



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**  
**KAKINADA – 533 003, Andhra Pradesh, India**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

## **COURSE STRUCTURE AND SYLLABUS**

**For UG – R20**

**B. TECH - ELECTRONICS AND COMMUNICATION ENGINEERING**

*(Applicable for batches admitted from 2020-2021)*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**

**KAKINADA - 533 003, ANDHRA PRADESH, INDIA**



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**  
**KAKINADA – 533 003, Andhra Pradesh, India**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**COURSE STRUCTURE**

**I Year –I SEMESTER**

S. No.	Category	Subjects	L	T	P	Credits
1	HS	Communicative English	3	0	0	3
2	BS	Mathematics –I( Calculus)	3	0	0	3
3	BS	Applied Chemistry	3	0	0	3
4	ES	Programming for Problem Solving Using C	3	0	0	3
5	BS	Engineering Drawing	2	0	2	3
6	LC	English Communication Skills Laboratory	0	0	3	1.5
7	LC	Applied Chemistry Lab	0	0	3	1.5
8	LC	Programming for Problem Solving Using C Lab	0	0	3	1.5
<b>Total Credits</b>						<b>19.5</b>

**I Year – II SEMESTER**

S. No	Category	Subjects	L	T	P	Credits
1	BS	Mathematics –II (Linear Algebra and Numerical Methods)	3	0	0	3
2	BS	Applied Physics	3	0	0	3
3	ES	Object Oriented Programming through Java	2	0	2	3
4	ES	Network Analysis	3	0	0	3
5	ES	Basic Electrical Engineering	3	0	0	3
6	LC	Electronic workshop Lab	0	0	3	1.5
7	LC	Basic Electrical Engineering Lab	0	0	3	1.5
8	LC	Applied Physics Lab	0	0	3	1.5
9	MC	Environmental Science	3	0	0	0.0
<b>Total Credits</b>						<b>19.5</b>

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S. No	Category	Name of the Subject	L	T	P	Credits
1	PC	Electronic Devices and Circuits	3	1	0	3
2	PC	Switching Theory and Logic Design	3	1	0	3
3	PC	Signals and Systems	3	1	0	3
4	BS	Mathematics-III (Transforms and Vector Calculus)	3	1	0	3
5	BS	Random Variables and Stochastic Processes	3	1	0	3
6	LC	OOPS through Java Lab	0	0	2	1.5
7	LC	Electronic Devices and Circuits -Lab	0	0	2	1.5
8	LC	Switching Theory and Logic Design–Lab	0	0	2	1.5
9	SC	Python Programming	0	0	4	2
<b>Total Credits</b>						<b>21.5</b>

**II Year – II Semester**

S. No	Category	Name of the subject	L	T	P	Credits
1	PC	Electronic Circuit Analysis	3	1	0	3
2	PC	Digital IC Design	3	1	0	3
3	PC	Analog Communications	3	0	0	3
4	ES	Linear control Systems	3	1	0	3
5	HS	Management and Organizational Behavior	3	0	0	3
6	LC	Electronic Circuit Analysis Lab	0	0	3	1.5
7	LC	Analog Communications Lab	0	0	3	1.5
8	LC	Digital IC Design Lab	0	0	3	1.5
9	SC	Soft Skills	0	0	4	2
10	MC	Constitution of India	3	0	0	0
<b>Total Credits</b>						<b>21.5</b>
<b>Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)</b>						<b>4</b>



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**III Year - I Semester**

S. No	Category	Name of the subject	L	T	P	Credits
1	PC	Analog ICs and Applications	3	0	0	3
2	PC	Electromagnetic Waves and Transmission Lines	3	0	0	3
3	PC	Digital Communications	3	0	0	3
4	OE1	Open Elective Course/Job oriented elective-1	2	0	2	3
5	PE1	Professional Elective courses -1	3	0	0	3
6	LC	Analog ICs and Applications LAB	0	0	3	1.5
7	LC	Digital Communications Lab	0	0	3	1.5
8	SC	Data Structures using Java Lab	0	0	4	2
9	MC	Indian Traditional Knowledge	2	0	0	0
<b>Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester)</b>			0	0	0	1.5
<b>Total credits</b>						<b>21.5</b>
<b>Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)</b>						<b>4</b>

**PE1:**

1. Antenna and Wave Propagation
2. Electronic Measurements and Instrumentation
3. Computer Architecture & Organization

**OE1:**

Candidate should select the subject from list of subjects offered by other departments



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**III Year –II Semester**

S. No	Category	Name of the subject	L	T	P	Credits
1	PC	Microprocessor and Microcontrollers	3	1	0	3
2	PC	VLSI Design	3	0	0	3
3	PC	Digital Signal Processing	3	0	0	3
4	PE2	Professional Elective courses - 2	3	0	0	3
5	OE 2	Open Elective Course/Job oriented elective -2	2	0	2	3
6	LC	Microprocessor and Microcontrollers - Lab	0	0	3	1.5
7	LC	VLSI Design Lab	0	0	3	1.5
8	LC	Digital Signal Processing Lab	0	0	3	1.5
9	SC	ARM based/ Aurdino based Programming	1	0	2	2
10	MC	Research Methodology	2	0	0	0
<b>Total credits</b>						<b>21.5</b>
<b>Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)</b>						<b>4</b>

**Industrial/Research Internship (Mandatory) 2 Months during summer vacation**

**PE2:**

- 1.Microwave Engineering
- 2.Mobile & Cellular Communication
- 3.Embedded Systems
- 4.CMOS Analog IC Design

**OE2:**

Candidate should select the subject from list of subjects offered by other departments



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**IV Year –I Semester**

S. No	Category	Name of the subject	L	T	P	Credits
1	PE	Professional Elective courses -3	3	0	0	3
2	PE	Professional Elective courses -4	3	0	0	3
3	PE	Professional Elective courses -5	3	0	0	3
4	OE	Open Elective Courses/ Job oriented elective -3	2	0	2	3
5	OE	Open Elective Courses/ Job oriented elective -4	2	0	2	3
6	HS	<b>*Humanities and Social Science Elective</b>	3	0	0	3
7	SC	<b>Designer tools (HFSS, Microwave Studio CST. Cadence Virtuoso. Synopsys, Mentor Graphics, Xilinx.)</b>	1	0	2	2
<b>Industrial/Research Internship 2 Months (Mandatory) after third year (to be evaluated during VII semester)</b>			0	0	0	3
<b>Total credits</b>						<b>23</b>
<b>Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)</b>						<b>4</b>

<u>PE 3:</u>  1. Optical Communication 2. Digital Image Processing 3. Low Power VLSI Design	<u>PE5:</u>  1. Radar engineering 2. Pattern recognition & Machine Learning 3. Internet of Things
<u>PE4:</u>  1. Satellite Communications 2. Soft Computing Techniques 3. Digital IC Design using CMOS	

**IV Year – II Semester**

S. No.	Category	Code	Course Title	Hours per week			Credits
1	Major Project	PROJ	Project work, seminar and internship in industry	-	-	-	12
<b>INTERNSHIP (6 MONTHS)</b>							
<b>Total credits</b>						<b>12</b>	



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**SUBJECTS FOR  
HONORS**

**POOL-1**

**Instrumentation and Control Systems:** (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject	L-T-P	Credits
1	Data Acquisition systems	3-1-0	4
2	Adaptive Control Systems	3-1-0	4
3	Bio-Medical Instrumentation	3-1-0	4
4	Digital Control Systems	3-1-0	4
5	Process Control Instrumentation	3-1-0	4
6	Transducers & sensors	3-1-0	4
7	MEMS	3-1-0	4
8	Intelligent & Smart Instrumentation	3-1-0	4

In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering

**POOL-2**

**Integrated circuits and Systems:** (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No	Subject	L-T-P	Credits
1	VLSI Technology and Design	3-1-0	4
2	CMOS Analog IC Design	3-1-0	4
3	CMOS Digital IC design	3-1-0	4
4	Design for Testability	3-1-0	4
5	System on Chip	3-1-0	4
6	Programmable Logic Devices and ASIC	3-1-0	4
7	Scripting Language	3-1-0	4
8	Low Power VLSI Design	3-1-0	4

In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering



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**POOL-3**

**Communication Engineering:** (any four of the following subjects which are not chosen as a professional electives are to be considered for Honors Degree)

S. No	Subject	L-T-P	Credits
1	Wireless Sensor Networks	3-1-0	4
2	Software defined radio	3-1-0	4
3	Data Communications & Computer Networks	3-1-0	4
4	Cognitive radio	3-1-0	4
5	5G Communications	3-1-0	4
6	Satellite communication	3-1-0	4
7	Optical Communication	3-1-0	4
8	Global navigational satellite systems	3-1-0	4

In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering

**POOL-4**

**Digital Signal processing** (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No	Subject	L-T-P	Credits
1	Speech Signal Processing	3-1-0	4
2	Video Signal Processing	3-1-0	4
3	Adaptive Signal Processing	3-1-0	4
4	Bio- Medical Signal Processing	3-1-0	4
5	DSP Processors and Architectures	3-1-0	4
6	Wavelet Theory	3-1-0	4
7	Multirate Systems And Filter Banks	3-1-0	4
8	Mathematical methods for signal processing	3-1-0	4

In addition to any of the four subjects Compulsory MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each)





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**GENERAL MINOR TRACKS**

S. No.	Subject	L-T-P	Credits
1	Electronics Devices and Basic Circuits	3-1-0	4
2	Digital Electronics	3-1-0	4
3	Principles of Communication	3-1-0	4
4	Signal Analysis	3-1-0	4

In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering

List of the **OPEN ELECTIVES** offered by **ECE** Department to **other Branches**:

1. Basics of Signals and Systems
2. Electronic Measurements and Instrumentation
3. Principles of Signal Processing
4. Industrial Electronics
5. Consumer Electronics
6. Fundamentals of Microprocessors and Microcontrollers
7. Transducers and Sensors
8. IOT and Applications
9. Soft Computing Techniques
10. IC Applications
11. Principles of Communications
12. Basic Electronics
13. Data Communications
14. Digital Logic design
15. Remote Sensing and GIS
16. Bio Medical Instrumentation



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I Year - I Semester	L	T	P	C
	3	0	0	3

**COMMUNICATIVE ENGLISH**

### Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

### Course Objectives

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

### Learning Outcomes

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms



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**Unit 1:**

**Lesson-1: A Drawer full of happiness** from “**Infotech English**”, Maruthi Publications

**Lesson-2: Deliverance by Premchand** from “**The Individual Society**”, Pearson Publications. (Non-detailed)

**Listening:** Listening to short audio texts and identifying the topic. Listening to prose, prose and conversation.

**Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

**Reading:** Skimming text to get the main idea. Scanning to look for specific pieces of information.

**Reading for Writing:** Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.

**Vocabulary:** Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.

**Grammar:** Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.

**Pronunciation:** Vowels, Consonants, Plural markers and their realizations

**Unit 2:**

**Lesson-1: Nehru’s letter to his daughter Indira on her birthday** from “**Infotech English**”, Maruthi Publications

**Lesson-2: Bosom Friend by Hira Bansode** from “**The Individual Society**”, Pearson Publications.(Non-detailed)

**Listening:** Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.

**Speaking:** Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings. **Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

