D signals in the frequency domain through the Fourier transform	**b,k**	**3**
CO3	Design and implement with Matlab algorithms for digital image processing operations such as histogram equalization, enhancement	**b,k**	**3**
CO4	Design and implement with Matlab algorithms such as restoration, filtering, and de-noising which develops an appreciation for the image processing issues.	**b,k**	**3**
CO5	New techniques and be able to apply these techniques to real world problems.	**b,k**	**3**

SYLLABUS:

Introduction : Digital Image definitions ,Types of Operations ,Types of neighborhoods, Video parameters 2D convolution ,Properties of 2D convolution, 2D Fourier Transforms, Properties of 2D Fourier Transforms , Importance of phase and magnitude , Circularly Symmetric Signals, Examples of 2D Signals and transforms, Statistical Description of Images, Perception, Brightness Sensitivity, Wavelength Sensitivity , Stimulus Sensitivity, Spatial Frequency Sensitivity, Psychophysics of Color vision, Perceived color, Color metrics, CIE chromaticity coordinates, Spatial effects in color vision, Optical illusions. MATLAB Implementations.

Image Sampling: Two dimensional Sampling theory, Extensions of sampling theory, Non rectangular Grid sampling, Hexagonal sampling, Optimal sampling. **Image Quantization:** The optimum Mean Square Lloyd-Max quantizer, Optimum mean square uniform quantizer

for non uniform densities, Analytic Models for practical quantizes, Visual quantization, Vector Quantization. MATLAB Implementations.

Image Transforms: Two dimensional orthogonal and unitary transforms, Separable unitary transforms, Basis images: Dimensionality of Image Transforms, Discrete linear orthogonal, DFT, WHT, KLT, DCT and SVD, Quantization of Transform coefficients, Transform Coding of Color images.

Image Enhancement: Contrast and dynamic Range Modification, Histogram-based operations, Smoothing operations, Edge Detection-derivative based operation, Image Interpolation and Motion Estimation, Pseudo coloring.

Image Restoration: Degradation Estimation, Reduction of Additive Noise, Reduction of Image Blurring, Simultaneous reduction of noise and blurring, Reduction of Signal dependent noise, Temporal filtering for Image Restoration, Extrapolation of Band limited Signals.

Simulation Software: MATLAB® Image processing Toolbox, Simulink for Image Analysis, PDEs, and Applications to Image Analysis.

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Edition, Hardcover August 31, (2007).

2. J. R. Parker, "Algorithms for Image Processing and Computer Vision", Paperback, December 21, (2010).

3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Hardcover – December 26, (2003).

Embedded systems and applications

Course Code : 15 EC 3103 **L–T–P: 3-0-2**

Pre Requisite : NIL **Credits: 4**

Syllabus: ES Basics: Introduction to Embedded Systems: Definition, Comparison with Loaded Systems, Challenges of Embedded systems, Application of Embedded Systems. Hardware fundamentals: Power and decoupling, Open collector out puts, Tristate outputs, Signal loading related issues, Memories type and selection, Processor types and selection, Timers, Counters, Pulse width Modulators for speed control, LCD Controllers, Key Pad Controllers, Stepper motor controllers, A/D Converters, Sensors and Actuators: Temp Sensors, Flow Control devices, Humidity Control devices, Speed Control devices. Interfacing Sensors and Actuators with microcontrollers. Interfacing: Communication basics, Basic Terminology, Basic Protocol concepts, I/O Addressing: Port Based Addressing, Bus Based addressing, Interfacing Micro Processors through Interrupts, Shared data problems Interrupt Latency and DMA. Overview: Interfacing through Serial Communication using RS232C, I2C, CAN, USB, and Wireless Communication using IrDA, Blue Tooth, 802.11g, and Parallel Communication: PCI Bus, AMBA Bus. Software Architectures and RTOS: Overview of Round Robin, Round Robin with Interrupts, Function Queue Scheduling, RTOS architectures and selecting the architecture. Real Time Operating Systems: Tasks and Task data, Scheduler, Reentrancy, Semaphores, Semaphore Problems, Message Queues, Mail Boxes, Pipes, Timer Functions, Event Handling, Memory Management, Interrupt Processing,

and Power Saving Functions. Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

PROFESSIONAL ELECTIVES

(*Skill based Domains***)**

SIGNAL AND IMAGE PROCESSING DOMAIN

ARTIFICIAL NEURAL NETWORKS

Course Code: 15EC3052 **L–T–P : 3-0-0**
Pre Requisite: 15EC2206 **Credits: 3**

Syllabus: Introduction to Artificial Neural Networks: Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. **Artificial Neural Networks:** McCulloch-Pitts model, different network structures, approximation of nonlinear phenomenon, MCP error correction-based learning **Logic Networks:** Boolean functions, feed-forward vs. recurrent networks, finite automata and finite state machines, harmonic analysis via Hadamard-Walsh Transform. **Weighted Networks - The Perceptron:** pattern recognition via Perceptron, limitations of the perceptron, linearly separable functions, **Perceptron Learning Algorithms:** learning algorithm types (supervised vs. unsupervised), vector notation, algorithmic learning, Markov Decision Processes and Dynamic Programming. **The Back-Propagation Learning Algorithm:** multi-layer perceptron networks, alternative activation functions (e.g. sigmoid), back propagation learning algorithm theory, implementation of back propagation on Feed Forward Nets. **More Advanced Neural Network Topics Overview:** clustering, k-means and k-nearest neighbours, PCA, one vs. two-layer networks, over fitting vs. under fitting, gradient descent, momentum, initial weight selection, data decorrelation, complexity theory, associative memories. **Advanced Networks:** Hopfield ANN, Training and Testing algorithms. Bi – Directional Associative Memories, types, Training and testing. **Software:** Python and Matlab to simulate various network architectures, learn training and testing procedures, validate the outputs and deployment for commercial applications. **Commercially Available ANNs:** A Case study and Simulation. 1. Use ANN to recognize Hand written characters using a benchmark dataset.2. Study ANN and their Business applications. 3. Simulation of an industrial wastewater treatment plant using artificial neural networks and principal components analysis.

Text Books:

1. Laurene Fausett, "Fundamentals of Neural Networks" , Pearson Education, 2004.
2. Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2003.

Reference Books:

1. S.N.Sivanandam, S.Sumathi,S. N. Deepa "Introduction to Neural Networks using MATLAB 6.0", TATA Mc Graw Hill, 2006.
2. S. Rajasekharan and G. A. Vijayalakshmi pai, "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publication, 2004.

FUZZY LOGIC SYSTEMS

Course Code: 15EC3053 **L–T–P–S: 3-0-0**
Pre Requisite: NIL **Credits: 3**

Syllabus: Introduction to Fuzzy Logic: Classical and Fuzzy Sets, Membership Function, Membership Grade, Universe of Discourse, Linguistic Variables, Operations on Fuzzy Sets: Intersections, Unions, Negation, Product, Difference, Properties of Classical set and Fuzzy sets, Fuzzy vs Probability, Fuzzy Arithmetic, Fuzzy Numbers.
Fuzzy Relations &Aggregations: Essential Elements of Fuzzy Systems, Classical Inference Rule, Classical Implications and Fuzzy Implications, Crisp Relation and Fuzzy Relations, Composition of fuzzy relations, Cylindrical Extension and Projection. Fuzzy IF-THEN rules, Inference: Scaling and Clipping Method, Aggregation, Fuzzy rule based Model: Mamdani Model, TSK model, Fuzzy Propositions, Defuzzification: MOM, COA.
Fuzzy Optimization and Neuro Fuzzy Systems: Fuzzy optimization –one-dimensional optimization. Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks.
Application of fuzzy logic: Power plants, Industrial Control, AC Induction motor control, Traffic control, water treatment system, chilling systems, Washing machine Control, Fuzzy logic in DCS &PLC, Industrial Index motion control, Automatic generation control, power control, Automotive applications, Drying process control. Implement using an open source software such as python.

Text Books:

1. Timothy J. Ross, " Fuzzy Logic With Engineering Applications", Tata McGraw- Hill Inc. 2000.
2. Kwang Hyung Lee, First Course on Fuzzy Theory and Applications, Springer, 2005

References:

1. Klir, J.G. – Bo Yuan: Fuzzy Sets and Fuzzy Logic, Prentice Hall 1995.
2. Nguyen, H. T. – Walker, E. A.: Fuzzy Logic, Chapman and Hall, NY 2000.

MACHINE LEARNING AND COMPUTING

Course Code :15EC3054 **L–T–P–S: 3-0-0**

Pre Requisite: NIL **Credits: 3**

Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation.

Machine Learning Perception: Learning from data, Overfitting, regularization, cross-validation **Supervised Learning:** Nearest Neighbour, Naive Bayes, Logistic Regression, Support Vector Machines, Neural Networks, Decision Trees.

Unsupervised & Semi-Supervised Learning: Clustering (K-means, GMMS), Factor Analysis (PCA, LDA), **Learning Theory:** Bias and Variance, Probably Approximately Correct (PAC) Learning.

Structured Models: Bayesian Network, Hidden Markov Models, Reinforcement Learning, Applications of ML to Perception: Computer Vision, Natural Language Processing, Design

and implementation Machine Learning Algorithms, Feedforward Networks for Classification, Convolutional Neural Network based Recognition using Keras, Tensorflow and OpenCV.

Simulation: Use VGG Net and AlexNet pre-trained models for face recognition and human pose estimation problems.

Text Books:

1. Mitchell, Tom. *Machine Learning*. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
2. MacKay, David. *Information Theory, Inference, and Learning Algorithms*. Cambridge, UK: Cambridge University Press, 2003. ISBN: 9780521642989.

Reference Books:

1. Bishop, Christopher. *Neural Networks for Pattern Recognition*. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
2. Duda, Richard, Peter Hart, and David Stork. *Pattern Classification*. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
3. Hastie, T., R. Tibshirani, and J. H. Friedman. *The Elements of Statistical Learning: Data mining, Inference and Prediction*. New York, NY: Springer, 2001. ISBN: 9780387952840.

Journals:

1. IEEE Transactions on Evolutionary Computation.
2. IEEE Transactions on Pattern Analysis and Machine Intelligence.
3. Machine Vision and Applications, Springer.