**Reading for Writing:** Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

**Vocabulary:** Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)

**Grammar:** Use of articles and zero article; prepositions.

**Pronunciation:** Past tense markers, word stress-di-syllabic words



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**Unit 3:**

**Lesson-1: Stephen Hawking-Positivity ‘Benchmark’** from “**Infotech English**”, Maruthi Publications

**Lesson-2: Shakespeare’s Sister** by **Virginia Woolf** from “**The Individual Society**”, Pearson Publications.(Non-detailed)

**Listening:** Listening for global comprehension and summarizing what is listened to, both in speaking and writing.

**Speaking:** Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.

**Reading:** Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.

**Reading for Writing:** Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV’s.

**Vocabulary:** Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words

**Grammar:** Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

**Pronunciation:** word stress-poly-syllabic words.

**Unit 4:**

**Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography** from “**Infotech English**”, Maruthi Publications

**Lesson-2: Telephone Conversation-Wole Soyinka** from “**The Individual Society**”, Pearson Publications.(Non-detailed)

**Listening:** Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.

**Speaking:** Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.

**Reading:** Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.

**Reading for Writing:** Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.

**Vocabulary:** Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.



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**Grammar:** Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

**Pronunciation:** Contrastive Stress

**Unit 5:**

**Lesson-1: Stay Hungry-Stay foolish** from “**Infotech English**”, Maruthi Publications

**Lesson-2: Still I Rise** by Maya Angelou from “**The Individual Society**”, Pearson Publications.(Non-detailed)

**Listening:** Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

**Speaking:** Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.

**Reading:** Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.

**Reading for Writing:** Writing academic proposals- writing research articles: format and style.

**Vocabulary:** Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.

**Grammar:** Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

**Pronunciation:** Stress in compound words

**Prescribed text books for theory for Semester-I:**

1. “**Infotech English**”, Maruthi Publications. (Detailed)

2. “**The Individual Society**”, Pearson Publications.(Non-detailed)

**Prescribed text book for Laboratory for Semesters-I & II:**

1. “**Infotech English**”, Maruthi Publications. (with Compact Disc)

**Reference Books:**

- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking*. Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.



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I Year - I Semester	L	T	P	C
	3	0	0	3

**MATHEMATICS-I**

**Course Objectives:**

- This course will illuminate the students in the concepts of calculus.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

**Course Outcomes:**

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

- Utilize mean value theorems to real life problems (L3)
- Solve the differential equations related to various engineering fields (L3)
- Familiarize with functions of several variables which is useful in optimization (L3)
- Apply double integration techniques in evaluating areas bounded by region (L3)
- Students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5 )

**UNIT I: Sequences, Series and Mean value theorems:** (10 hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy’s root test – Alternate series – Leibnitz’s rule.

Mean Value Theorems (without proofs): Rolle’s Theorem – Lagrange’s mean value theorem – Cauchy’s mean value theorem – Taylor’s and Maclaurin’s theorems with remainders.

**UNIT II: Differential equations of first order and first degree:** (10 hrs)

Linear differential equations – Bernoulli’s equations – Exact equations and equations reducible to exact form.

Applications: Newton’s Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

**UNIT III: Linear differential equations of higher order:** (10 hrs)

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ , polynomials in  $x^n$ ,  $e^{ax} V(x)$  and  $x^n V(x)$  – Method of Variation of parameters.

Applications: LCR circuit, Simple Harmonic motion.

**UNIT IV: Partial differentiation:** (10 hrs)

Introduction – Homogeneous function – Euler’s theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor’s and Mc Laurent’s series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange’s method (with constraints).



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**UNIT V: Multiple integrals:** (8 hrs)  
Double and Triple integrals – Change of order of integration – Change of variables.  
Applications: Finding Areas and Volumes.

**Text Books:**

- 1) B. S. Grewal, Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publishers.
- 2) B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

**Reference Books:**

- 1) Erwin Kreyszig, Advanced Engineering Mathematics, 10<sup>th</sup> Edition, Wiley-India.
- 2) Joel Hass, Christopher Heil and Maurice D. Weir, Thomas calculus, 14<sup>th</sup> Edition, Pearson.
- 3) Lawrence Tury, Advanced Engineering Mathematics, CRC Press, 2013.
- 4) Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press.



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<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>APPLIED CHEMISTRY</b>					

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

### COURSE OBJECTIVES

- **Importance** of usage of plastics in household appliances and composites (FRP) in aerospace and automotive industries.
- **Outline** the basics for the construction of electrochemical cells, batteries and fuel cells. Understand the mechanism of corrosion and how it can be prevented.
- **Explain** the preparation of semiconductors and nanomaterials, engineering applications of nanomaterials, superconductors and liquid crystals.
- **Recall** the increase in demand for power and hence alternative sources of power are studied due to depleting sources of fossil fuels. Advanced instrumental techniques are introduced.
- **Outline** the basics of computational chemistry and molecular switches

### UNIT I: POLYMER TECHNOLOGY

**8 hrs**

**Polymerisation:-** Introduction, methods of polymerization (emulsion and suspension), mechanical properties.

**Plastics:** Compounding, fabrication (compression, injection, blown film and extrusion), preparation, properties and applications (PVC, polycarbonates and Bakelite), mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste (waste to wealth).

**Elastomers:-** Introduction, preparation, properties and applications (Buna S, thiokol and polyurethanes).

**Composite materials:** Fiber reinforced plastics, conducting polymers, biodegradable polymers, biopolymers, biomedical polymers.

**Course Outcomes:** *At the end of this unit, the students will be able to*

- **Analyze** the different types of composite plastic materials and **interpret** the mechanism of conduction in conducting polymers.

### UNIT II: ELECTROCHEMICAL CELLS AND CORROSION

**10 hrs**

Single electrode potential, electrochemical series and uses of series, standard hydrogen electrode, calomel electrode, construction of glass electrode, batteries (Dry cell, Li ion battery and zinc air cells), fuel cells (H<sub>2</sub>-O<sub>2</sub>, CH<sub>3</sub>OH-O<sub>2</sub>, phosphoric acid and molten carbonate).

**Corrosion:-** Definition, theories of corrosion (chemical and electrochemical), galvanic corrosion, differential aeration corrosion, stress corrosion, galvanic series, factors influencing rate of corrosion, corrosion control (proper designing and cathodic protection), Protective coatings (surface preparation, cathodic coatings, anodic coatings, electroplating and electroless plating [nickel]), Paints (constituents, functions and special paints).

**Course Outcomes:** *At the end of this unit, the students will be able to*

- **Utilize** the theory of construction of electrodes, batteries and fuel cells in redesigning new engineering products and **categorize** the reasons for corrosion and study methods to control corrosion.





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**UNIT III: MATERIAL CHEMISTRY**

**10 hrs**

**Part I : Non-elemental semiconducting materials:-** Stoichiometric, controlled valency & chalcogen photo/semiconductors-preparation of semiconductors (distillation, zone refining, Czochralski crystal pulling, epitaxy, diffusion, ion implantation) - Semiconductor devices (p-n junction diode as rectifier, junction transistor).

**Insulators & magnetic materials:** electrical insulators-ferro and ferri magnetism-Hall effect and its applications.

**Part II:**

**Nano materials:-** Introduction, sol-gel method, characterization by (Brunauer Emmet Teller [BET]), (scanning electron microscopy [SEM]) and (transmission electron microscopy [TEM]), applications of graphene and fullerenes, carbon nanotubes (types, preparation and applications)

**Liquid crystals:-** Introduction-types-applications.

**Super conductors:-**Type –I, Type II-characteristics and applications

**Course Outcomes: At the end of this unit, the students will be able to**

- **Synthesize** nanomaterials for modern advances of engineering technology.
- **Summarize the** preparation of semiconductors; analyze the applications of liquid crystals and superconductors.

**UNIT IV:**

**SPECTROSCOPIC TECHNIQUES &NON-CONVENTIONAL ENERGY SOURCES**

**10 hrs**

**Part A: SPECTROSCOPIC TECHNIQUES**

Electromagnetic spectrum-UV (laws of absorption, instrumentation, theory of electronic spectroscopy, Frank-condon principle, chromophores and auxochromes, intensity shifts, applications), FT-IR [instrumentation and differentiation of sp, sp<sup>2</sup>, sp<sup>3</sup> and IR stretching of functional groups (alcohols, carbonyls, amines) applications], magnetic resonance imaging and CT scan (procedure & applications).

**Part B: NON-CONVENTIONAL ENERGY SOURCES**

Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell, hydropower, geothermal power, tidal and wave power, ocean thermal energy conversion.

**Course Outcomes: At the end of this unit, the students will be able to**

- **Analyze** the principles of different analytical instruments and their applications.
- **Design** models for energy by different natural sources.

**UNIT V: ADVANCED CONCEPTS/TOPICS IN CHEMISTRY**

**8 hrs**

**Computational chemistry:** Introduction to computational chemistry, molecular modelling and docking studies

**Molecular switches:** characteristics of molecular motors and machines, Rotaxanes and Catenanes as artificial molecular machines, prototypes – linear motions in rotaxanes, an acid-base controlled molecular shuttle, a molecular elevator, an autonomous light-powered molecular motor

**Course Outcomes: At the end of this unit, the students will be able to**

- **Obtain** the knowledge of computational chemistry and molecular machines



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**Standard Books:**

1. P.C. Jain and M. Jain “**Engineering Chemistry**”, 15/e, Dhanpat Rai & Sons, Delhi, (Latest edition).
2. Shikha Agarwal, “**Engineering Chemistry**”, Cambridge University Press, New Delhi, (2019).
3. S.S. Dara, “**A Textbook of Engineering Chemistry**”, S.Chand & Co, (2010).
4. Shashi Chawla, “Engineering Chemistry”, Dhanpat Rai Publishing Co. (Latest edition).

**Reference:**

1. K. Sessa Maheshwaramma and Mridula Chugh, “**Engineering Chemistry**”, Pearson India Edn.
2. O.G. Palana, “**Engineering Chemistry**”, Tata McGraw Hill Education Private Limited, (2009).
3. CNR Rao and JM Honig (Eds) “**Preparation and characterization of materials**” Academic press, New York (latest edition)
4. B. S. Murthy, P. Shankar and others, “**Textbook of Nanoscience and Nanotechnology**”, University press (latest edition)



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<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>PROGRAMMING FOR PROBLEM SOLVING USING C</b>				

**COURSE OBJECTIVES:**

**The objectives of Programming for Problem Solving Using C are**

- To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
- To gain knowledge of the operators, selection, control statements and repetition in C
- To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
- To assimilate about pointers, dynamic memory allocation and know the significance of Preprocessor.
- To assimilate about File I/O and significance of functions

**UNIT I**

**Introduction to Computers:** Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

**Introduction to the C Language:** Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

**Structure of a C Program:** Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

**UNIT II**

**Bitwise Operators:** Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

**Selection & Making Decisions:** Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

**Repetition:** Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

**UNIT III**

**Arrays:** Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

**Strings:** String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

**Enumerated, Structure, and Union:** The Type Definition (Type-def), Enumerated Types, Structure, Unions, and Programming Application

**UNIT IV**

**Pointers:** Introduction, Pointers to pointers, Compatibility, L value and R value

**Pointer Applications:** Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application

**Processor Commands:** Processor Commands



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**UNIT V**

**Functions:** Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

**Text Input / Output:** Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

**Binary Input / Output:** Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

**TEXT BOOKS:**

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F. Gilberg, CENGAGE
2. The C Programming Language, Brian W. Kernighan, Dennis M. Ritchie, 2e, Pearson

**REFERENCES:**

1. Computer Fundamentals and Programming, Sumithabha Das, McGrawHill
2. Programming in C, Ashok N. Kamthane, Amit Kamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

**COURSE OUTCOMES:**

Upon the completion of the course the student will learn

- To write algorithms and to draw flowcharts for solving problems
- To convert flowcharts/algorithms to C Programs, compile and debug programs
- To use different operators, data types and write programs that use two-way/ multi-way selection
- To select the best loop construct for a given problem
- To design and implement programs to analyze the different pointer applications
- To decompose a problem into functions and to develop modular reusable code
- To apply File I/O operations.



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		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>
<b>ENGINEERING DRAWING</b>					

**Course Objective:**

Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

**Unit I**

**Objective:** To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

**Polygons:** Constructing regular polygons by general methods, inscribing and describing polygons on circles.

**Curves:** Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.

**Scales:** Plain scales, diagonal scales and vernier scales

**Unit II**

**Objective:** To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.

**Orthographic Projections:** Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.

Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

**Unit III**

**Objective:** The objective is to make the students draw the projections of the plane inclined to both the planes.

Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

**Unit IV**

**Objective:** The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

**Unit V**

**Objective:** The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Computer Aided Design, Drawing practice using Auto CAD, Creating 2D&3D drawings of objects using Auto CAD

**Note:** In the End Examination there will be no question from CAD.



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**TEXT BOOKS:**

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

**REFERENCE BOOKS:**

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

**Course Outcome:** The student will learn how to visualize 2D & 3D objects.



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<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>ENGLISH COMMUNICATION SKILLS LABORATORY</b>					

**TOPICS**

**UNIT I:**

Vowels, Consonants, Pronunciation, Phonetic Transcription, Common Errors in Pronunciation,

**UNIT II:**

Word stress-di-syllabic words, poly-syllabic words, weak and strong forms, contrastive stress (Homographs)

**UNIT III:**

Stress in compound words, rhythm, intonation, accent neutralisation.

**UNIT IV:**

Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions in speaking.

**UNIT V:**

Newspapers reading; Understanding and identifying key terms and structures useful for writing reports.

**Prescribed text book: “Infotech English”, Maruthi Publications.**

**References:**

1. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
2. English Pronunciation in use- Mark Hancock, Cambridge University Press.
3. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
4. English Pronunciation in use- Mark Hewings, Cambridge University Press.
5. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
6. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.



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I Year - I Semester		L	T	P	C
		0	0	3	1.5
<b>APPLIED CHEMISTRY LAB</b>					

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions, volumetric titrations, quantitative analysis

1. Determination of HCl using standard  $\text{Na}_2\text{CO}_3$  solution.
2. Determination of alkalinity of a sample containing  $\text{Na}_2\text{CO}_3$  and NaOH.
3. Determination of  $\text{Mn}^{+2}$  using standard oxalic acid solution.
4. Determination of ferrous iron using standard  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.
5. Determination of  $\text{Cu}^{+2}$  using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of  $\text{Fe}^{+3}$  by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of iso-electric point of amino acids using pH-metry method/conductometric method.
10. Determination of the concentration of strong acid vs strong base (by conductometric method).
11. Determination of strong acid vs strong base (by potentiometric method).
12. Determination of  $\text{Mg}^{+2}$  present in an antacid.
13. Determination of  $\text{CaCO}_3$  present in an egg shell.
14. Estimation of Vitamin C.
15. Determination of phosphoric content in soft drinks.
16. Adsorption of acetic acid by charcoal.
17. Preparation of nylon-6, 6 and Bakelite (demonstration only).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.

**Outcomes:** The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

**Reference Books**

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.





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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>PROGRAMMING FOR PROBLEM SOLVING USING C LAB</b>					

**Course Objectives:**

- 1) Apply the principles of C language in problemsolving.
- 2) To design flowcharts, algorithms and knowing how to debug programs.
- 3) To design & develop of C programs using arrays, strings pointers & functions.
- 4) To review the file operations, preprocessor commands.

**Exercise 1:**

1. Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
3. Write a C program to display multiple variables.

**Exercise 2:**

1. Write a C program to calculate the distance between the two points.
2. Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

**Exercise 3:**

1. Write a C program to convert a string to a long integer.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
3. Write a C program to calculate the factorial of a given number.

**Exercise 4:**

1. Write a program in C to display the n terms of even natural number and their sum.
2. Write a program in C to display the n terms of harmonic series and their sum.  $1 + 1/2 + 1/3 + 1/4 + 1/5 \dots 1/n$  terms.
3. Write a C program to check whether a given number is an Armstrong number or not.

**Exercise 5:**

1. Write a program in C to print all unique elements in an array.
2. Write a program in C to separate odd and even integers in separate arrays.
3. Write a program in C to sort elements of array in ascending order.

**Exercise 6:**

1. Write a program in C for multiplication of two square matrices.
2. Write a program in C to find transpose of a given matrix.

**Exercise 7:**

1. Write a program in C to search an element in a row wise and column wise sorted matrix.
2. Write a program in C to print individual characters of string in reverse order.



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**Exercise 8:**

1. Write a program in C to compare two strings without using string library functions.
2. Write a program in C to copy one string to another string.

**Exercise 9:**

1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in the program.

**Exercise 10:**

1. Write a program in C to demonstrate the use of & (address of) and \*(value at address) operator.
2. Write a program in C to add two numbers using pointers.

**Exercise 11:**

1. Write a program in C to add numbers using call by reference.
2. Write a program in C to find the largest element using Dynamic Memory Allocation.

**Exercise 12:**

1. Write a program in C to swap elements using call by reference.
2. Write a program in C to count the number of vowels and consonants in a string using a pointer.

**Exercise 13:**

1. Write a program in C to show how a function returning pointer.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc() function.

**Exercise 14:**

1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc() function. Understand the difference between the above two programs
2. Write a program in C to convert decimal number to binary number using the function.

**Exercise 15:**

1. Write a program in C to check whether a number is a prime number or not using the function.
2. Write a program in C to get the largest element of an array using the function.

**Exercise 16:**

1. Write a program in C to append multiple lines at the end of a text file.
2. Write a program in C to copy a file in another name.
3. Write a program in C to remove a file from the disk.

**Course Outcomes:****By the end of the Lab, the student**

- 1) Gains Knowledge on various concepts of a C language.
- 2) Able to draw flowcharts and write algorithms.
- 3) Able design and development of C problem solving skills.
- 4) Able to design and develop modular programming skills.
- 5) Able to trace and debug a program



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<b>I Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MATHEMATICS-II</b>					

**Course Objectives:**

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

**Course Outcomes:** At the end of the course, the student will be able to

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
- evaluate the approximate roots of polynomial and transcendental equations by different algorithms (L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
- apply numerical integral techniques to different Engineering problems (L3)
- apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations (L3)

**UNIT – I: Solving systems of linear equations, Eigen values and Eigen vectors: (10hrs)**

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous linear equations – Gauss Elimination method – Eigen values and Eigen vectors and properties (article-2.14 in text book-1).

**Unit – II: Cayley–Hamilton theorem and Quadratic forms: (10hrs)**

Cayley-Hamilton theorem (without proof) – Applications – Finding the inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation. Singular values of a matrix, singular value decomposition (text book-3).

**UNIT – III: Iterative methods: (8 hrs)**

Introduction– Bisection method–Secant method – Method of false position– Iteration method – Newton-Raphson method (One variable and simultaneous Equations) – Jacobi and Gauss-Seidel methods for solving system of equations numerically.

**UNIT – IV: Interpolation: (10 hrs)**

Introduction– Errors in polynomial interpolation – Finite differences– Forward differences– Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula– Newton's divide difference formula.



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**UNIT – V: Numerical differentiation and integration, Solution of ordinary differential equations with initial conditions: (10 hrs)**

Numerical differentiation using interpolating polynomial – Trapezoidal rule– Simpson's  $1/3^{\text{rd}}$  and  $3/8^{\text{th}}$  rule– Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method – Runge-Kutta method (second and fourth order).

**Text Books:**

1. **B. S. Grewal**, Higher Engineering Mathematics, 44<sup>th</sup> Edition, Khanna Publishers.
2. **B. V. Ramana**, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
3. **David Poole**, Linear Algebra- A modern introduction, 4<sup>th</sup> Edition, Cengage.

**Reference Books:**

1. **Steven C. Chapra**, Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.
2. **M. K. Jain, S.R.K. Iyengar and R.K. Jain**, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
3. **Lawrence Turyn**, Advanced Engineering Mathematics, CRC Press.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>APPLIED PHYSICS</b>					

**Unit-I: Wave Optics****12hrs**

**Interference:** Principle of superposition – Interference of light - Interference in thin films (Reflection Geometry) & applications - Colors in thin films- Newton’s Rings- Determination of wavelength and refractive index.

**Diffraction:** Introduction - Fresnel and Fraunhofer diffraction - Fraunhofer diffraction due to single slit, double slit - N-slits (Qualitative) – Diffraction Grating - Dispersive power and resolving power of Grating(Qualitative).

**Polarization:** Introduction-Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol’s Prism -Half wave and Quarter wave plates.

*Unit Outcomes:**The students will be able to*

- **Explain** the need of coherent sources and the conditions for sustained interference(L2)
- **Identify** engineering applications of interference(L3)
- **Analyze** the differences between interference and diffraction with applications(L4)
- **Illustrate** the concept of polarization of light and its applications(L2)
- **Classify** ordinary polarized light and extraordinary polarized light(L2)

*Unit-II: Lasers and Fiberoptics***8hrs**

**Lasers:** Introduction – Characteristics of laser – Spontaneous and Stimulated emissions of radiation – Einstein’s coefficients – Population inversion – Lasing action - Pumping mechanisms – Ruby laser – He-Ne laser - Applications of lasers.

**Fiber optics:** Introduction –Principle of optical fiber- Acceptance Angle - Numerical Aperture - Classification of optical fibers based on refractive index profile and modes – Propagation of electromagnetic wave through optical fibers - Applications.

*Unit Outcomes:**The students will be able to*

- **Understand** the basic concepts of LASER light Sources(L2)
- **Apply** the concepts to learn the types of lasers(L3)
- **Identifies** the Engineering applications of lasers(L2)
- **Explain** the working principle of optical fibers(L2)
- **Classify** optical fibers based on refractive index profile and mode of propagation(L2)
- **Identify** the applications of optical fibers in various fields(L2)



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**Unit III: Quantum Mechanics, Free Electron Theory and Band theory** **10hrs**

**Quantum Mechanics:** Dual nature of matter – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent and dependent wave equations – Particle in a one-dimensional infinite potential well.

**Free Electron Theory:** Classical free electron theory (Qualitative with discussion of merits and demerits) – Quantum free electron theory – Equation for electrical conductivity based on quantum free electron theory- Fermi-Dirac distribution- Density of states (3D) - Fermi energy.

**Band theory of Solids:** Bloch's Theorem (Qualitative) - Kronig - Penney model (Qualitative)- E vs K diagram - v vs K diagram - effective mass of electron – Classification of crystalline solids – concept of hole.