COMPUTER VISION APPLICATIONS

Course Code: 15EC3055 **L–T–P–S: 3-0-0**
Pre Requisite: 15EC2206 **Credits: 3**

Syllabus: Image formation and Image Processing: Introduction to Computer Vision; Geometric primitives and transformations: Geometric primitives, 2D transformations, 3D transformations, 3D rotations, 3D to 2D projections; Image Processing: Histogram Processing, Linear filtering, Fourier transforms, Image Enhancement, Restoration.

Local Image Features Extraction: Edges: Edge detection, Edge linking; Lines: Hough transforms, Orientation Histogram, HOG, SIFT, SURF; Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation and Recognition: Active contours: Snakes, Dynamic snakes and Condensation, Scissors, Level Sets; Graph-based segmentation, Texture Segmentation; Object detection: Face detection, Detecting Humans, Detecting Boundaries, Datasets and Resources.

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians; Classifiers: SVM, ANN, CNN; Dimensionality Reduction: PCA, LDA, ICA.**Case Study and Simulations:** Study how Facebook, Google, Netflix, LinkedIn, Instagram and Amazon use various image processing algorithms for face recognition, human identification, scene

analysis and content analysis. Develop a computer vison model for face detection in the wild on KLEF campus.

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2011.

References:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

PATTERN RECOGNITION AND ANALYSIS

Course Code: 15EC3056 **L–T–P: 3-0-0**
Pre-Requisite: 15EC2206 **Credits: 3**

Syllabus: Introduction and general pattern recognition concerns: What is Pattern Recognition (PR). Pattern Recognition Approaches, Examples of PR Applications, Pattern Recognition Extensions.

Statistical pattern recognition: Introduction, Supervised, Parametric Approaches, Unsupervised Approaches. Bayes Classifier: Bayes Theorem, Minimum Error Rate Classifier, Estimation of Probabilities Comparison with the NNC, Naive Bayes Classifier. Hidden Markov Models: Markov Models for Classification, Hidden Markov Models, HMM Parameters, Learning HMMs, Classification Using HMMs, Classification of Test Patterns.

Syntactic (structural) pattern recognition: Introduction, Structural Analysis Using Constraint Satisfaction and Structural Matching, The Formal Language-based Approach, Learning/Training in the Language-based Approach. **Neural pattern recognition:** Nearest Neighbour Based Classifiers: Nearest Neighbour Algorithm, Variants of the NN Algorithm, Use of the Nearest Neighbour Algorithm for Transaction Databases, Minimal Distance Classifier (MDC).

Applications: Finger print recognition, Leaf classification, failure analysis of an Engineering student in a subject, predict your marks using a pattern classifier in the end exam based on the previous performances and other factors, Defective bottle elimination in a bottling plant, rice classification, food quality inspection.

Text Book:

1. R. O. Duda, P. E. Hart, and D. G. Stork, *Pattern Classification*, 2nd edition, Wiley-Inter science. ISBN 0-471-05669-3 .

2. Hastie, Tibshirani, Friedman," The Elements of Statistical Learning," Springer.
3. Pattern Recognition, An Algorithmic Approach, M. Narasimha Murty · V. Susheela Devi, 2011, Universities Press (India) Pvt. Ltd, Co-Published by SPRINGER.

References:

1. Fukunaga, " Introduction to Statistical Pattern Recognition,"AcademicPress.
2. C.M.Bishop, " Pattern Recognition and Machine learning," Springer.
3. Ewens& Grant," Statistical Methods in Bioinformatics ," Springer.

HUMAN MACHINE INTERACTION

Course Code: 15EC3057 **L–T–P–S: 3-0-0**
Pre Requisite: 15EC2206 **Credits: 3**

Syllabus: Introduction: Historical evolution of the field, Concept of usability - definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques.

Model-based Design and evaluation: Basic idea, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS, Fitts' law and Hick-Hyman's law, Guidelines in HCI: Norman's seven principles, Norman's model of interaction, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough.

Empirical research methods in HCI: Experiment design and data analysis (with explanation of one-way ANOVA), Task modelling and analysis through Hierarchical task analysis (HTA), Dialog Design using FSM (finite state machines), Cognitive architecture, Object Oriented Modelling of User Interface Design.

Design -Case Studies: 1. Multi-Key press Hindi Text Input Method on a Mobile Phone, GUI design for a mobile phone based Matrimonial application, Employment Information System for unorganised construction workers on a Mobile Phone.

Text Books:

1. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.

Reference Books:

1. B. Shneiderman; Designing the User Interface, Addison Wesley 2000 (Indian Reprint).

VIDEO SURVEILLANCE

Course Code :15EC3058 **L–T–P–S : 3-0-0**
Pre Requisite: 15EC4110 **Credits : 3**

Fundamentals: Image feature extraction: Feature point detection, Scale Invariant Feature Transform, Edge Detection, Color features. Multiple View Geometry: Perspective Projection Camera Model, Epipolar Geometry, Probabilistic inference, Pattern recognition and Machine learning: SVM and AdaBoost. Background Modelling and Subtraction: Kernel Density Approximation, Background Modelling and Subtraction Algorithms.

Detection and Tracking: Pedestrian Detection and Tracking: Pedestrian detection by boosting local shape features: Tree learning algorithms, Edgelet features. Occluded pedestrian detection by part combination. Pedestrian tracking by Associating Detection

Responses. Vehicle Tracking and Recognition: Joint tracking and Recognition framework, Joint appearance-motion generative model, Inference algorithm for joint tracking and recognition. Human Motion Tracking: Image feature representation, Dimension reduction and Movement dynamics learning.

Activity Recognition and Camera Networks: Human action recognition: Discriminative Gaussian Process dynamic model. Human Interaction recognition: Learning human activity, Track-body Synergy framework; Multi-camera calibration and global trajectory fusion: Non-overlapping and overlapping cameras.

Systems and Applications: Attribute-based people search, Soft biometrics for video surveillance: Age estimation from face, Gender recognition from face and body, Detection and tracking of Moving Objects.

Text Books:

1. Yunqian Ma, Gang Qian, "Intelligent Video Surveillance: Systems and Technology", CRC Press (Taylor & Francis Group), 2010.
2. Fredrik Nilsson, Communications Axis, "Intelligent Network Video: Understanding Modern Video Surveillance Systems", CRC Press (Taylor & Francis Group), 2008.

Reference Books:

1. Anthony C. Caputo, "Digital Video Surveillance and Security", Butterworth-Heinemann, 1st Ed., 2010.
2. Herman Kruegle, "CCTV Surveillance, Second Edition: Video Practices and Technology" Butterworth-Heinemann, 2nd Ed., 2006.

AUDIO SIGNAL PROCESSING

Course Code : 15EC3059 **L–T–P:3-0-0**
Pre-Requisite: 15EC2206 **Credits: 3**

Introduction To Audio Systems: Introduction, Studio Technology, Digital Transmission System, Storage Media, Audio Components at Home, Signal Quantization, Dither, AD/DA Conversion, jitter, spectral analysis, audio and Speech processing fundamentals.

Audio Processing Systems: Digital Audio Interfaces, Single-processor System, Scalable Audio System, types of audio formats, decoding, encoding audio quality measurements, algorithms. **Equalizers:** Recursive Audio Filters, Non-recursive Audio Filters, Multi-complementary Filter Bank. ***Audio Room Simulation:*** Room Acoustics, Model-based Room Impulse Responses, Measurement of Room Impulse Responses, Simulation of Room Impulse Responses, Early Reflections, Subsequent Reverberation. ***Audio Coding:*** Lossless Audio Coding, Lossy Audio Coding, Psychoacoustics, ISO-MPEG-1 Audio Coding, MPEG-2.Programming:audio codecs, voice codecs, Simulate aAudio codec and data converter on any software platform. Also develop a noise canceller in audio systems.

Text Books:

1. Digital Audio Signal Processing, 2nd Edition, Udo Zolzer, ISBN: 978-0-470-99785-7, A John Wiley & Sons, Ltd, Publication.
2. Audio signal processing for nextgeneration multimedia communication systems, Yiteng (Arden) Huang, Jacob Benesty, Kluwer Academic Publishers 2004.

REFERENCE BOOKS:

1. Applications of digital signal processing to audio and acoustics, Mark Kahrs and Karlheinz Brandenburg, Kluwer Academic Publishers 2002.

2. Audio signal processing and coding, Andreas Spanias, Ted Painter and Venkatraman Atti, Wiley-Interscience, A John Wiley & Sons, Inc., Publication, 2007.

STATISTICAL SIGNAL PROCESSING

Course Code : 15EC3060 **L–T–P:** 3– 0 – 0
Pre Requisite: 15EC2206 **Credits:3**

Syllabus: Review of random variables: Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto covariance functions, Gaussian Process and White noise process.

Parameter Estimation Theory: Bayesian estimation, Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties.

Estimation of signal in presence of white Gaussian Noise: Linear Minimum Mean-Square Error Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter. **Spectral analysis:** Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Introduction to parametric and frequency methods.

Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, extended Kalman filter using Matlab.

Text Books:

1. M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.

ADAPTIVE SIGNAL PROCESSING

Course Code :15EC3061 **L–T–P : 3-0-0**

Pre Requisite: 15EC2206 **Credits: 3**

Syllabus: Adaptive systems: Definitions and characteristics - applications – properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction - linear optimum filtering-orthogonality - Wiener – Hopf equation-performance surface.

Searching performance surface-stability and rate of convergence: Learning curve-gradient search - Newton's method - method of steepest descent - comparison - Gradient estimation - performance penalty - variance - excess MSE and time constants – mis-adjustments

LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm - adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals

Applications-adaptive modelling and system identification: Multipath communication channel, geophysical exploration, FIR digital filter synthesis. **Inverse adaptive modelling:** Equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis.

Text Books:

1. B. Widrow and S.D. Stearns, Adaptive Signal Processing, Prentice Hall, Englewood Cliffs, NJ, 1985.

2. Alexander D. Poularikas, Zayed M. Ramadan, Adaptive filtering primer with MATLAB, CRC Press, 2006.

References:

1. S. Haykin, Adaptive Filter Theory, Fourth Edition, Pearson Education LPE, 2007
2. A. H. Sayed, Adaptive Filters, John Wiley & Sons, NJ, ISBN 978-0-470-25388-5, 2008.

BIOMEDICAL SIGNAL PROCESSING

Course Code : 15EC4062 **L–T–P:3-0-0**
Pre Requisite: 15EC2206 **Credits: 3**

Syllabus: Introduction To Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc., Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random &Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments. **Concurrent, Coupled and Correlated Processes - Illustration with case studies –** Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection – case studies with ECG & EEG - Independent Component Analysis - Cocktail party problem applied to EEG signals -Classification of biomedical signals. **Cardio Vascular Applications:** Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multi-scale analysis for ECG parameters estimation - Noise &Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection -Arrhythmia analysis. **Data Compression: Lossless & Lossy- Heart Rate Variability –** Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals. **Neurological Applications:** The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non-linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.

TEXT BOOKS

1. D.C.Reddy ,“Biomedical Signal Processing: Principles and techniques” ,Tata McGraw Hill, New Delhi, 2005
2. Willis J Tompkins , Biomedical Signal Processing -, ED, Prentice – Hall, 1993

REFERENCES BOOKS

1. R. Rangayan, “Biomedical Signal Analysis”, Wiley 2002.
2. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley, 2001
3. Sörnmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”
4. Semmlow, “Bio-signal and Biomedical Image Processing”, Marcel Dekker
5. Enderle, “Introduction to Biomedical Engineering,” 2/e, Elsevier, 2005

BIO-MEDICAL IMAGING

Course Code : 15EC4063 **L–T–P:** 3-0-0
Pre Requisite: 15EC4110 **Credits:3**
Syllabus:

Introduction to Biomedical Imaging: Basic definitions (biomedical imaging, body planes, structural and an atomicalimaging), Physics concepts (e.g. wave equations, energy transport, chromophores and contrasts), Image formation and reconstruction, and levels of analysis, The temporal-spatial-signal matrix, Examples of imaging systems.
Image formation and acquisition principles: Fundamental models of image formation, The imaging system, Image quality and uncertainties in image formation (digitization, quantum efficiency, metamerism, calibration, CNR, SNR), Major imaging modalities: Magnetic Resonance Imaging, Optical Imaging (inc. X-Ray, OCT, NIRS, microscopy, confocal imaging, one and two photon imaging, fluoroscopy, CT), Electrical and magnetic imaging (inc. EEG/MEG, EMG, ECG, etc), Ultrasound.
Image reconstruction: Inverse problem and the Jacobian, Regularization, Image processing and analysis, Registration, Feature extraction; edge detection, Hough transform, Filtering; Noise removal and signal enhancement, Segmentation, Domain transformation; Fourier and Wavelets.
Image interpretation: Data mining, Advanced topics on Neuroimaging, Neuroimages (EEG, fNIRS, fMRI, PET/SPECT), Analysis and Interpretation Models: Ultrasound image enhancement (De-Noising). MRI image segmentation. Compare the medical images and their contents. Use Various image processing models on medical images for content extraction and their success and failure analysis.**Case Study:** Use of IBM Watson in medical diagnostics. Design a model for miming medical image contents to diagnose a disease (Cancer, Diabetic retinopathy, liver disfunction) in real time.

Textbook:

1. Introduction to Biomedical Imaging, Andrew G. Webb. December 2002, Wiley-IEEE press.

References:

1. The Essential Physics of Medical Imaging (2nd Edition), J. T. Bushberg, J.A. Seibert, E.M. Leidholdt Jr., J. M. Boone. November 2001.

KNOWLEDGE BASED SYSTEMS

Course Code : 15EC4064 **L–T–P: 3-0-0**
Pre Requisite: NIL **Credits: 3**

Introduction to Knowledge Based Systems: Objectives of KBS, Components, Categories, Difficulties with the KBS. Knowledge Based System Architecture – Source of Knowledge, Types of Knowledge, Basic Structure, Knowledge Bases, Inference Engine, Self-Learning, Reasoning, Explanation, Applications. Limitations of Knowledge Based Systems.

Developing Knowledge Based Systems – Knowledge Based System Development Model, Knowledge Acquisition, Techniques for Knowledge Acquisition, Sharing Knowledge, Updating Knowledge. **Knowledge Representation and Reasoning** – The propositional calculus and Resolution, Predicate calculus and Resolution, Representing Procedural Knowledge, Reasoning with Uncertain Information, Learning and Acting with Bayes Nets.

Knowledge Management - Introduction, Perspectives, Evolution, Elements of Knowledge Management, Knowledge Management Process, Tools and Technologies, Knowledge Management Roles and Responsibilities, Knowledge Management Models. Agent Based Systems – Characteristics, Types of Agents, Agent Communication Language, Multi Agent Systems.

Fuzzy Logic, Artificial Intelligence and Genetic Algorithm: Fuzzy logic and fuzzy sets: Membership functions, operations on fuzzy sets, types of fuzzy functions, Fuzzy relationships; Biological Neurons, Artificial Neurons, Neural Network Architecture; Genetic Algorithms, Genetic cycles, Basic Operations of a Genetic algorithm.

Text Books:

1. Rajendra Akerkar, Priti Sajja, "Knowledge-Based Systems", Jones & Bartlett Learning, 1st Ed., 2010.
2. Nils J Nilsson "Artificial Intelligence – A New Synthesis", Morgan Kaufman Publishers 1st Ed., 2003.

Reference Books:

1. Cornelius T Leondes, "Knowledge-Based Systems: Techniques and Applications", Academic Press, 1st Ed., 2000.
2. Elias M Awad, Hassan M Ghaziri, "Knowledge Management", Pearson Education, 1st Ed., 2007.

MOBILE & COMMUNICATIONS DOMAIN

INFORMATION THEORY& CODING

Course Code: 15EC3065 **L-T-P: 3-0-0**
Pre Requisite: 15EC2205 **Credits: 3**

Syllabus: Introduction: Measure of information, Average information content of symbols in long independent and dependent sequences, Entropy calculation for extension of source. Mark-off statistical model for information source, Entropy and information rate of mark-off source.

Encoding of source output Shannon's encoding algorithm for dependent and independent sequences. Discrete communication channels, Continuous channels. Source coding theorem, Huffman coding, discrete memory less Channels, Mutual information, Properties of mutual information, Channel Capacity. Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity Theorem

Error Control coding: Introduction, Types of errors, examples, Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding.

Binary cycle codes: Algebraic structures of cyclic codes, encoding using an (n-k) bit shift register, Syndrome calculation, BCH codes, RS Codes, Olay codes, Shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes.

Convolution Codes: Block diagram of encoder, Impulse response of encoder, Time domain approach and Transform domain approach. State representation and state diagram, Tree diagram, trellis diagram.

Text Books

1. K. Sam Shanmugam, "Digital and Analog communication systems", John Wiley, (1996).
2. Simon Haykin, "Digital communication", John Wiley, (2003).
3. R Bose, "Information Theory, Coding and Cryptography", TMH 2007

Reference books:

1. Elements of Information Theory by Thomas Cover, Joy Thomas
2. Channel Codes: Classical and Modern by William Ryan, Shu Lin
3. Information Theory and Reliable Communication by Robert Gallager
4. Kennedy, "Electronic Communication systems", McGraw Hill, 4th Ed., 1999.

ANTENNAS AND WAVE PROPAGATION

Course Code: 15EC3066 **L-T-P: 3-0-0**
Prerequisite: 15EC2205 **Credits:3**
SYLLABUS:

Radiation Fields and Antenna Fundamentals: Concept of Vector Potential, Radiation of Small Current Element. Radiation of Short Dipole, Radiation from Half-Wave Dipole and its Radiation Resistance & Quarter-Wave Monopole. Antenna Parameters like Radiation Patterns, Directivity, Gain, Radiation Resistance, Polarization, Effective Length and Effective Area and Antenna efficiency.

Antenna Arrays and Antenna Types: Two Element Arrays, N- Element Linear Arrays – BSA, EFA, Directivity N-Element Linear Array with Uniform Spacing, Non-Uniform Amplitudes, Binomial Arrays, Principal of Pattern Multiplication Related Problems. Antenna Types: Travelling Wave, Folded Dipole, Yagi –Uda, Vee, Rhombic, Helical, Horn, Slot, Biconical Antenna, Reflector and Lens Antennas.

Antenna Measurements: Introduction, Impedance/VSWR measurements, scattering parameters Types of Ranges: Anechoic Chamber, Elevated Ranges, Slant Range Ground Ranges, Near Field Ranges, CATR, Radiation Pattern Measurements, Gain Measurements.

Wave Propagation: The Three basic types of Propagation; Ground wave, space wave & sky wave propagation. Ground Wave propagation: Attenuation characteristics for Ground Wave Propagation, Summerfield analysis of Ground wave, Losses due to earth constants. Space Wave propagation: Effect of curvature of an Ideal earth, Atmospheric effects in Space-wave propagation, Duct Propagation, Maximum range of distance for LOS. Sky Wave Propagation: Structure of Ionosphere Propagation, Refraction and Reflection of sky waves by Ionosphere, Critical frequency, Skip distance, Maximum unable Frequency, Virtual Height.

Text Books

1.C.A Balanis, “Antenna Theory”, John Wiley & Sons, 2nd ed.
2.E.C. Jordan and K.G. Balamain, “Electromagnetic Waves and Radiating Systems”. 2nd ed., Pearson
3. Evans, Gray E," Antenna Measurements Techniques", Artech House, Inc
4. J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements, Scientific Atlants, Inc

Reference Books

1.John D Kraus, “Antennas”. 2nd ed., Mc Graw-Hill
2.William Gosling, "Radio Antennas And Propagation, Newnes
3.F.E.Terman , “Radio Engineering”, McGraw Hill
4.Warren L. Stutzman, Gary A. Thiele," Antenna Theory and Design, Second Edition , John Wiley & Sons, Inc
5.Yi Huang, Kevin Boyle ," Antennas From Theory to Practice, John Wiley and Sons
6.Vincent F. Fusco, "Foundations of Antenna Theory and Techniques, Pearson Education

MICROWAVE ENGINEERING

Course Code: 15EC3067 **L-T-P: 3-0-0**
Pre-requisite: 15EC2205 **Credits: 3**

Syllabus:

Microwave devices: Introduction to microwave Components, Reflex klystron, TWT, phase shifters, Microwave bends, E-plane Tee, H-plane Tee, Magic Tee, Directional Coupler, Isolator, Circulator & their Scattering.
Transformers & Resonators: Parameters, Impedance Transformers – Quarter wave Transformers, Microwave Resonators – Rectangular and Cylindrical Resonators, Obstacles in waveguides-Introduction, Posts in Waveguides, Diaphragms in Waveguides, Waveguide Junctions, Waveguide Feeds, Excitation of Apertures.
Filters and periodic structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.
Millimetre wave circuits: Wave Propagation in microstrip lines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers, Microwave and Millimetre Wave Integrated Circuits.
Text Books:

1. Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", McGraw-Hill.
2. Robert E Collin, "Foundation for Microwave Engineering", McGraw-Hill.