**Unit Outcomes:**

*The students will be able to*

- **Explain** the concept of dual nature of matter(L2)
- **Understand** the significance of wave function(L2)
- **Interpret** the concepts of classical and quantum free electron theories(L2)
- **Explain** the importance of K-P model
- **Classify** the materials based on band theory(L2)
- **Apply** the concept of effective mass of electron(L3)

**Unit-IV: Dielectric and Magnetic Materials** **8hrs**

**Dielectric Materials:** Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility and Dielectric constant - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field- Clausius- Mossotti equation- Piezoelectricity.

**Magnetic Materials:** Introduction - Magnetic dipole moment - Magnetization- Magnetic susceptibility and permeability - Origin of permanent magnetic moment - Classification of magnetic materials: Dia, para, Ferro, antiferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials- Eddy currents- Engineering applications.

**Unit Outcomes:**

*The students will be able to*

- **Explain** the concept of dielectric constant and polarization in dielectric materials(L2)
- **Summarize** various types of polarization of dielectrics(L2)
- **Interpret** Lorentz field and Clausius- Mossotti relation in dielectrics(L2)
- **Classify** the magnetic materials based on susceptibility and their temperature dependence (L2)
- **Explain** the applications of dielectric and magnetic materials(L2)
- **Apply** the concept of magnetism to magnetic data storage devices(L3)



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***Unit – V: Semiconductors and Superconductors***

***10hrs***

**Semiconductors:** Introduction- Intrinsic semiconductors – Density of charge carriers – Electrical conductivity – Fermi level – extrinsic semiconductors – density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein’s equation- Hall effect – Hall coefficient – Applications of Hall effect.

**Superconductors:** Introduction – Properties of superconductors – Meissner effect – Type I and Type II superconductors – BCS theory (Qualitative) – Josephson effects (AC and DC) – SQUIDS – High  $T_c$  superconductors – Applications of superconductors.

***Unit Outcomes:***

***The students will be able to***

- **Classify** the energy bands of semiconductors(L2)
- **Interpret** the direct and indirect band gap semiconductors(L2)
- **Identify** the type of semiconductor using Hall effect(L2)
- **Identify** applications of semiconductors in electronic devices(L2)
- **Classify** superconductors based on Meissner’s effect(L2)
- **Explain** Meissner’s effect, BCS theory & Josephson effect in superconductors(L2)

***Text books:***

1. M. N. Avadhanulu, P.G.Kshirsagar & TVS Arun Murthy” A Text book of Engineering Physics”- S.Chand Publications, 11<sup>th</sup> Edition 2019.
2. Engineering Physics” by D.K.Bhattacharya and Poonam Tandon, Oxford press(2015).
3. Applied Physics by P.K.Palanisamy SciTech publications.

***Reference Books:***

1. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley & Sons
2. Engineering Physics by M.R.Srinivasan, New Age international publishers(2009).
3. Shatendra Sharma, Jyotsna Sharma, “ Engineering Physics”, Pearson Education, 2018
4. Engineering Physics - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press
5. Semiconductor physics and devices- Basic principle – Donald A, Neamen, Mc Graw Hill
6. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**  
**KAKINADA – 533 003, Andhra Pradesh, India**  
**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

<b>I Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>2</b>	<b>3</b>
<b>OBJECT ORIENTED PROGRAMMING THROUGH JAVA</b>					

**Course Objectives:**

This subject will help to improve

- the analytical skills of object oriented programming
- Overall development of problem solving and critical analysis.
- Formal introduction to Java programming language

**Course Outcomes:**

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

- Show competence in the use of the Java programming language in the development of small to medium- sized application programs that demonstrate professionally acceptable coding and performance standard
- Illustrate the basic principles of the object-oriented programming
- Demonstrate an introductory understanding of graphical user interfaces, multithreaded programming, and event-driven programming.

**Unit I**

**Introduction to Java :** Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, Math class, Arrays in java.

**Objects and Classes :** Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, StringBuffer, File, this reference.

**Unit II**

**Inheritance and Polymorphism :** Inheritance in java, Super and sub class, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, UTIL package.

**Unit III**

**Event and GUI programming :** Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing, Creating a swing applet, swing controls and components.

**Unit IV**

**I/O programming:** Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files. Event driven model, handling events

**Unit V**

**Multithreading in java:** Thread life cycle and methods, Runnable interface, Thread synchronization, Exception handling with try-catch-finally, Collections in java, Introduction to JavaBeans and Network Programming.





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**Text Books:**

- 1) Introduction to Java Programming (Comprehensive Version), Daniel Liang, Seventh Edition, Pearson.
- 2) Programming in Java, Sachin Malhotra & Saurabh Chaudhary, Oxford University Press.

**Reference Books:**

- 1) Murach's Beginning Java 2, Doug Lowe, Joel Murach and Andrea Steelman, SPD.
- 2) Core Java Volume-I Fundamentals, Eight Edition, Horstmann & Cornell, Pearson Education.
- 3) The Complete Reference, Java 2 (Fourth Edition), Herbert Schild, TMH.  
Java Programming, D. S. Malik, Cengage Learning.



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<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>NETWORK ANALYSIS</b>				

### **UNIT – I**

**Introduction to Electrical Circuits :** Network elements classification, Electric charge and current, Electric energy and potential, Resistance parameter – series and parallel combination, Inductance parameter – series and parallel combination, Capacitance parameter – series and parallel combination. Energy sources: Ideal, Non-ideal, Independent and dependent sources, Source transformation, Kirchoff's laws, Mesh analysis and Nodal analysis problem solving with resistances only including dependent sources also. (Text Books: 1,2,3, Reference Books: 3)

**Fundamentals and Network Topology:** Definitions of terms associated with periodic functions: Time period, Angular velocity and frequency, RMS value, Average value, Form factor and peak factor- problem solving, Phase angle, Phasor representation, Addition and subtraction of phasors, mathematical representation of sinusoidal quantities, explanation with relevant theory, problem solving. Principal of Duality with examples.

**Network Topology:** Definitions of branch, node, tree, planar, non-planar graph, incidence matrix, basic tie set schedule, basic cut set schedule. (Text Books: 2,3, Reference Books: 3)

### **UNIT – II**

**Transients:** First order differential equations, Definition of time constants, R-L circuit, R-C circuit with DC excitation, Evaluating initial conditions procedure, second order differential equations, homogeneous, non-homogenous, problem solving using R-L-C elements with DC excitation and AC excitation, Response as related to s-plane rotation of roots. Solutions using Laplace transform method. (Text Books: 1,2,3, Reference Books: 1,3)

### **UNIT – III**

**Steady State Analysis of A.C Circuits:** Impedance concept, phase angle, series R-L, R-C, R-L-C circuits problem solving. Complex impedance and phasor notation for R-L, R-C, R-L-C problem solving using mesh and nodal analysis, Star-Delta conversion, problem solving. (Text Books: 1,2, Reference Books: 3)

**Coupled Circuits :** Coupled Circuits: Self inductance, Mutual inductance, Coefficient of coupling, analysis of coupled circuits, Natural current, Dot rule of coupled circuits, Conductively coupled equivalent circuits- problem solving.

### **UNIT – IV**

**Resonance:** Introduction, Definition of Q, Series resonance, Bandwidth of series resonance, Parallel resonance, Condition for maximum impedance, current in anti resonance, Bandwidth of parallel resonance, general case-resistance present in both branches, anti resonance at all frequencies. (Text Books: 2,3, Reference Books: 3)

**Network Theorems:** Thevenin's, Norton's, Milliman's, Reciprocity, Compensation, Substitution, Superposition, Max Power Transfer, Tellegens- problem solving using dependent sources also. (Text Books: 1,2,3, Reference Books: 2)



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**UNIT – V**

**Two-port Networks:** Relationship of two port networks, Z-parameters, Y-parameters, Transmission line parameters, h-parameters, Inverse h-parameters, Inverse Transmission line parameters, Relationship between parameter sets, Parallel connection of two port networks, Cascading of two port networks, series connection of two port networks, problem solving including dependent sources also. (Text Books: 1,2, Reference Books: 1,3)

**TEXT BOOKS:**

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, 3rd Edition, 2000.
2. Network Analysis by K. Satya Prasad and S Sivanagaraju, Cengage Learning
3. Electric Circuit Analysis by Hayt and Kimmarle, TMH

**REFERENCES:**

1. Network lines and Fields by John. D. Ryder 2<sup>nd</sup> edition, Asia Publishing House.
2. Basic Circuit Analysis by DR Cunningham, Jaico Publishers.
3. Network Analysis and Filter Design by Chadha, Umesh Publications.

**COURSE OBJECTIVES:**

- To understand the basic concepts on RLC circuits.
- To know the behavior of the steady states and transients states in RLC circuits.
- To know the basic Laplace transforms techniques in periodic waveforms.
- To understand the two port network parameters.
- To understand the properties of LC networks and filters.

**COURSE OUTCOME:**

- gain the knowledge on basic network elements.
- will analyze the RLC circuits behavior in detail.
- analyze the performance of periodic waveforms.
- gain the knowledge in characteristics of two port network parameters (Z, Y, ABCD, h & g).
- analyze the filter design concepts in real world applications.



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<b>I Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>BASIC ELECTRICAL ENGINEERING</b>					

**Preamble:**

This course covers various topics related to principle of operation and performance of various electrical machines.

**Course Educational Objectives:**

- To understand the principle of operation, constructional details and operational characteristics of DC generators.
- To understand the principle of operation, characteristics of DC motor. Methods of starting and speed control methods of DC motors.
- To learn the constructional details, principle of operation and performance of transformers.
- To study the principle of operation, construction and details of synchronous machines.
- To learn the principle of operation, constructional details, performance, torque – slip characteristics and starting methods of 3-phase induction motors.

**Unit I****DC Machines**

Principle of operation of DC generator – emf equation – types of DC machines – torque equation of DC motor – applications – three point starter - losses and efficiency - swinburne's test - speed control methods – OCC of DC generator- Brake test on DC Shunt motor- numerical problems

**Unit II****Transformers**

Principle of operation of single phase transformer constructional features – EMF equation – Losses and efficiency of transformer- regulation of transformer – OC & SC tests predetermination of efficiency and regulations – Sumpner's test-Numerical Problems.

**Unit III****Synchronous Generators**

Principle of operation and construction of alternators – types of alternators Regulation of alternator by synchronous impedance method-EMF equation of three phase alternator

**Synchronous Motors**

Construction of three phase synchronous motor - operating principle – equivalent circuit of synchronous motor.

**Unit IV**

**Induction Machine:** Principle of operation and construction of three-phase induction motors – slip ring and squirrel cage motors – slip-torque characteristics – efficiency calculation – starting methods-Brake test on 3-Phase Induction Motor.

**Unit V**

**Special Machines:** Principle of operation and construction - single phase induction motor - shaded pole motors – capacitor motors and AC servomotor.



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***Course Outcomes:***

- Able to explain the operation of DC generator and analyze the characteristics of DC generator.
- Able to explain the principle of operation of DC motor and analyze their characteristics. Acquire the skills to analyze the starting and speed control methods of DC motors.
- Ability to analyze the performance and speed – torque characteristics of a 3-phase induction motor and understand starting methods of 3-phase induction motor.
- Able to explain the operation of Synchronous Machines
- Capability to understand the operation of various special machines.