Reference Books:

1. "Analysis Methods for RF, Microwave, and Millimetre-Wave Planar Transmission Line Structures", by Cam Nguyun.

OPTICAL COMMUNICATION

Course Code: 15EC3068 **L-T-P: 3-0-0**
Prerequisite: 15EC2205 **Credits:3**
Syllabus: Overview of optical fiber communication: Optical Fiber Communication system, optical fiber waveguides, types of fibers, cutoff wave length.
Transmission characteristics of optical fibers: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra model dispersion, Inter model dispersion.
Optical Sources and Detectors: Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Photo diodes
Fiber Couplers and Connectors: Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers.
Analog and Digital Links: Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links. Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, transmission distance for single mode fibers, Power penalties.
WDM and Components: WDM standards, Interferometer, multiplexer, Isolators and circulators, active optical components, variable optical attenuators, tunable optical fibers, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion compensators, tunable light sources.

Optical Amplifiers and Networks: Optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA. OPTICAL NETWORKS: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides. OTDR, FTTX networks, digital cross connects.

Text Books:

1. Senior, John M., and YousifJamro, M., Optical fiber communications: principles andpractice, Prentice Hall, (2009) 2nded.
2. Ramaswami Rajiv, Kumar N. Sivarajan, Optical Networks: A Practical Perspective, MorganKaufmann Publishers, Elsevier (2004).
3. Willebrand Heinz, Ghuman Baksheesh. S., Free Space Optics: Enabling Optical Connectivityin Today's Networks, Sams (2001).

Reference Books:

1. Ajoy Kumar Ghatak and K. Thyagarajan, Optical Electronics, Cambridge UniversityPress (2001) 2nded.
2. Bahaa E. A. Saleh, Malvin C. Teich, Fundamentals of Photonics, John Wiley & Sons, (2013) 2nded.
3. Mukherjee, Biswanath, Optical WDM Networks, Springer (2006).
4. Murthy, C. Siva Ram, Mohan Gurusamy, WDM Optical Networks: Concepts, Design, andAlgorithms, Prentice Hall of India (2001).
5. Maier, Marti, Optical Switching Networks, Cambridge University Press (2008).
6.Sivalingam, Krishna M., Subramaniam, Suresh, Emerging Optical Networks Technologies:Architectures, Protocols, and Performance, Springer (2004).

ELECTRONIC NAVIGATION SYSTEMS

Course Code: 15EC3069 **L-T-P: 3-0-0**

Prerequisite: 15EC2205 **Credits: 3**

Syllabus: Navigation Systems: Brief History of Navigation-Methods of Radio Navigation-Terrestrial and Satellite Navigation Systems-Inertial Navigation System-Inertial Measurement Unit-Accelerometers-Gyroscopes-Magnetometers-Coordinate Systems-ECI, ECEF, ENU and NED.

Analysis on Global Positioning Systems (GPS): Segments of GPS-Positioning using carrier phase measurements-GPS error sources-Differential GPS-Error minimizing using DGPS, GPS receiver architecture-Code and Carrier tracking loops-Signal detection and acquisition in Novatel GPS receiver.

Applications of Electronic Navigation Systems: GPS and INS in aircraft management- Low-Cost commercial GPS receiver-Low Cost IMU MEMS sensor-Attitude Determination-Role of Kalman Filtering in GPS/INS sensor fusion-Loosely coupled schemes-Tightly coupled schemes, UAVs for agriculture applications, google maps, missile and marine navigation applications, mining, location based services and remote sensing application.

Text Books:

1. Misra P, Enge P. "Global positioning system: Signals, measurements and performance", Second Edition, Ganga-Jamuna Press, 2011.
2. Mohinder S. Grewal, Lawrence R. Weill and Angus P. Andrews "Global Positioning Systems, Inertial Navigation Systems and Integration", Second Edition, John Wiley and Sons, 2007.

References:

1. Hofmann-Wellenhof, Bernhard, Herbert Lichtenegger, and James Collins. Global positioning system: theory and practice. Springer Science & Business Media, 2012.
2. Paul D. Groves "Principles of GNSS, inertial, and multisensor integrated navigation systems", Artech house, 2013.
3. Salychev, Oleg Stepanovich. "Applied Inertial Navigation: problems and solutions" Moscow, BMSTU press, 2004.

RF SYSTEM DESIGN

Course Code: 15EC3070 **L-T-P: 3-0-0**
Prerequisite: 15EC2205 **Credits: 3**

Syllabus: INTRODUCTION Overview of RF System design, RF behaviour of passive components, basics of transmission lines, S parameters, smith chart. **RF DIODE AND BJT:** RF diodes-bipolar junction transistor - RF field effect transistor-high electron mobility transistors-diode models-transistor models-measurement of active devices-scattering parameter device characterization. **IMPEDANCE MATCHING:** Impedance matching using discrete components-microstrip line matching networks, amplifier classes of operation and biasing networks. **CHARACTERISTICS OF AMPLIFIERS:** Characteristics of amplifier-amplifier power relations-stability consideration-constant gain-broadband, high power, and multistage amplifiers. **HIGH FREQUENCY OSCILLATORS:** Basic oscillator model-high frequency oscillator configuration-basic characteristics of mixer.

Text Book

1. Reinhold Ludwig, Gene Bogdanov, "RF circuit design, theory and applications", Pearson Asia Education, 2nd edition, 2009.
2. Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition.

SATELLITE COMMUNICATIONS

Course Code: 15EC3071 **L-T-P: 3-0-0**
Prerequisite: 15EC2205 **Credits: 3**

Syllabus: Introduction: Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. *Orbital Mechanics:*Look Angle determination

Satellite Subsystems: Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas.

Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design Of Satellite Links For Specified C/N, *System Design Examples*-DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite- based personal communication.

Multiple Access Techniques: Frequency Division Multiple Access (FDMA), Inter-modulation, Calculation of C/N, Time Division Multiple Access (TDMA), Frame Structure, Satellite Switched TDMA, Onboard Processing, Code Division Multiple Access (CDMA), *Satellite RF impairments:* Rain attenuation, Space weather effects on Satellite

communications, Atmospheric drag. *Satellite Navigation & Global Positioning System:* Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Navigation Message, GPS Signal Levels, GPS Receiver Operation. TCP over satellite, ITU regulations,Standards and examples, DBS and DBB.

Text Books:

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt – Wiley Publications– Second Edition, 2003.
2. Satellite Communications – L.Pritchard, Robert A Nelson and Henri G.Suyderhoud – Pearson Publications – Second Edition.

Reference Books:

1. Satellite Communications – M. Richharia, BS Publications, Second Edition.
2. Fundamentals of Satellite Communications – K.N. Raja Rao, PHI, 2004.
3. Satellite Communication – D.C Agarwal, John Khanna Publications, 5th Ed.
4. Satellite Communications – Dennis Roddy, McGraw Hill, 4th Edition, 2009.
5. Satellite Communications - Robert M Gagliardi, DTS Publishers Ltd.

SMART ANTENNAS

Course Code: 15EC3072 **L-T-P: 3-0-0**
Prerequisite: 15EE1201 **Credits:3**

Syllabus: Smart Antennas: Introduction, Need for Smart Antennas, Overview, Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.

DOA Estimation Fundamentals: Introduction, Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Auto-covariance, Conventional DOA Estimation Methods, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates.

Beamforming Fundamentals: Classical Beamformer, Statistically Optimum Beam forming Weight Vectors, Maximum SNR Beam former, Multiple Side-lobe Canceller and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV).

Integration and Simulation of Smart Antennas: Overview, Antenna Design, Mutual Coupling, Adaptive Signal Processing Algorithms, DOA, Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart Antenna Systems for Mobile Ad Hoc Networks (MANETs).

Text Books:

1. Constantine A. Balanis & Panayiotis I. Ioannides, "Introduction to Smart Antennas", Morgan & Claypool Publishers' series-2007
2. Joseph C. Liberti Jr., Theodore S Rappaport - "Smart Antennas for Wireless Communications IS-95 and Third Generation CDMA Applications", PTR – PH publishers, 1st Edition, 1989.

Reference Books:

1. T.S Rappaport - "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE press 1998, PTR – PH publishers 1999.
2. Lal Chand Godara, "Smart Antennas", CRC Press, LLC-2004.

RADAR ENGINEERING

Course Code: 15EC4073 **L-T-P: 3-0-0**
Prerequisite: 15EE1201 **Credits:3**

Syllabus: Introduction: Basic Radar, Block Diagram of Pulse Radar, Radar equation, Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar.

MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation, MTI improvement factor, N-pulse delay line canceller, Non recursive and Recursive filters.

Tracking: Sequential Lobing Radar, Conical Scan and Monopulse acquisition and tracking, Types of Duplexers and receiver protectors, Air Traffic Control applications.

Transmitter and Receivers: Introduction, Linear- Beam Power Sources, Magnetron, Crossed- Field Amplifiers, Other RF Power Sources. The Radar Receivers, Receiver Noise Figure, Duplexers and Receiver Protectors, Radar Displays.

Radar Applications: SAR,LIDAR ,OTH radar, remote sensing radar, airport surveillance radar, weather / meteorological radar, ground penetration radar, through-wall radar, automobile radar.

TEXT BOOKS

1. Merrill I Skolnik, "Introduction to Radar Systems", 3rd Edition, TMH, (2003).
2. William L. Melvin, James A. Scheer, "Principles of Modern Radar", SciTech Publishing.

REFERENCE BOOKS

1. Peyton Z Peebles Jr, "Radar Principles", John Wiley Inc., (2004)
2. Donald R Wehner, "High Resolution Radar", Artchtech house.

EMI/EMC

Course Code:15EC4074 **L-T-P: 3-0-0**
Prerequisite: 15EE1201 **Credits:3**

Syllabus: EMI Environment: Sources of EMI, Conducted and Radiated EMI, Transient EMI, EMI – EMC Definitions and Units of Parameters. EMI Specifications/Standards/Limits: Units of specifications, Civilian Standards and Military Standards.

EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal control, Component Selection and mounting.

EMC Design Guidelines and Choice of passive components for EMC: EMC Design Guidelines: Typical Sub systems in Electronic Equipment, Transmitters, Receivers, Antenna Systems, Power Supplies, Motors, Control Devices, Digital Circuits, Digital Computers. Capacitors, Inductors, Transformers, Resistors, Conductors, Ferrite Beads, Coaxial Connectors, Conductive Gaskets.

EMI Measurements: MI Test Instrument / Systems, EMI Test, EMI Shielded Chamber, Open Area Test Site, TEM cell Antennas

Textbook

1. V P Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press,
2. Bernard Kieser, "Principles of Electromagnetic Compatibility", Artech House 3rd Edition.

3. Henry W. Ott, “Electromagnetic Compatibility Engineering”, A John Wiley & Sons publication.

References

1. Clayton R Paul, “Electromagnetic Compatibility”, John Wiley.
2. Tim Williams, “EMC for Product Designer”, Elsevier.
3. PR Chatterton, “Electromagnetic Theory to practical design”, Wiley.
4. Sonia Ben Dhia, “Electromagnetic Compatibility as Integrated Circuits”, Springer.

VLSI DESIGN DOMAIN

VLSI TECHNOLOGY

Course Code : 15EC3075 **L-T-P: 3-0-0**
Pre-requisite: 15EC3107 **Credits: 3**

Syllabus: Introduction to IC Fabrication: Environment of IC Technology: Concepts of Clean room, Classification and Design Concepts, basic fabrication steps and their Importance Czochralski crystal growing, processes considerations, Wafer cleaning processes.
Oxidation, diffusion, Ion Implantation and Lithography techniques: Oxidation technologies in VLSI, Vapor phase Epitaxy, Molecular Beam Epitaxy, Oxidation of Poly Silicon, Diffusion and Ion Implantation Process, Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, reactive Plasma Etching techniques and Equipment.
Deposition techniques, CVD, APCVD, LPCVD, PECVD and other deposition Methods; plasma assisted Deposition, Physical vapor deposition, sputtering techniques, Rapid Thermal Process. Metallization: Introduction, Failure mechanisms in metal interconnects Multi-level Structures. Rapid Thermal Processing: Introduction, RTP techniques; Etching: Reactive Plasma etching Techniques and Equipment, Wet Chemical etching.
Assembly Techniques and Packaging of VLSI Devices: NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology - Bipolar IC Technology – IC Fabrication, Package types – packaging design considerations – VLSI assembly technology – Package fabrication technology

BoS Approved Text books:

1. .K. Goser, P. Glosekotter & J. Dienstuhl, “Nanoelectronic and Nanosystems–From Transistors to Molecular Quantum Devices”, Springer, (2004).
2. RainerWaser, “Nanoelectronics and Information Technology: Advanced Electronic Materials Novel and Devices”, Wiley VCH, (2005).
3. George W. Hanson, “Fundamentals of Nanoelectronics”, Prentice Hall, (2008).

BoS Approved Reference Books:

1. S.M.Sze, “VLSI Technology”, McGraw Hill Second Edition. 1998.
2. James D Plummer, Michael D. Deal, Peter B. Griffin, “Silicon VLSI Technology: Fundamentals Practice and Modeling”, Prentice Hall India.2000.
3. Wai Kai Chen, “VLSI Technology” CRC Press, 2003

VLSI SUBSYSTEM DESIGN

Course Code : 15EC 3076 **L-T-P: 3-0-0**
Pre-requisite: 15EC3107 **Credits: 3**

Syllabus: Design Methodology: structured design strategies; hierarchy; PLAs; standard-cell design; full-custom design; physical design styles.

Data Path Subsystems: adders; one/zero detectors; comparators; counters; shifters; multipliers. Memory andArray Subsystems: SRAM, DRAM, Read Only Memory, Serial Access Memories, Content-addressable Memory.

Special-purpose Subsystems: Packaging: package options, chip-to-package connections, package parasitic, heat dissipation. Power distribution I/Os: basic I/O pad circuits, level converters. Clock: Clock system architecture, global clock generation and distribution, local clock gates, clock skew budgets.

Implementation Strategies: custom arrays; semicustom and structured arrays; custom circuit design; cell-based design methodology.

BoS Approved Text books:

1. Neil H. E. Weste, David. Harris and Ayan Banerjee, "CMOS VLSI Design", Pearson Education, Third Edition, (2004).
2.Jan M. Rabaey, AnanthaChandrakasan, BorivojeNikolic, "Digital Integrated Circuits" Pearson Education, Second Edition, (2003)

BoS Approved Reference Books:

1. Wayne Wolf, "Modern VLSI Design", 2nd Edition, Prentice Hall, (1998).
2.Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", TMH, Third Edition, (2003).

DIGITAL IC DESIGN AND IT'S APPLICATIONS

Course Code : 15EC3077 **L-T-P : 3-0-0**
Pre-requisite : 15EC1101 **Credits:3**

Syllabus: MOS Inverters: Introduction, Definitions and Properties, Static CMOS Inverter, Static and Dynamic Power Dissipation, CMOS inverter delay time definitions and calculations

Designing Combinational Logic Gates in CMOS: Introduction, Static CMOS Design, Dynamic CMOS Design, Power Consumption in CMOS Gates.

Designing Sequential Logic Gates in CMOS: Introduction, Static Sequential Circuits Dynamic Sequential Circuits, Non-Bistable Sequential Circuits, Logic Style for Pipelined Structures. Timing Issues in Digital Circuits**:** Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization.

Designing Arithmetic Building Blocks: Introduction, The Adder: Definition, Circuit and Logic Design, The Multiplier: Definition, The Shifter: Definition, Power Considerations in Data path Structures. Designing Memory: Introduction, Semiconductor Memories - An Introduction, The Memory Core: RAM, ROM, Memory Peripheral Circuitry

BoS Approved Text books:

1. Gary Yeap, "Practical low power digital VLSI design", Kluwer Academic Publishers, 2002
2. Massoud Pedram, Jan M. Rabaey , "Low power design methodologies ", Kluwer Academic Publishers

BoS Approved Reference Books:

1. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2002
2. Yeo "CMOS/BiCMOS ULSI low voltage low power,", Pearson Education Publishers, Boston, 1995. (Added)

DESIGN FOR TESTABILITY

Course Code : 15EC3078 **L-T-P: 3-0-0**
Pre-requisite: 15EC3107 **Credits:3**

Basic Concepts: Need for testing, Levels of Abstraction, Reliability concepts, Reliability and failure rate, Relation between reliability and MTBF, Maintainability, Availability, series and parallel systems, Failure and faults, Modelling of faults, Temporary faults. Fault simulation, combinational and Sequential SCOAP measures

Fault Tolerant Design: Importance of fault tolerance, Basic concepts of fault tolerance, Static redundancy, schemes of fault redundancy, Time redundancy, Software redundancy, Fail-Safe Operation.

Fault diagnosis and testing, Test generation for combinational logic circuits: Fault table method, Path sensitization, Boolean difference, Basic ATPG algorithms, Detection of multiple faults in combinational logic circuits, ATPG for non-stuck-at faults, Test generation for sequential logic circuits, Random testing, Signature analysis.

Design for Testability: Controllability and Observability, Design of testable combinational circuits, Design of testable sequential circuits: Scan path technique, Scan golden rules, hierachial and top-down scan design, boundary scan basics, LSSD, RAS, JTAG.

Built in self test: BIST concepts, BIST design rules, ATPG for BIST, BIST architectures, Memory BIST, RAM fault models, Test generation of RAM, Low power BIST, Thermal aware testing.

TEXT BOOKS

1. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.
2. M. Baranovichi, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House.

REFERENCE BOOKS

1. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press.
2. A.L Crouch, "Design Test for Digital ICs and Embedded Core Systems", Prentice-Hall International.

ANALOG VLSI DESIGN

Course Code: 15EC3079 **L-T-P: 3-0-0**
Pre-requisite: 15EC2103 **Credits:3**

Basic MOS Device physics: MOSFET operation, Drain current equation, MOSFET large and small signal models, second order effects; **Single Stage Amplifiers**: Single Stage (CS,CG,CD) amplifiers, single stage amplifiers with different loads, Cascode Stage, folded cascode, design of amplifier stages; frequency response of CS,CD,CG.

Passive & Active Current Mirrors: Basic current mirrors, Cascode current mirror, Active Current Mirrors - large signal analysis, small signal analysis, Band-gap References: Supply independent biasing, Temperature independent references;

Differential and Operational Amplifiers: Basic Differential Pair, Common mode response, differential pair with MOS loads, Op-Amp topologies-One stage, two stage, cascade, Folded Cascade, Comparison; Gain boosting, slew rate, power supply rejection.

Feedback: Properties of Feedback, Feedback equation, Feedback topologies and effect of loading, Effect of Feedback on Noise. Ring oscillators, LC oscillators, cross-coupled oscillators, Colpitts oscillator, One-port oscillator, and voltage controlled oscillators. Simulation of oscillators using SPICE.

Text Books

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata Mc Graw Hill, (2005)

Reference Books

1. Jacob Baker, “CMOS Mixed Signal Circuit Design”, John Wiley, (2008)
2. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
3. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002

MEMS Technology

Course Code: 15EC3080 **L–T–P: 3-0-0**
Pre-Requisite: NIL **Credits: 3**

Syllabus: Overview of MEMS: MEMS and Microsystems - Microsystems and microelectronics, Benefits of miniaturization, Working principle of micro system - Micro sensors, Micro actuators, MEMS with Micro actuators. Materials For MEMS, Scaling Laws in Miniaturization, MEMS Design Considerations. **Micro fabrication:** Introduction, Fabrication Process - Photolithography, Ion implantation, Oxidation, Chemical vapor deposition (CVD), Physical vapor deposition, Deposition by Epitaxy, Etching, Manufacturing Process -Bulk Micromachining, Surface Micromachining and LIGA Process. **Microsystems design, Assembly and Packaging:** Micro system Design - Design consideration, process design, Mechanical design, Mechanical design using MEMS. Mechanical packaging of Microsystems, Microsystems packaging, interfacings in Microsystems packaging, packaging technology, selection of packaging materials, signal mapping and transduction. **Case Study of MEMS Devices:** MEMS with Micro sensors: Pressure sensors, Temperature sensors, Humidity sensors, Accelerometers, Gyroscopes, Biomedical Sensors, Chemical sensors, Optical Sensors. MEMS with micro actuators: Microgrippers, Micromotors, Micro gears, Micropumps. RF MEMS devices: Switch parameters- Basics of switching - Mechanical Switches-Electronic switches for RF and microwave applications - Approaches for low-actuation-voltage switches, Case study of MEMS pressure sensor Packaging.