***TEXT BOOKS:***

1. Principles of Electrical Machines by V.K. Mehta & Rohit Mehta, S. Chand publications
2. Theory & performance of Electrical Machines by J.B. Gupta, S.K. Kataria & Sons

***REFERENCE BOOKS:***

1. Basic Electrical Engineering by M.S. Naidu and S. Kamakshiah, TMH Publications
2. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications, 2<sup>nd</sup> edition
3. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications, 2<sup>nd</sup> edition



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I Year - II Semester	L	T	P	C
	<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>ELECTRONIC WORKSHOP LAB</b>				

- I. Identification of components
- II. Laboratory equipment
- III. Soldering practice
- IV. PCB Layout
- V. Testing of Components
- VI. CRO

**I. Identification of components:**

- Resistors:- Types of Resistors, Value of Resistance using color code, DRBS.
- Capacitors:- Types of capacitors, value of capacitance using color code, DCBS.
- Inductors:- Types of Inductors, DLB
- Rheostats:- Types of Rheostats, Types of potentiometers, Relays.
- Switches:- Types of Switches.
- Cables: Types of Cables.
- Types of Instruments used.

**Identification of active elements.**

(Two Terminal, Three Terminal Devices)

- (SC diode, Zener diode, D.AC)
- Three Terminal Devices: BJT, UJT, SCR, FET, MOSFET, TRIAC.
- Digital and Analog ICs. (TO and Flat packages) IC regulator types.
- Testing of above components using Multimeter.

**II. Laboratory Equipment:**

A) Meters:-

- Types of Voltmeters, Types of Ammeters both Analog and Digital.
- Types of Multi meters (Analog & Digital)
- AVO Meters.
- FET input Voltmeter.

B) Laboratory Function Generators and Audio Oscillators.

C) Power Supplies.

D) RF generators.

E) Different Types of Transformers. (Power, AF, RF, etc.)



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**III. *Solderingpractice***

Tools kit including soldering iron

Tools Kit:

- Insulatednoseplayer
- Insulatedcuttingplayer
- Screw driverkit
- Electricaltester
- Soldering iron,Lead,Flex

**IV. *PCB layoutandDesign.***

Materials required, centimeter graph sheets, marker.

**V. *Testing of Components.***

Active and Passive Components

**VI. *CRO***

Acquaintance with CRO

Measurements on CRO



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<b>I Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>BASIC ELECTRICAL ENGINEERING LAB</b>					

***Learning Objectives:***

- To plot the magnetizing characteristics of DC shunt generator and understand the mechanism of self-excitation.
- To control the speed of DC motors.
- To determine and predetermine the performance of DC machines.
- To predetermine the efficiency and regulation of transformers and assess their performance.
- To analyse performance of three phase induction motor.
- To understand the significance of regulation of an alternator using synchronous impedance method.

***Any ten of the following experiments are to be conducted***

1. Magnetization characteristics of D.C. Shunt generator.
2. Speed control of D.C. shunt motor.
3. Brake test on DC shunt motor.
4. Swinburne's test on DC machine
5. Load test on DC shunt generator
6. Load test on DC series generator.
7. Separation of losses in DC shunt motor
8. OC & SC tests on single-phase transformer
9. Sumpner's test on single phase transformer
10. Brake test on 3-phase Induction motor.
11. Regulation of alternator by synchronous impedance method.

***Learning Outcomes:***

The student should be able to:

- Determine and predetermine the performance of DC machines and transformers.
- Control the DC shunt machines.
- Compute the performance of 1-phase transformer.
- Perform tests on 3-phase induction motor and alternator to determine their performance characteristics.





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 (Any 10 of the following listed experiments)

<b>I Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>APPLIED PHYSICS LABORATORY</b>					

**List of Applied Physics Experiments**

1. Determination of thickness of thin object by wedgemethod.
2. Determination of radius of curvature of a given plano convex lens by Newton'srings.
3. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
4. Determination of dispersive power of theprism.
5. Determination of dielectric constant using charging and dischargingmethod.
6. Study the variation of B versus H by magnetizing the magnetic material (B-Hcurve).
7. Determination of numerical aperture and acceptance angle of an opticalfiber.
8. Determination of wavelength of Laser light using diffractiongrating.
9. Estimation of Planck's constant using photoelectriceffect.
10. Determination of the resistivity of semiconductor by four probemethod.
11. To determine the energy gap of a semiconductor using p-n junctiondiode.
12. Magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method
13. Determination of Hall voltage and Hall coefficient of a given semiconductor usingHall Effect.
14. Measurement of resistance of a semiconductor with varyingtemperature.
15. Resistivity of a Superconductor using four probe method & Meissnereffect.

**References:**

S. Balasubramanian, M.N. Srinivasan "A Text Book of Practical Physics"- S Chand Publishers,2017.



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<b>I Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>ENVIRONMENTAL SCIENCE</b>					

**Course Objective:**

Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

**Unit I**

**Objective:** To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

**Polygons:** Constructing regular polygons by general methods, inscribing and describing polygons on circles.

**Curves:** Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.

**Scales:** Plain scales, diagonal scales and vernier scales

**Unit II**

**Objective:** To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.

**Orthographic Projections:** Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.

Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

**Unit III**

**Objective:** The objective is to make the students draw the projections of the plane inclined to both the planes. Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

**Unit IV**

**Objective:** The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

**Unit V**

**Objective:** The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views. Computer Aided Design, Drawing practice using Auto CAD, Creating 2D&3D drawings of objects using Auto CAD

**Note:** In the End Examination there will be no question from CAD.



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**TEXT BOOKS:**

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

**REFERENCE BOOKS:**

1. Engineering Drawing by K.L.Narayana& P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

**Course Outcome:** The student will learn how to visualize 2D & 3D objects.



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<b>II Year-I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>ELECTRONIC DEVICES AND CIRCUITS</b>					

### Course Objectives:

The main objectives of this course are

- To learn and understand the basic concepts of semi conductor physics.
- Study the physical phenomena such as conduction, transport mechanism and electrical characteristics of different diodes.
- To learn and understand the application of diodes as rectifiers with their operation and characteristics with and without filters are discussed.
- Acquire knowledge about the principle of working and operation of Bipolar Junction Transistor and Field Effect Transistor and their characteristics.
- To learn and understand the purpose of transistor biasing and its significance.
- Small signal equivalent circuit analysis of BJT and FET transistor amplifiers and compare different configurations.

**UNIT-I: Review of Semiconductor Physics:** Hall effect, continuity equation, law of junction, Fermi-Dirac function, Fermi level in intrinsic and extrinsic Semiconductors

**Junction Diode Characteristics :** energy band diagram of PN junction Diode, Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in PN junction Diode, diode equation, V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance.

#### UNIT-II:

**Special Semiconductor Devices:** Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Varactor Diode, Photodiode, Tunnel Diode, UJT, PN-PN Diode, SCR. Construction, operation and V-I characteristics.

**Rectifiers and Filters:** Basic Rectifier setup, half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, rectifier circuits-operation, input and output waveforms, Filters, Inductor filter (Series inductor), Capacitor filter (Shunt inductor),  $\pi$ - Filter, comparison of various filter circuits in terms of ripple factors.

#### UNIT-III: Transistor Characteristics:

**BJT:** Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through/reach through, Photo transistor, typical transistor junction voltage values.

**FET:** FET types, construction, operation, characteristics  $\mu$ ,  $g_m$ ,  $r_d$  parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.



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**UNIT- IV: Transistor Biasing and Thermal Stabilization :** Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias,

self bias, Stabilization against variations in  $V_{BE}$ ,  $I_c$ , and  $\beta$ , Stability factors,  $(S, S', S'')$ , Bias compensation, Thermal runaway, Thermal stability.

FET Biasing- methods and stabilization.

**UNIT-V: Small Signal Low Frequency Transistor Amplifier Models:**

**BJT:** Two port network, Transistor hybrid model, determination of h-parameters, conversion of h-parameters, generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers.

**FET:** Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers, comparison of FET amplifiers.

**Text Books:**

1. Electronic Devices and Circuits-J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition, 2007
2. Electronic Devices and Circuits-K. Lal Kishore, BS Publications, Fourth Edition, 2016.
3. Electronics devices & circuit theory-Robert L. Boylestad and Loui Nashelsky, Pearson / Prenticehall, tenth edition, 2009

**References:**

1. Integrated Electronics-J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition, 2009
2. 2. Electronic Devices and Integrated Circuits – B.P. Singh, Rekha, Pearson publications
3. 3. Electronic Devices and Circuits-Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, 4<sup>th</sup> Edition, 2008.

**Course Outcomes:**

At the end of this course the student will be able to

- Apply the basic concepts of semiconductor physics.
- Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
- Know the construction, working principle of rectifiers with and without filters with the relevant expressions and necessary comparisons.
- Understand the construction, principle of operation of transistors, BJT and FET with their  $V-I$  characteristics in different configurations.
- Know the need of transistor biasing, various biasing techniques for BJT and FET and stabilization concepts with necessary expressions.
- Perform the analysis of small signal low frequency transistor amplifier circuits using BJT and FET in different configurations



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<b>II Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>SWITCHING THEORY AND LOGIC DESIGN</b>					

**Course Objectives:**

- To solve a typical number base conversion and analyze new error coding techniques.
- Theorems and functions of Boolean algebra and behavior of logic gates.
- To optimize logic gates for digital circuits using various techniques.
- Boolean function simplification using Karnaugh maps and Quine-McCluskey methods.
- To understand concepts of combinational circuits.
- To develop advanced sequential circuits.

**UNIT – I****REVIEW OF NUMBER SYSTEMS & CODES:**

Representation of numbers of different radix, conversion from one radix to another radix,  $r-1$ 's complements and  $r$ 's complements of signed members. Gray code, 4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc. Error detection & correction codes: parity checking, even parity, odd parity, Hamming code.

**BOOLEAN THEOREMS AND LOGIC OPERATIONS:**

Boolean theorems, principle of complementation & duality, De-morgan theorems. Logic operations ; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX- NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations, Realization of three level logic circuits. Study the pin diagram and obtain truth table for the following relevant ICs 7400,7402,7404,7408,7432,7486.

**UNIT – II****MINIMIZATION TECHNIQUES:**

Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables) and tabular method (Quine-mccluskey method) with only four variables and single function.

**COMBINATIONAL LOGIC CIRCUITS DESIGN:**

Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-ahead adder circuit, Design code converters using Karnaugh method and draw the complete circuit diagrams.

**UNIT – III****COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI & LSI :**

Design of encoder, decoder, multiplexer and de-multiplexers, Implementation of higher order circuits using lower order circuits . Realization of Boolean functions using decoders and multiplexers. Design of Priority encoder, 4-bit digital comparator and seven segment decoder. . Study the relevant ICs pin diagrams and their functions 7442,7447,7485,74154.



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**INTRODUCTION OF PLD's :**

PLDs:PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

**UNIT – IV**

**SEQUENTIAL CIRCUITS I:**

Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another flip-flop. Design of 5 ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift, register.

Study the following relevant ICs and their relevant functions 7474,7475,7476,7490,7493,74121.

**UNIT – V**

**SEQUENTIAL CIRCUITS II :**

Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa. Realization of sequence generator, Design of Clocked Sequential Circuit to detect the given sequence (with overlapping or without overlapping).