TEXT BOOKS

Tai-Ran Hsu, MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.

REFERENCES

1. Marc Madou, “Fundamentals of Micro Fabrication” CRC Press
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press
3. Gabriel M Rebeiz, "RF MEMS - Theory Design and Technology", John Wiley, 2004
4. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press, 2002
5. Chang Liu, “Foundations of MEMS”, Pearson Indian Print, 1st Edition, 2012

LOW POWER VLSI DESIGN

Course Code : 15EC3081 **L-T-P: 3-0-0**
Pre-requisite: 15EC3107 **Credits:3**

Syllabus: Introduction: Need for low power VLSI chips, Emerging Low Power Approaches, Sources of Dissipation in Digital Integrated Circuits, Basic Principles of Low Power Design, Physics of power dissipation in CMOS FET Devices, noise margin. **Probabilistic Power Analysis**: Random logic signals, probability & frequency, probabilistic power analysis techniques. **Circuit**: Transistor and Gate Sizing, Network Restructuring and Reorganization, Flip Flops & Latches design, low power digital cells library. **Logic Level:** Gate

reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. **Low Power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network. **Low Power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation. **Special & Advanced Techniques:** Power Reduction in Clock Networks, CMOS Floating Node,Power gating techniques,Low Power Bus, Delay Balancing, Low Power Techniques for SRAM,Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits.

Text books:

1. Gary Yeap, "Practical low power digital VLSI design", Kluwer Academic Publishers, 2002
2. MassoudPedram, Jan M. Rabaey , "Low power design methodologies ", Kluwer Academic Publishers

Reference Books:

1. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2002
2. Yeo "CMOS/BiCMOS ULSI low voltage low power,", Pearson Education Publishers, Boston, 1995. (Added)

NANOELECTRONICS

Course Code :18EC3082 **L-T-P: 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus: Introduction to Nanoelectronics: Nanotechnology potential, Development of Microelectronics, Region of Nanostructures, Complexity Problem, Challenge initiated by Nanoelectronics, Top-down and bottom-up approach and Nanostructures.

Quantum electron devices: From classical to quantum physics: upcoming electronic devices, Electrons in mesoscopic structure, Short channel MOS transistor, Split gate transistor, Electron wave transistor, Electron spin transistor, Quantum Cellular Automate, Quantum Dot Array.

Nano electronics with tunnelling Devices: Tunnelling Element, Technology of RTD, digital circuit design based on RTD, Principles of Single Electron Transistor (SET), SET circuit design – comparison between FET and SET circuit designs. Nanofabrication: Nano patterning of nanostructures (e-beam/X-ray, Optical lithography, STM/AFM- SEM & Soft-lithography).

Memory devices and sensors: Nano ferroelectrics, Ferroelectric Random-Access Memory, circuit design, thin film properties and integration. Calorimetric sensors, Electrochemical cells, Surface and bulk acoustic devices, Gas sensitive FETs, Resistive semiconductor gas sensors, Electronic noses, Identification of hazardous solvents and gases, Semiconductor sensor array.

BoS Approved Text books:

1. .K. Goser, P. Glosekotter & J. Dienstuhl, "Nanoelectronic and Nanosystems–From Transistors to Molecular Quantum Devices", Springer, (2004).
2. RainerWaser, "Nanoelectronics and Information Technology: Advanced Electronic Materials Novel and Devices", Wiley VCH, (2005).
3. George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, (2008).

BoS Approved Reference Books:

1. Mick Wilson, Kamali Kannangara, Geoff smith, "Nanotechnology: Basic Science and Emerging Technologies", Overseas press, (2005).
2. W.R. Fahrner, "Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques", Springer, (2010).
3. Branda Paz, "A Handbook on Nanoelectronics", Vedams books, (2008).

CAD FOR VLSI DESIGN

Course Code : 15EC4083 **L-T-P: 3-0-0**
Pre-requisite: 15EC3107 **Credits:3**

Syllabus: VLSI Design Methodologies: Introduction to VLSI Design methodologies - Review of Data structures and algorithms - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity - Tractable and Intractable problems - general purpose methods for combinatorial optimization. **Design Rules:** Layout Compaction - Design rules - problem formulation - algorithms for constraint graph compaction - placement and partitioning - Circuit representation - Placement algorithms – partitioning. **Floor Planning:** Floor planning concepts - shape functions and floor plan sizing - Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing. **Simulation:** Simulation - Gate-level modelling and simulation - Switch-level modelling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis. **Modelling And Synthesis:** High level Synthesis - Hardware models - Internal representation - Allocation - assignment and scheduling - Simple scheduling algorithm - Assignment problem - High level transformations.

Text Books:

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, (2002).
2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, (2002).

DESIGN OF SEMICONDUCTOR MEMORIES

Course Code : 15EC4084 **L-T-P: 3-0-0**
Pre-requisite: 15EC3107 **Credits:3**

Syllabus: Random Access Memory Technologies: Static Random-Access Memories: Cell Structures, Architecture Peripheral Circuit Operation, SRAM Cell, Noise Margin, and Noise, Bipolar SRAM Technologies, Advanced SRAM Architectures and Technologies, Application, Dynamic Random-Access Memories: CMOS DRAMs, Cell Theory and Advanced Cell Structures, Advanced DRAM Designs and Architecture, Application. **Non-volatile Memories:** Masked Read-Only Memories, High Density ROMs, Programmable Read-Only Memories, Erasable Programmable Road- Only Memories, Electrically Erasable PROMs, Flash Memories. Memory Fault Modelling, Testing, and Memory Design for Testability and Fault Tolerance. **Reliability and Radiation Effects:** General Reliability Issues, RAM Failure Modes and Mechanism, Non-volatile Memory, Design for Reliability, Reliability Screening and Qualification. Single Event Phenomenon, Radiation Hardening Process and Design Issues, Radiation Hardness Assurance and Testing - Radiation Dosimetry-Wafer Level Radiation Testing. **Advanced Memory and Packaging Technologies:** Ferroelectric Random-Access Memories, Gallium Arsenide FRAMs, Analog, Magneto resistive RAM,

Experimental Memory Devices: Quantum mechanical switch and Single electron memory. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D), Memory Cards-High Density Memory Packaging Future Directions.

Text books:

1. Ashok K.Sharma, "Semiconductor Memories Technology, Testing and Reliability", Prentice-Hall of India Private Limited, New Delhi, (1997).
2. David A. Hodges," Semiconductor Memories ",John Wiley & Sons Inc (Nov 1, 1972)

Reference Books:

1. Luecke Mize Care, "Semiconductor Memory design & application", Mc-Graw Hill.
2. Belty Prince, "Semiconductor Memory Design Handbook".
3. Mikhail I. Dyakonov, "Spin Physics in Semiconductors to Perel Memory".
4. "Memory Technology design and testing", IEEE International Workshop on: IEEE Computer Society Sponsor (S), (1999).
5. Brent Keeth, R. Jacob Baker,"DRAM circuit design ",IEEE, 2001.

COMPUTER COMMUNICATIONS DOMAIN

DATA NETWORKS AND PROTOCOLS

Course Code : 15EC3085 **L–T–P:3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

Introduction: Components and characteristics of data communication; Classification of data networks – PAN, LAN, MAN and, WAN.

Physical Layer: Role, multiplexing and multiple accesses; switching RS 232 standard; Controlled Area networks bus model.

Data Link Layer: MAC/LLC sub layer, Ethernet, ARP, HDLC, WLAN 802.11, Point-to-Point protocol, Multiprotocol label switching architecture (MPLS).

Network Layer: Role, IPV4 and IPV6 protocols, PDP context. Mobile IP

Transport Layer: Datagram congestion control protocol, Stream control Transmission protocol, Resource reservation protocol, VoIP Architecture and IMS architecture.

Application Layer: DHCP, SNMP, IP telephony: SIP and H.323 Protocol stack, Network security-firewalls

Text books:

1. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Prentice Hall, Fifth Edition. 2011
2. Douglas E Comer, Computer Networks and Internets, fifth edition, 2010.

Reference books:

1. Behrouz A. Fourouzan, TCP/IP Protocol Suite, Tata McGraw Hill, Third Edition, 2006.

William Stallings, Data and Computer Communications, 7/e, Pearson Edition, 2007

BROADBAND NETWORKS

Course Code :15EC3086 **L – T – P – S:3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

CO 1 - Fundamental concepts: Broadband communication- Concepts, Network architecture, Standards, - Internet-Based Networks **:** TCP/IP Protocol suite, IP addresses, Next-Generation Internet, QOS, VoIP Networks, IMS over view, SIP - Network and Services Convergence,Extranet Technologies, Topologies andDesign Standards

CO 2 - Networking Technologies: X.25 and Frame Relay, Virtual Circuits, X.25 Protocols, Frame Relay Networks and standardsFiber Technology and Topologies, SONET protocol and frame structures, Network components and topologies, Next-Generation Networks, DCC, VPNs, Architecture, Tunneling Protocol, IpSec, VPN Standards, MPLS architecture,ISDN and BISDN, ISDN Topologies, ATM Technology: Protocol, Layers and Network configurations and LANs,Ip over ATM.

CO 3Acess Networks: DSL and ADSL: Network Concepts, 32 PSK and 32 QAM, CAP and DMT, XDSL flavours and derivatives, DSLAM, ADSL LANs.Cable Modem Systems: DOCSIS standard, Interactive Set top box and IPTV.PONs: Architectures of APON, BPON, EPON, GPON, WDM PON,HFC broadband network and link budget

CO 4 Wireless Networks: Wireless Data Services: WLAN standards, protocols and layers, 802.XX Technologies, Wirelss ATM, PAN architectures,. Cellular communications concepts,Overview of GSM, GPRS CDMA, HSPA, LTE and WiMax. Overview of Satellite Communication, VSAT networks, DBS and MMDS Applications

Text Books:

1. Introduction to Broadbaod Communication Systems by Cajetan M. Akujuabi · Matthew N O Sadiku
2. BUILDING BROADBAND NETWORKS by Marlyn Kemper Littman, Ph.D.,

TCP/IP PROTOCOL SUITE

Course Code: 15EC3087 **L-T-P: 3-0-0**
Pre-requisite: 15EC3111 **Credits:3**

The Internet Address Architecture, Link Layer, ARP: Address Resolution Protocol, The Internet Protocol (IP), System Configuration: DHCP and Auto configuration, Firewalls and Network Address Translation (NAT), ICMPv4 and ICMPv6: Internet Control Message Protocol, Broadcasting and Local Multicasting (IGMP and MLD), User Datagram Protocol (UDP) and IP Fragmentation, Name Resolution and the Domain Name System (DNS), TCP: The Transmission Control Protocol, TCP Connection Management, TCP Timeout and Retransmission, TCP Data Flow and Window Management, TCP Congestion Control, TCP Keepalive, Security: EAP, IPsec, TLS, DNSSEC, and DKIM, Case Study: Simulation Of Network
Protocols Using NS.