**TEXT BOOKS:**

1. Switching and finite automata theory Zvi.KOHAVI,Niraj.K.Jha 3<sup>rd</sup> Edition,Cambridge University Press,2009
2. Digital Design by M.Morris Mano,Michael D Ciletti,4<sup>th</sup> edition PHI publication,2008
3. Switching theory and logic design by Hill and Peterson,Mc-Graw Hill TMH edition, 2012.

**REFERENCES:**

1. Fundamentals of Logic Design by Charles H. Roth Jr,Jaico Publishers,2006
2. Digital electronics by R S Sedha.S.Chand & company limited,2010
3. Switching Theory and Logic Design by A. Anand Kumar,PHI Learning Pvt Ltd,2016.
4. Digital logic applications and design by John M Yarbough, Cengage learning,2006.
5. TTL 74-Series data book.

**Course Outcomes:**

- Classify different number systems and apply to generate various codes.
- Use the concept of Boolean algebra in minimization of switching functions
- Design different types of combinational logic circuits.
- Apply knowledge of flip-flops in designing of Registers and counters
- The operation and design methodology for synchronous sequential circuits and algorithmic state machines.
- Produce innovative designs by modifying the traditional design techniques.



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<b>II Year-I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>SIGNALS AND SYSTEMS</b>					

**Course Objectives:**

The main objectives of this course are given below:

- To study about signals and systems.
- To analyze the spectral characteristics of signal using Fourier series and Fourier transforms.
- To understand the characteristics of systems.
- To introduce the concept of sampling process
- To know various transform techniques to analyze the signals and systems.

**UNIT- I: INTRODUCTION:** Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function, signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions. Related problems.

**UNIT-II: FOURIER SERIES AND FOURIER TRANSFORM:**

Fourier series representation of continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Relation between Trigonometric and Exponential Fourier series, Complex Fourier spectrum. Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Introduction to Hilbert Transform, Related problems.

**UNIT-III: ANALYSIS OF LINEAR SYSTEMS:** Introduction, Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system, Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Transfer function of a LTI system, Related problems. Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Poly-Wiener criterion for physical realization, relationship between bandwidth and rise time.

**UNIT-IV:**

**CORRELATION:** Auto-correlation and cross-correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between Convolution and correlation, Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.

**SAMPLING THEOREM:** Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling –Aliasing, Introduction to Band Pass sampling, Related problems.





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**UNIT–V:**

**LAPLACE TRANSFORMS:** Introduction, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Inverse Laplace transform, Relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.

**Z–TRANSFORMS:** Concept of Z-Transform of a discrete sequence. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms. Distinction between Laplace, Fourier and Z transforms.

**TEXTBOOKS:**

1. Signals, Systems & Communications-B.P.Lathi, BS Publications, 2003.
2. Signals and Systems-A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn, 1997
3. Signals & Systems-Simon Haykin and Van Veen, Wiley, 2nd Edition, 2007

**REFERENCEBOOKS:**

1. Principles of Linear Systems and Signals–B.P.Lathi, Oxford University Press, 2015
2. Signals and Systems–TK Rawat, Oxford University press, 2011

**Course Outcomes:** At the end of this course the student will be able to:

- Differentiate the various classifications of signals and systems
- Analyze the frequency domain representation of signals using Fourier concepts
- Classify the systems based on their properties and determine the response of LTI Systems.
- Know the sampling process and various types of sampling techniques.
- Apply Laplace and z-transforms to analyze signals and Systems (continuous & discrete).



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		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>RANDOM VARIABLES AND STOCHASTIC PROCESSES</b>					

**Course Objectives:**

- To give students an introduction to elementary probability theory, in preparation to learn the concepts of statistical analysis, random variables and stochastic processes.
- To mathematically model the random phenomena with the help of probability theory Concepts.
- To introduce the important concepts of random variables and stochastic processes.
- To analyze the LTI systems with stationary random process as input.

**UNIT I**

**THE RANDOM VARIABLE:** Introduction, Review of Probability Theory, Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variables, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional Distribution, Conditional Density, Properties.

**UNIT II**

**OPERATION ON A RANDOM VARIABLE-EXPECTATIONS:** Introduction,

Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Non-monotonic Transformations of Continuous Random Variable.

**UNIT III**

**MULTIPLE RANDOM VARIABLES:** Vector Random Variables, Joint Distribution Function, Properties of Joint Distribution, Marginal Distribution Functions, Conditional Distribution and Density, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem: Unequal Distribution, Equal Distributions.

**OPERATIONS ON MULTIPLE RANDOM VARIABLES:** Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variables case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables.

**UNIT IV**

**RANDOM PROCESSES –TEMPORAL CHARACTERISTICS:** The Random Process Concept, Classification of Processes, Deterministic and Non deterministic Processes, Distribution and Density Functions, Concept of Stationarity and Statistical Independence. First-Order

Stationary Processes, Second-order and Wide-Sense Stationarity, Nth-order and Strict-Sense Stationarity, Time Averages and Ergodicity, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process.



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**UNIT V**

**RANDOM PROCESSES -SPECTRAL CHARACTERISTICS:** The Power Density Spectrum: Properties, Relationship between Power Density Spectrum and Auto correlation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Density Spectrum and Cross-Correlation Function.

**LINEAR SYSTEMS WITH RANDOM INPUTS:** Random Signal Response of Linear Systems: System Response – Convolution, Mean and Mean-squared Value of System Response, Auto correlation Function of Response, Cross-Correlation Functions of Input and Output, Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectra of Input and Output, Bandpass, Band-Limited and Narrow band Processes, Properties.

**TEXTBOOKS:**

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH, 4<sup>th</sup> Edition, 2001.
2. Probability, Random Variables and Stochastic Processes, Athanasios Papoulis and S. Unnikrishna, PHI, 4<sup>th</sup> Edition, 2002.
3. Probability and Random Processes with Applications to Signal Processing, Henry Stark and John W. Woods, Pearson Education, 3<sup>rd</sup> Edition, 2001.

**REFERENCE BOOKS:**

1. Schaum's Outline of Probability, Random Variables, and Random Processes, 1997.
2. An Introduction to Random Signals and Communication Theory, B.P. Lathi, International Textbook, 1968.
3. Probability Theory and Random Processes, P. Ramesh Babu, McGraw Hill, 2015.

**Course Outcomes:**

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

- Mathematically model the random phenomena and solve simple probabilistic problems.
- Identify different types of random variables and compute statistical averages of the random variables.
- Characterize the random processes in the time and frequency domains.
- Analyze the LTI systems with random inputs.



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		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>MATHEMATICS-III</b>					

**Course Objectives:**

- To familiarize the techniques in partial differential equations
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

**Course Outcomes:** At the end of the course, the student will be able to

- Interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- Estimate the work done against a field, circulation and flux using vector calculus (L5)
- Apply the Laplace transform for solving differential equations (L3)
- Find or compute the Fourier series of periodic signals (L3)
- Know and be able to apply integral expressions for the forwards and inverse Fourier transform to arrange of non-periodic wave forms (L3)
- Identify solution methods for partial differential equations that model physical processes (L3)

**Unit–I: Vector calculus:****(10hrs)**

Vector Differentiation: Gradient – Directional derivative – Divergence – Curl – Scalar Potential.  
 Vector Integration: Line integral – Work done – Area – Surface and volume integrals – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof).

**Unit–II: Laplace Transforms:****(10hrs)**

Laplace transforms of standard functions – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (with out proof).

Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

**Unit–III: Fourier series and Fourier Transforms:****(10hrs)**

Fourier Series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.



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**Unit–IV: PDE of first order:**

**(8hrs)**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lag range) equation and nonlinear (standard types) equations.

**UNIT V: Second order PDE and Applications:**

**(10hrs)**

Second order PDE: Solutions of linear partial differential equations with constant coefficient – RHS term of the type  $e^{ax+by}$ ,  $\sin(ax + by)$ ,  $\cos(ax + by)$ ,  $x^m y^n$ .

Applications of PDE: Method of separation of Variables – Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

**Text Books:**

1. B.S.Grewal, **Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publishers.**
2. **B.V.Ramana**, Higher Engineering Mathematics, 2007 Edition, Tata Mc.Graw Hill Education.

**Reference Books:**

1. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10<sup>th</sup> Edition, Wiley-India.
2. **Dean. G. Duffy**, Advanced Engineering Mathematics with MATLAB, 3<sup>rd</sup> Edition, CRC Press.
3. **Peter O'Neil**, Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, SCBhunja**, Engineering Mathematics, Oxford University Press.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>OOPS THROUGH JAVA LAB</b>					

**Course Outcomes:** At the end of the course, students will be able to

		Knowledge Level (K)#
<b>CO1</b>	Identify classes, objects, members of a class and the relationship among them needed for a specific problem	K3
<b>CO2</b>	Implement programs to distinguish different forms of inheritance	K4
<b>CO3</b>	Create packages and to reuse them	K3
<b>CO4</b>	Develop programs using Exception Handling mechanism	K3
<b>CO5</b>	Develop multithreaded application using synchronization concept.	K6
<b>CO6</b>	Design GUI based applications using Swings and AWT.	K6

**List of programs to be executed:**

1. The Fibonacci sequence is defined by the following rule. The first 2 values in the sequence are 1, 1. Every subsequent value is the sum of the 2 values preceding it. Write a Java Program that uses both recursive and non-recursive functions to print the nth value of the Fibonacci sequence.
2. Write a Java Program that prompts the user for an integer and then prints out all the prime numbers up to that integer.
3. Write a Java program to implement call by value and call by reference mechanisms.
4. Write a Java Program that checks whether a given string is a palindrome or not.
5. Write a Java Program to check the compatibility for multiplication, if compatible multiply two matrices and find its transpose.
6. Write a Java program to implement constructor overloading and method overloading.
7. Write a Java Program that illustrates how runtime polymorphism is achieved.
8. Write a Java Program that illustrates the use of super keyword.
9. Write a Java Program to create and demonstrate packages.
10. Write a Java Program, using String Tokenizer class, which reads a line of integers and then displays each integer and the sum of all integers.
11. Write a Java Program that reads a file name from the user then displays information about whether the file exists, whether the file is readable/ writable, the type of file and the length of the file in bytes and displays the content of the file using FileInputStream class.
12. Write a Java Program that displays the number of characters, lines and words in a text/textfile.
13. Write a Java Program to implement a Queue, using user defined Exception Handling (also make use of throw, throws).



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14. Write a Java Program that creates 3 threads by extending Thread class. First thread displays “Good Morning” every 1 sec, the second thread displays “Hello” every 2 seconds and the third displays “Welcome” every 3 seconds. (Repeat the same by implementing Runnable).
15. Write a Java Program demonstrating the lifecycle of a thread.
16. Write an Applet that displays the content of a file.
17. Write a Java Program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -, \*, % operations. Add a text field to display the result.
18. Write a Java Program for handling mouse events, keyboard events.
19. Write a Java Program that allows user to draw lines, rectangles and ovals.
20. Write a Java Program that lets users create Pie charts. Design your own user interface (with Swings & AWT).



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>ELECTRONIC DEVICES AND CIRCUITS LAB</b>					

**Note:** The students are required to perform the experiment to obtain the V-I characteristics and to determine the relevant parameters from the obtained graphs.

**List of Experiments: (Minimum of Ten Experiments has to be performed)**

1. P-N Junction Diode Characteristics  
 Part A: Germanium Diode (Forward bias & Reverse bias)  
 Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics
3. Part A: V-I Characteristics  
 Part B: Zener Diode as Voltage Regulator
4. Rectifiers (without and with c-filter)  
 Part A: Half-wave Rectifier  
 Part B: Full-wave Rectifier
5. BJT Characteristics (CE Configuration)  
 Part A: Input Characteristics  
 Part B: Output Characteristics
6. FET Characteristics (CS Configuration)  
 Part A: Drain Characteristics  
 Part B: Transfer Characteristics
7. SCR Characteristics
8. UJT Characteristics
9. Transistor Biasing
10. CRO Operation and its Measurements
11. BJT-CE Amplifier
12. Emitter Follower-CC Amplifier
13. FET-CS Amplifier





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**Equipmentrequired:**

1. Regulated Power supplies
2. Analog/Digital Storage Oscillo scopes
3. Analog/Digital Function Generators
4. Digital Multi-meters
5. Decade Résistance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Ammeters (Analogor Digital)
8. Voltmeters (Analogor Digital)
9. Active & Passive Electronic Components



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>SWITCHING THEORY AND LOGIC DESIGN LAB</b>					

**List of Experiments:** (Minimum of Twelve Experiments has to be performed)

1. Verification of truth tables of Logic gates  
Two input (i) OR (ii) AND (iii) NOR (iv) NAND (v) Exclusive OR  
(vi) Exclusive NOR
2. Design a simple combinational circuit with four variables and obtain minimal SOP expression and verify the truth table using Digital Trainer Kit
3. Verification of functional table of 3 to 8 line Decoder/De-multiplexer
4. 4 variable logic function verification using 8 to 1 multiplexer.
5. Design full adder circuit and verify its functional table.
6. Verification of functional tables of  
(i) JK Edge triggered Flip-Flop (ii) JK Master Slave Flip-Flop (iii) D Flip-Flop
7. Design a four bit ring counter using D Flip-Flops/JK Flip Flop and verify output
8. Design a four bit Johnson's counter using D Flip-Flops/JK Flip Flops and verify output
9. Verify the operation of 4-bit Universal Shift Register for different Modes of operation.
10. Draw the circuit diagram of MOD-8 ripple counter and construct a circuit using T- Flip-Flops and Test it with a low frequency clock and Sketch the output wave forms.
11. Design MOD-8 synchronous counter using T Flip-Flop and verify the result and Sketch the output wave forms.
12. (a) Draw the circuit diagram of a single bit comparator and test the output  
(b) Construct 7 Segment Display Circuit Using Decoder and 7 Segment LED and test it.

**ADDOn Experiments:**

1. Design BCD Adder Circuit and Test the Same using Relevant IC
2. Design Excess-3 to 9-Complement convertor using only four Full Adders and test the Circuit.
3. Design an Experimental model to demonstrate the operation of 74154 De-Multiplexer using LEDs for outputs.



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		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>PYTHON LAB (SKILL ORIENTED COURSE)</b>					

**COURSE OUTCOMES:**

At the end of the course the student shall be able to

CO1: Know comprehensions, generators in python. CO2: Know exception handling in python

CO3: Know file I/O

CO4: Understand various data types like lists, tuples, strings etc

CO5: Know the usage of various pre-defined functions on the above data types

**PROGRAMMES:**

1. a. Write a program to get the list of even numbers upto a given number.
- b. Write a program to get the ASCII distance between two characters.
- c. Write a program to get the binary form of a given number.
- d. Write a program to convert base 36 to octal.
2. a. Write a program to get the number of vowels in the input string (No control flow allowed)
- b. Write a program to check whether a given number has even number of 1's in its binary representation (No control flow, thenumbercanbein any base)
- c. Write a program to sort given list of strings in the order of their vowel counts.
3. a. Write a program to return the top 'n' most frequently occurring chars and their respective counts. E.g. aaaaabbbbcccc, 2 should return [(a5) (b 4)]
- b. Write a program to convert a given number into a given base.

Note: Convert the given number into a string in the given base. Valid base is  $2 \leq \text{base} \leq 36$

Raise exceptions similar to how `int("XX", YY)` does (play in the console to find what errors it raises). Handle negative numbers just like `bin` and `oct` do.

4. a. Write a program to convert a given iterable into a list. (Using iterator)
- b. Write a program to implement user defined `map()` function.

Note: This function implements a map. It goes through the iterable and applies function on each of the elements and returns a list of results.

Don't use a for loop or the built-in map function. Use exceptions, while loop and iter.

- c. Write a program to generate an infinite number of even numbers (Use generator)
- d. Write a program to get a list of even numbers from a given list of numbers. (use only comprehensions)



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5. Write a program to implement round robin. Note: This routine to take a variable number of sequences and return elements from them in round robin till each sequence is exhausted. If one of the input sequences is infinite, this is also infinite.

e.g if input is [1,2,3], (4,5) -> yield 1,4,2,5,3 one after the other. Use exception control and comprehensions to write elegant code.

Hint: This requires you to use understand variable arguments, lists, listcopy, comprehensions, iterators, generators, exception handling, control flow etc.

6. a. Write a program to sort words in a file and put them in another file. The output file should have only lower case words, so any upper case words from source must be lowered.

(Handle exceptions)

b. Write a program return a list in which the duplicates are removed and the items are sorted from a given input list of strings.

7. a. Write a program to test whether given strings are anagrams or not.

b. Write a program to implement left binary search.

Note: Left binary search returns the left most element when a search key repeats.

For eg if input is [1,2,3,3,4,4,5] and I search 3, it should return 2 as index 2 is the left most occurrence of 3.

8. a. Write a class Person with attributes name, age, weight (kgs), height (ft) and takes them through the constructor and exposes a method get\_bmi\_result() which returns one of "underweight", "healthy", "obese"

b. Write a program to convert the passed in positive integer number into its prime factorization form.

Note: If number =  $a_1^{p_1} * a_2^{p_2} \dots$  where  $a_1, a_2$  are primes and  $p_1, p_2$  are powers  $\geq 1$

then were present that using lists and tuples in python as [(a1,p1),(a2,p2), ...]

e.g. [(2,1),(5,1)] is the correct prime factorization of 10

**Text book:**

1. Mark Lutz & David Ascher, "Learning Python", O'Reilly Publications, 5<sup>th</sup> edition

**Web reference:**

1. docs.python.com



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**  
**KAKINADA – 533 003, Andhra Pradesh, India**  
**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

II Year - II Semester		L	T	P	C
		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>ELECTRONIC CIRCUIT ANALYSIS</b>					

**Course Objectives:**

The main objectives of this course are:

- To learn hybrid-pi parameters at high frequency and compare with low frequency parameters.
- Learn and understand the purpose of cascading of single stage amplifiers and derive the overall voltage gain.
- Analyze the effect of negative feedback on amplifier characteristics and derive the characteristics.
- Learn and understand the basic principle of oscillator circuits and perform the analysis of different oscillator circuits.
- Compare and analyze different Power amplifiers like Class A, Class B, Class C, Class AB and other types of amplifiers.
- Analyze different types of tuned amplifier circuits.

**UNIT-I Small Signal High Frequency Transistor Amplifier models:**

**BJT:** Transistor at high frequencies, Hybrid-  $\pi$  common emitter transistor model, Hybrid  $\pi$  conductance, Hybrid  $\pi$  capacitances, validity of hybrid  $\pi$  model, determination of high-frequency parameters in terms of low-frequency parameters, CE short circuit current gain, current gain with resistive load, cut-off frequencies, frequency response and gain bandwidth product.

**FET:** Analysis of common Source and common drain Amplifier circuits at high frequencies.

**UNIT-II**

**Multistage Amplifiers:** Classification of amplifiers, methods of coupling, cascaded transistor amplifier and its analysis, analysis of two stage RC coupled amplifier, high input resistance transistor amplifier circuits and their analysis-Darlington pair amplifier, Cascode amplifier, Boot-strap emitter follower, Differential amplifier using BJT.

**UNIT-III**

**Feedback Amplifiers:** Feedback principle and concept, types of feedback, classification of amplifiers, feedback topologies, Characteristics of negative feedback amplifiers, Generalized analysis of feedback amplifiers, Performance comparison of feedback amplifiers, Method of analysis of feedback amplifiers.

**Unit-IV**

**Oscillators:** Oscillator principle, condition for oscillations, types of oscillators, RC-phase shift and Wien bridge oscillators with BJT and FET and their analysis, Generalized analysis of LC Oscillators, Hartley and Colpitt's oscillators using BJT, Frequency and amplitude stability of oscillators.



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**UNIT-V**

**Power Amplifiers:** Classification of amplifiers(A to H), Class A power Amplifiers, Class B Push-pull amplifiers, Complementary symmetry push pull amplifier, Class AB power amplifier, Class-C power amplifier, Thermal stability and Heat sinks.

**Tuned Amplifiers:** Introduction, Q-Factor, small signal tuned amplifier, capacitance-coupled tuned amplifier, double-tuned amplifiers, staggered-tuned amplifiers

**TextBooks:**

1. Integrated Electronics- J.Millman and C.C.Halkias, Tata McGraw-Hill, 1972.
2. Electronic Devices and Circuits Theory – Robert L. Boylestad and Louis Nashelsky, Pearson/Prentice Hall, Tenth Edition, 2009.
3. Electronic Devices and Integrated Circuits – B.P. Singh, Rekha, Pearson publications, 2006

**References:**

1. Electronic Circuit Analysis and Design – Donald A. Neuman, McGraw Hill, 2010.
2. Micro electronic Circuits- Sedra A.S. and K.C. Smith, Oxford University Press, Sixth Edition, 2011.
3. Electronic Circuit Analysis- B.V.Rao, K.R.Rajeswari, P.C.R.Pantulu, K.B.R.Murthy, Pearson Publications.

**Course Outcomes:**

At the end of this course the student can able to

- Design and analysis of small signal high frequency transistor amplifier using BJT and FET.
- Design and analysis of multistage amplifiers using BJT and FET and Differential amplifier using BJT.
- Derive the expressions for frequency of oscillation and condition for oscillation of RC and LC oscillators and their amplitude and frequency stability concept.
- Know the classification of the power and tuned amplifiers and their analysis with performance comparison



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		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>DIGITAL IC DESIGN</b>					

### OBJECTIVES

The main objectives of this course are:

- Introduction of digital logic families and inter facing concepts for digital design is considered.
- VHDL fundamentals were discussed to modeling the digital system design blocks.
- Design and implementation of combinational and sequential digital logic circuits is explained.

### Outcomes:

At the end of this course the student can able to:

- Understand the structure of commercially available digital integrated circuit families.
- Learn the IEEE Standard 1076 Hardware Description Language (VHDL).
- Model complex digital systems at several levels of abstractions, behavioral, structural, and rapid system prototyping.
- Analyze and design basic digital circuits with combinatorial and sequential logic circuits using VHDL.

### UNIT-I

#### Hardware Description Languages.

**VHDL:** Introduction to VHDL, entity declaration, architecture, data-flow, behavioral and structural style of modelings, datatypes, dataobjects, configuration declaration, package, generic, operators and identifiers, PROCESS, IF, CASE & LOOP statements, VHDL libraries.