Text Books :

1. Richard Stevens W, “TCP/IP Illustrated Volume 1”, 2nd Edition, Prentice Hall of India/ Pearson Education, New Delhi, (2014).

2. Douglas E Comer, “Internetworking with TCP/IP- Volume I”, Prentice Hall of India/ Pearson Education, New Delhi, Fourth Edition,(2002).

Reference Books:

1. Washburn K and Evans J, “TCP/IP”, Addison Wesley, USA, Second Edition, (2003).
2. Behrouz A Forouzan, “Local Area Networks”, Tata McGraw Hill Publishing Company, New Delhi, (2002).

VOIP Systems

Course Code :15EC3088 **L – T – P – S :3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signaling ,PCM, digital channel & bandwidth constraints,SS7,Services.

IP Networking Review (simple): Protocol layering, encapsulation, Ethernet, QoS at layer 2, IP, UDP, TCP,IP Addressing (network, subnet, NAT),IP Routing (RIP, OSPF).

Overview of VoIP Architectures and Protocols: Peer protocols (SIP, H323): signaling, call routing, Master-slave protocols (MGCP/Megaco et.al.): signaling, call routing, SS7 Transport (SIP-T), RTP and Codecs, RTP and RTCP: real time traffic over ip (rfc 1889), Codecs (compression, bandwidth, quality), Waveform codecs (G711, G726), CLEP codecs (G729, G723, etc.), Bandwidth control (VAD, dynamic packing, etc.).

SIP: Signaling Protocol Components (RFC 3261),SIP language elements, call flows,, Network routing: Proxies, Servers, Services, Advanced Routing, Presence/Chat, SIMPLE, ENUM, DNS, Firewalls, NATand STUN. Network QoS and QoS Mechanisms (DFWQ, MPLS)

Text Book:

1. Internet Communications Using SIP, Henry Sinnreich and Alan Johnston, Willey (second edition 2006).

2. IP Telephony, Oliver Hersent, Jean-Pierre Petit, and David Gurle, Wiley (2005).

References:

1. Johnston, A. (2015). SIP: Understanding the Session Initiation Protocol, Fourth Edition. (ISBN: 1608078639). Chappell, L. (2013). Wireshark 101: Essential Skills for Network Analysis (Wireshark Solutions). (ISBN 1893939723)

5G AND IOT

Course Code: 15EC3089 **L-T-P:3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

Introduction to 5G: IoT and 5G, Global initiatives, Standardization activities. 5G use cases examples and system concept: Extreme mobile broadband, Machine-type communications Dynamic radio access network. **5G architecture**: NFV and SDN, RAN architecture, Functional architecture, LTE and 5G integration, Physical architecture, Machine-type communications, Fundamental techniques for MTC Massive MTC, Low-latency MTC. Device-to-device (D2D) communications: RRM D2D, Multi-hop D2D Multi-operator D2D. **Milli-meter wave communications**: Spectrum and regulations, Hardware technologies for

mmW, Deployment scenarios, Architecture and mobility, Beam forming. 5G RAN technologies Access design principles, Multi-carrier with filtering: Non-orthogonal schemes, Dense radio access, V2X access communication. **Massive MIMO systems**: Resource allocation, transceiver algorithms, RF implementations in massive MIMO, Channel models, JT CoMP in 5G. **Relaying and wireless network coding**: Multi-flow backhauling and multi-flow relaying Interference management, mobility management, and dynamic reconfiguration in 5G. Network deployment types. Spectrum challenges in 5G, Spectrum toolbox. 5G wireless propagation channel models, Modeling requirements and scenarios, The METIS channel models

Text book:
5G Mobile and Wireless Communications Technology by AFIF OSSEIRAN, JOSE F . MONSERRAT, PATRICK MARSCH

NETWORK ARCHITECTURE AND DESIGN

Course Code: 15EC3090 **L-T-P:3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

Cloud Computing - Concept, Characteristics, Service models IaaS, PaaS, SaaS, Deployments- Public and private. Various Service Models. Mobile cloud computing: Concepts and techniques, Wireless Optimizations of Data Processing and Storage in Mobile Clouds, Cloud computing performance,DAG, Case Study, Green CC, Pre-emptable Algorithm in MCC, Resource Allocation Mechanism, Messaging Methods, Advance Reservation vs. Best-Effort, RA algorithms, Round-Robin, List Scheduling, Min-Min. Big Data and Service Computing in CC: BIG DATA concepts and processing, Phase reconfigurable shuffle, Spilling, Reduce Side Security Issues and Solutions: Concepts, Issues, Data Over-Collect, Privacy Control, Trust Management, Multi-Tenancy, Taxonomy threat, Data Mining , Attack Interfaces, Various Threat models. Privacy Protection: Infrastructure Security, Data Security and Storage. Mobile Identity and Access Management, Data Life Cycle, Monitoring-Based Solutions, Access Control-Based Solutions, Web Services in CC: Overview, Web Services Architecture, Simple Object Access Protocol, JavaScript Object Notation, Service-Oriented Architecture and integration, WS-Security Framework

Text Books

1) MOBILE CLOUD COMPUTING Models, Implementation, and Security by Meikang Qiu and Keke Gai

2) MOBILE CLOUD COMPUTING -- Architectures, Algorithms and Applications BY Debashis De

NETWORK PROGRAMMING

Course :15EC3091 **L-T-P:3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

Introduction to Cloud Networking: Networking Basics, The network stack, Packets and frames, Network equipment, Interconnect, Cloud Data Center, Cloud Networking, Characteristics of Cloud Networking, Ethernet usage, Virtualization, Convergence,

Scalability, Software. Data Center Evolution: Mainframes to the Cloud: The Data Center Evolution, Computer Networks, Ethernet, Enterprise versus Cloud Data Centers, Movement to the Cloud.

Switch Fabric Technology: Switch Fabric Architecture Overview, Switch Fabric Topologies, Congestion Management, Flow Control, Traffic Management, Switch Chip Architecture Examples, Cloud Data Center Networking Topologies: Traditional Multi-tiered Enterprise Networks, Data Center Network Switch Types, Flat Data Center Networks, Rack Scale Architectures, Network Function Virtualization.

Data Center Networking Standards: Ethernet Data Rate Standards, Virtual Local Area

Networks, Data Center Bridging, Improving Network Bandwidth, Remote Direct Memory

Access. Server Virtualization and Networking**:** VM Overview, Virtual Switching, PCI Express, Edge Virtual Bridging, VM Migration.

Network Virtualization: Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel locations, Load balancing Software defined networking : Data Center Software Background, OpenStack, Open Flow, Network Function Virtualization, SDN Deployment.

Text books:

1. Gary Lee, "Cloud Networking - Understanding Cloud-based Data Center Networks", Elsevier, (2014).

Reference books

1. Andrew Tanenbaum," Computer networks", 5/e, PHI,
2. Larry L. Peterson, Bruce S. Davie." Computer Networks a system approach", 2/Harcourt Asia PTE LTD., (2007)

NETWORK SECURITY

Course Code :15EC3092 **L–T–P:3-0-0**

Pre-requisite: 15EC3111 **Credits: 3**

CO 1: Physical Network Security: Physical layer security,Copper and Optical Media, **Data Centre and Enterprise network**: LAN Security and Resilient Network Topologies,

CO 2: Router Mechanisms for security: Router and Switch Architectures, Lookup and Classification Algorithms, Packet scheduling and fair queuing, Queuing and Scheduling Algorithms,**Network configuration security**: Internet Policy Routing,

CO 3: Securing Distributed and networked systems: Securing Distributed Algorithms, **Big picture:** Physical Security, Wireless Media, Malware, QoS and Multicast.

CO 4: Current topics in Network security: Web and DNS security, Wireless Security, Covert Channels in Networks, Quantum Cryptography/ Communication, Security of Internet Architectures, Secure Multiparty Computation , Anomaly Detection and Traffic

Analysis, Operational Network Security, Intrusion Detection Algorithms, Data Mining for Intrusion Detection, Traffic Anomaly Detection and DHT Security.

References:

1. Charlie Kaufman, Radiaperlman, Mike Speciner, *Network Security Private Communication in Public World,*Second Edition, 2004, Pearson.
2. William Stallings, *Network Security Essentials-Applications & Standards,* Pearson.
3. Eric Maiwald, *Fundamentals of Network Security*, 2004, Osborne/McGraw Hill, Dreamtech Press
4. Network Security -- Private Communication in a Public World, Charlie Kaufman, Radia Perlman and Mike Speciner, 2nd Edition, Prentice-Hall, 2002, ISBN 0-13-046019-
5. Network Algorithmics, 1st Ed. (2004), by George Varghese.
6. LAN Wiring, 3th Ed. (2007), by James Trulove.
7. LAN Switch Security: What Hackers Know About Your Switches, 1st Ed. (2007), by Eric Vyncke and Christopher Paggen.
8. Building Resilient IP Networks, 1st Ed. (2012), by Kok-Keong Lee and Beng-Hui Ong.
9. CSSP All-In-One Exam Guide, 6th Ed. (2012), by Shon Harris.

WIRELESS LAN 802 STANDARDS

Course Code :185EC4093 **L – T – P :3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

CO 1: Wi Fi (IEEE 80.11): Wired and Wireless transmission techniques: wireless modems, Smart receiving techniques, integration of voice and data traffic.Wi Fi :Network topologies, Protocol Architecture, Different Physical Layeres, Data Link Layer, MAC layer, Hiper LAN: Wireless ATM Functions, Mobility, Security, Service sets, Public Hotspot, 802.11 family and derivatives, WiFi application scenarios

CO 2: Bluetooth (IEEE 802.15.1) : Concept, Device Types, Pi-connects and Scatter nets, Device connectivity, Network scenarios, Protocol architecture, Throughputs, OSI Layer Stack, Physical layer, Baseband layer, Channels, Link Manager, LLC (L2CAP), Adaptation Protocol, RFCOMM, SDP, HCI, BNEC. IP over Bluetooth, Application scenarios, Bluetooth vs.Wi-Fi.

CO 3: Zigbee (IEEE 802.15.4): Concept, Device types, Zig bee basics, Networking examples, Connectivity, Industry applications scenarios, OSI Protocol layers Physical layer (900 MHz and 2400 MHz), MAC, Frame structures, , Architecture, Network topologies,, Zigbee security, Bluetooth vs Zigbee

CO 4: WiMAX (IEEE 802.16) : WiMax concepts , Protocol layers, MAC layer, Physical Layer, OFDM concept, , Broadband wireless, Link analysis TX/RX, Path loss and link budget, Antenna techniques, MIMO and beam forming, Netwok topologies, Application scenarios Comparison of all technologies

Text Books:

1. HoudaLabiod, Hossam Afifi, Costantino de Santis - Wi-Fi, Bluetooth, Zigbee and WiMax (2007, Springer)

2. Nathan J. Muller - Bluetooth Demystified (2000, McGraw-Hill Professional Publishing)
3. Mobile Broadcasting with WiMAX: Principles, Technology, and Applications by Amitabh KumarShahinFarahani PhD - ZigBee Wireless Networks and Transceivers (2008, Newnes)

IP MULTIMEDIA SUBSYSTEMS

Course Code :15EC4094 **L – T – P :3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

CO-1 Introduction: Trends for telephony services, Evolution of mobile networks, Next Generation Networks, IMS,, IMSservice examples.**IMS Architecture:** Origin of IMS,IMS Standards,IMSconcepts,IMSArchitecture,Core network and Access networkArchitecture reference models, Components and functions,Control Plane and Data plane in IMS, IMSInterface reference points, User identities

CO2 IMS Protocol Stacks: Session Initiation Protocol, DIAMETER and H.248/Megaco, RTP and RTCP, IMS service path. IMS Layer mapping.

CO-3 IMS Operation:IMS and the DNS, IMS session setup, IMS registration, IMS call flow examples, IMS to IMS call, IMS Charging, IMS Security, IMS Scenarios, Role of application servers, Examples.

CO-4 IMS and PSTN: Interoperability between PSTN and IMS, Comparison of PSTN, GSM and IMS networks, Establishing a call with the PSTN.Layer 2 and 3 Messages for call flow.

Text books:

1. The IMS: IP Multimedia Concepts and Services, 3rd Edition, Wiley
2. IP Multimedia Subsystem (IMS) Handbook, CRC Press
3. The IP Multimedia Subsystem (IMS): Session Control and Other Network Operations, McGraw-Hill

Reference Book

1. The 3G IP Multimedia subsystem (IMS)-merging the internet and the cellular worlds third edition by Gonzalo Camarillo Ericsson, Finland. Miguel A. Garcia-Martin Ericsson,Spain

EMERGING TECHNOLOGIES-SDN, NFV,CLOUD AND IOT

Course Code :15EC4095 **L – T – P:3-0-0**
Pre-requisite: 15EC3111 **Credits: 3**

MODERN NETWORKING: Elements of Modern Networking: Modern Network Architectures,Network Convergence, Unified Communications, Types of Network and Internet Traffic, Big Data, Cloud Computing, and Mobile Traffic, Congestion Control; SDN and NFV;**SDN:** SDN Approach;; SDN/NFV Standards, SDN Data Plane and OpenFlowin detail. SDN Control Plane in detail, SDN Application Planein detail Data Center Networking;; Information-Centric Networking

VIRTUALIZATION

Network Functions Virtualization:NFV Concepts and Architecture in detail, NFV Reference Architecture;NFV Functionality,NFV Use Cases; SDN and NFV, Virtual LANs;; EEE 802.1Q VLAN Standard;; Nested VLANs; OpenFlow IPsec VPNs;; MPLS VPNs;; Virtual Tenant Network;;

Quality of Service: QoS Architectural Framework;; Integrated Services Architecture;;DiffServ, IP Performance Metrics;; OpenFlow QoS.**QoE: User Quality of Experience**; QoE Strategies in Practice;; Applications of QoE. Network Design Implications

of QoS and QoE, Service-Oriented QoE Versus QoS Service Monitoring.**MODERN NETWORK ARCHITECTURE: Cloud Computing :**Basic Concepts;; Cloud Services;; SaaS;; PaaS;; IaaS;; XaaS;; Cloud Deployment Models;; Cloud Architecture;; SDN and NFV from Cloud perspective;; ITU-T Cloud Computing Functional Reference Architecture **The Internet of Things: Components:** The IoT Era;; Scope of IoT;; Components of IoT-Enabled Things (Sensors, Actuators, Microcontrollers, Transceivers, RFID).**The Internet of Things: Architecture and Implementation :** IoT Architecture;; ITU-T IoT Reference Model;; IoT World Forum Reference Model;; IoT Implementation;; IoTivity

Text book:

Foundations of Modern Networking SDN, NFV, QoE, IoT, and Cloud William Stallings(With contributions by: Florence Agboma, British Sky Broadcasting, SofieneJelassi, Assistant Professor, University of Monastir, Tunisia)

SKILLING COURSES

Skilling(LabVIEW and MultiSim)

Course Code :15TS401 **L-T-P-S: 0-0-0-8**
Pre-requisite: C programming, Mathematics **Credits: 2**

Introduction To LabVIEW: Introduction to graphical system design (GSD), working on GSD platform, Benefits of GSD, Text based programming Vs LabVIEW, Introduction to LabVIEW Environment, Front Panel Window Toolbar, Block Diagram Window Toolbar, Introduction to VIs, Data types, Data Representation, Coercion dot, Selecting a Tool, Shortcut Keys, Basic debugging techniques, Introduction to Digital Electronics, Boolean operations , Digital Circuit design, string operations**,** Various Display Types (Normal, code, Password, HEX display), Exploring string functions

Graphical Programming using LabVIEW: Introduction to loop concept, Type of Loops, For loop, Nested For loop, While loop(Stop if true and Continue if True), hybrid nested loop, Feedback Node, Shift Register and Stack Shift register, Introduction to tunnel and its type, Auto-Indexing, Last Value, Concatenating, Introduction to Arrays, operations of Array Functions, 1-D Array, 2-D Array, Introduction to Clusters, Cluster Function, Difference between Array and Cluster, Chart**,** Graph, Difference between Chart and Graph by Execution Exercise, Signal Generation and Plotting, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes,

Structures Using LabVIEW: Introduction to Case structures, Case Control using Enumerated data type, Enum with type definition, Introduction to Flat Sequence, Create New Sub VI from Scratch**,** Input and Output Sub VI Connectors**,** Icon Editor**,** Making Sub VI from existing VI**,** Using Sub VIs Exercises, Finding Errors**,** Error handling and Debugging Techniques.

File I/O: Introduction to File I/O, Reading a Data from file, Writing a Data to file, Understanding File I/O using RefNum, File I/O Function Pallet, Introduction to Event Structure and operations, Design Technique, Introduction to Architecture, State machine Architecture.

Synchronization and Communication: producer and consumer (Multiple Loops/Parallel programming), Master Slave Architecture Exercises, Difference between Producer Consumer and Master Slave Architecture.

MultiSim: Simulation Using MultiSim, Using various instruments like Multimeter, Function Generator, Oscilloscope, Wattmeter, Bode plotter, IV analyzer using MultiSim, using Measurement Probe and Current Probe in MultiSim. Introduction to Simulation Analysis Using MultiSim, AC analysis, DC operating Point, Fourier Analysis, Transient Analysis, Noise Analysis, Distortion Analysis, DC Sweep, Parameter Sweep using MultiSim.

Software Tool:

NI LabVIEW, NI MultiSim.

Text Books:

1. John Essick “Hands-On Introduction to LabVIEW for Scientist and Engineers”, , OXFORD University Press, Second Edition.
2. DavidBaez-Lopez & Felix E. Guerrero- Castro “Circuit Analysis with MultiSim”, Morgan & Claypool Publisher.

Reference Books:

1. J. Travis &Jim Kring "LabVIEW for Everyone", , PRENTICE Hall , Third Edition.

2. Nilsson& Riedel "Introduction to MultiSim", , 9th Edition

Skilling (Matlab)

Course Code :15TS402 **L-T-P-S: 0-0-0-8**
Pre-requisite: C programming, Mathematics **Credits: 2**

Introduction to MATLAB Programming: Matlab Interactive Sessions, Menus and the toolbar, Computing with Matlab, Script files and the Editor Debugger, Matlab Help System, Programming in Matlab.
Arrays: Multidimensional Arrays, Element by Element Operations, Polynomial Operations Using Arrays, Cell Arrays, Structure Arrays. **Functions & Files:** Elementary Mathematical Functions, User Defined Functions, Advanced Function Programming, Working with Data Files.
Programming Techniques: Program Design and Development, Relational Operators and Logical Variables, Logical Operators and Functions, Conditional Statements, Loops, The Switch Structure, Debugging Mat Lab Programs.
Data types and Plotting: Numeric Types, Characters and Strings, Dates and Time, Categorical Arrays, Structures, Cell Arrays, Function Handles, Data Type Identification, Data Type Conversion. Plotting: XY- plotting functions, Subplots and Overlay plots, Special Plot types, Interactive plotting, Function Discovery, Regression, 3-D plots .
File Input/Output:
Saving/reading binary files and making calls to the operating system, Input/output of data to/from an ASCII file.
Applications:
Digital signal Processing Experiments: Filter Designs and Transforming of signals from domain to domain. Digital Image Processing: Reading and Writing of image, Morphological Operations of an Image. Artificial Neural Networks: create a Neuron Model, Differentiate Learning Methods, Training the Data with Neural network.

Software Tool:

Matlab.

Text Books:

1. Attaway, S., "A Practical Introduction to Programming and Problem Solving". Third Edition. Elsevier. San Fransisco

Reference Books:

1. Hahn B., and D. Valentine, "Essential Matlab for Engineers and Scientists: 5th Edition",2013, Academic Press. Waltham, MA.
2. Hart, David and Clinton Wolfe, "Getting Started with MATLAB," 1999, Indiana University, University Information Technology Services