**Verilog HDL:** Introduction to Verilog HDL, data types, data operators, module statement, wire statement, if-else statement, case-end case statement, Verilog syntax and semantics (qualitative approach)

### UNIT-II

**Combinational Logic Design:** Parallel binary adder, carry look ahead adder, BCD adder, Multiplexers and demultiplexers and their use in combinational logic design, ALU, digital comparators, parity generators, code converters, priority encoders. (Qualitative approach of designing and modeling the mentioned combinational logic circuits with relevant digital ICs using HDL)



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**UNIT-III**

**Sequential Logic Design:** Registers, applications of shift registers, ripple or a synchronous counters, synchronous counters, synchronous and a synchronous sequential circuits, hazards in sequential circuits. (Qualitative approach of designing and modeling the mentioned sequential logic circuits with relevant digital ICs using HDL)

**UNIT-IV**

**Combinational MOS Logic Circuits:** Introduction, MOS logic circuits with depletion nMOS loads: two-input NOR gate, generalized NOR structure with multiple inputs, transient analysis of NOR gate, two-input NAND gate, generalized NAND structure with multiple inputs, transient analysis of NAND gate, CMOS logic circuits: CMOS NOR2 gate, CMOS NAND2 gate, complex logic circuits, complex CMOS logic gates, AOI and OAI gates, Pseudo-nMOS gates, CMOS full-adder circuit, CMOS transmission gates (Pass Gates), complementary pass-transistor logic.

**UNIT-V**

**Sequential MOS Logic Circuits:** Introduction, behavior bistable elements, SR latch circuit, clocked latch and flip-flop circuits: clocked SR latch, clocked JK latch, master-slave flip-flop, CMOS D-latch and Edge-triggered flip-flop, Schmitt trigger circuit, basic principles of pass transistor circuits.

**TEXTBOOKS**

1. Modern Digital Electronics–R.P.Jain-Fourth Edition–Tata McGraw Hill Education Private Limited, 2010.
2. CMOS Digital Integrated Circuits-Analysis and Design–Sung-Mo Kang & Yusuf Leblebici-Tata McGraw Hill Publishing Company Limited, 2006.
3. VHDL/Verilog Primer - J.Bhasker, Pearson Education/PHI, 3<sup>rd</sup> Edition.

**REFERENCES**

1. Digital Design Principles & Practices-John F.Wakerly, PHI/Pearson Education Asia, 3<sup>rd</sup> Edition, 2005.
2. Fundamentals of Digital Logic with VHDL Design - Stephen Brown, Zvonko Vranesic, McGraw Hill, 3<sup>rd</sup> Edition.





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ANALOG COMMUNICATIONS</b>					

**Course Objectives:**

Students undergoing this course are expected to

- Familiarize with the fundamentals of analog communication systems.
- Familiarize with various techniques for analog modulation and demodulation of signals.
- Distinguish the figure of merits of various analog modulation methods.
- Develop the ability to classify and understand various functional blocks of radio transmitters and receivers.
- Familiarize with basic techniques for generating and demodulating various pulse modulated signals.

**UNIT I**

**AMPLITUDE MODULATION :** Introduction to communication system, Need for modulation, Frequency Division Multiplexing , Amplitude Modulation, Definition, Time domain and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves, square law Modulator, Switching modulator, Detection of AM Waves; Square law detector, Envelope detector.

**UNIT II**

**DSB & SSB MODULATION:** Double side band suppressed carrier modulators, time domain and frequency domain description, Generation of DSBSC Waves, Balanced Modulators, Ring Modulator, Coherent detection of DSB-SC Modulated waves, COSTAS Loop. Frequency domain description, Frequency discrimination method for generation of AM SSB Modulated Wave, Time domain description, Phase discrimination method for generating AMSSB Modulated waves. Demodulation of SSB Waves, Vestigial side band modulation: Frequency description, Generation of VSB Modulated wave, Time domain description, Envelope detection of a VSB Wave pulse Carrier, Comparison of AM Techniques, Applications of different AM Systems, FDM.

**UNIT III**

**ANGLE MODULATION:** Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrowband FM, Wideband FM, Constant Average Power, Transmission bandwidth of FM Wave- Generation of FM Waves, Detection of FM Waves: Balanced Frequency discriminator, Zero crossing detector, Phase locked loop. Comparison of FM & AM.

**UNIT IV**

**TRANSMITTERS & RECEIVERS: Radio Transmitter** - Classification of Transmitter, AM Transmitter, Effect of feedback on performance of AM Transmitter, FM Transmitter –Variable reactance type and phase modulated FM Transmitter, frequency stability in FM Transmitter. **Radio Receiver** - Receiver Types - Tuned radio frequency receiver, Super heterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, AGC, FM Receiver, Comparison with AM Receiver, Amplitude limiting. Communication Receivers, extensions of super heterodyne principle and additional circuits.



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**UNIT V**

**NOISE:** Review of noise and noise sources, noise figure, Noise in Analog communication Systems, Noise in DSB & SSB System, Noise in AM System, Noise in Angle Modulation Systems, Threshold effect in Angle Modulation System, Pre-emphasis & de-emphasis **PULSE MODULATION:** Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation & demodulation of PWM, PPM, Generation and demodulation of PPM, Time Division Multiplexing, TDM Vs FDM

**TEXTBOOKS:**

1. Principles of Communication Systems–HTaub&D.Schilling, GautamSahe, TMH, 3<sup>rd</sup> Edition, 2007.
2. Principles of Communication Systems–Simon Haykin, John Wiley, 2<sup>nd</sup> Edition, 2007.
3. Modern Digital and Analog Communication Systems –B.P.Lathi, Zhi Ding, Hari Mohan Gupta, Oxford University Press, 4<sup>th</sup> Edition, 2017

**REFERENCES:**

1. Electronics & Communication System– George Kennedyand Bernard Davis, TMH 2004.
2. Communication Systems–R.P.Singh, SP Sapre, Second Edition TMH, 2007.
3. Electronic Communication systems–Tomasi, Pearson, fourth Edition, 2007.

**Course Outcomes:**

After undergoing the course, students will be able to

- Differentiate various Analog modulation and demodulation schemes and their spectral characteristics
- Analyze noise characteristics of various analog modulation methods
- Analyze various functional blocks of radiotransmitters and receivers
- Design simple analog systems for various modulation techniques



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		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>LINEAR CONTROL SYSTEMS</b>					

**Course objectives:**

- To introduce the concepts of open loop and closed loop systems, mathematical models of mechanical and electrical systems, and concepts of feedback
- To study the characteristics of the given system in terms of the transfer function and introducing various approaches to reduce the overall system for necessary analysis
- To develop the acquaintance in analyzing the system response in time-domain and frequency domain in terms of various performance indices
- To analyze the system in terms of absolute stability and relative stability by different approaches
- To design different control systems for different applications as per given specifications
- To introduce the concepts of state variable analysis, design and also the concepts of controllability and observability.

**UNIT I - INTRODUCTION**

Concepts of System, Control Systems: Open Loop and closed loop control systems and their differences. Different examples of control systems, Feed-Back Characteristics, Effects of feedback. Mathematical models, Differential equations, Impulse Response and transfer functions. Translational and Rotational mechanical systems

**UNIT II – TRANSFER FUNCTION REPRESENTATION**

Transfer Function of DC Servo motor - AC Servo motor- Synchro-transmitter and Receiver, Block diagram representation of systems considering electrical systems as examples –Block diagram algebra–Representation by Signal flowgraph–Reduction using Mason's gain formula.

**TIME RESPONSE ANALYSIS**

Standard test signals – Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems – Time domain specifications – Steady state response - Steady state errors and error constants.

**UNIT III – STABILITY ANALYSIS IN S-DOMAIN**

The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability

**Root Locus Technique:**

The root locus concept - construction of root loci-effects of adding poles and zeros to  $G(s)H(s)$  on the root loci.

**UNIT IV**

**Frequency response analysis:** Introduction, Correlation between time and frequency response, Polar Plots, Bode Plots, Nyquist Stability Criterion



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**UNIT V – CLASSICAL CONTROL DESIGN TECHNIQUES**

Compensation techniques – Lag, Lead, Lead-Lag Controllers design infrequency Domain, PID Controllers. State Space Analysis of Continuous Systems Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

**TEXT BOOKS:**

1. Automatic Control Systems 8<sup>th</sup> edition– by B.C.Kuo – Johnwiley and son's, 2003.
2. Control Systems Engineering –by I. J.Nagrath and M.Gopal, New Age International (P) Limited, Publishers, 2<sup>nd</sup> edition, 2007
3. Modern Control Engineering–by Katsuhiko Ogata–Pearson Publications, 5<sup>th</sup> edition, 2015.

**REFERENCE BOOKS:**

1. Control Systems by A.Nagoorkani, RB Apublications, 3 edition, 2017.
2. Control Systems by A.Anandkumar, PHI, 2 Edition, 2014.

**Course Outcomes:**

- This course introduces the concepts of feedback and its advantages to various control systems
- The performance metrics to design the control system in time-domain and frequency domain are introduced.
- Control systems for various applications can be designed using time-domain and frequency domain analysis.
- In addition to the conventional approach, the state space approach for the analysis of control systems is also introduced.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MANAGEMENT AND ORGANISATIONAL BEHAVIOUR</b>					

**Course Objectives:**

- To familiarize with the process of management, principles, leadership styles and basic concepts on Organization.
- To provide conceptual knowledge on functional management that is on Human resource management and Marketing management.
- To provide basic insight into select contemporary management practices and Strategic Management.
- To learn theories of motivation and also deals with individual behavior, their personality and perception of individuals.
- To understand about organizations groups that affect the climate of an entire organizations which helps employees in stress management.

**Unit - I**

**Introduction:** Management and organizational concepts of management and organization- Nature and Importance of Management, Functions of Management, System approach to Management- Taylor's Scientific Management Theory, Fayol's Principles of Management, Leadership Styles, Social responsibilities of Management. Designing Organizational Structures: Basic concepts related to Organization - Departmentation and Decentralization, MBO, Process and concepts.

**Unit - II**

**Functional Management:** Human Resource Management (HRM) Concepts of HRM, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating.- Marketing Management: Concepts of Marketing, Marketing mix elements and marketing strategies.

**Unit - III**

**Strategic Management:** Strategic Management and Contemporary Strategic Issues: Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Card as Contemporary Business Strategies.

**Unit - IV**

**Individual Behavior:** Perception – Perceptual process – Impression management – Personality development – Socialization – Attitude – Process – Formation – Positive attitude – Change – Learning – Learning organizations – Reinforcement Motivation – Process – Motives – Theories of Motivation: Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation



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**Unit - V**

**Group Dynamics:** Types of Groups, Stages of Group Development, Group Behaviour and Group Performance Factors, Organizational conflicts: Reasons for Conflicts, Consequences of Conflicts in Organization, Types of Conflicts, Strategies for Managing Conflicts, Organizational Climate and Culture, Stress, Causes and effects, coping strategies of stress.

**Reference Books:**

1. Subba Rao P., *Organizational Behaviour*, Himalaya Publishing House, Mumbai.
2. Fred Luthans *Organizational Behaviour*, TMH, New Delhi.
3. Robins, Stephen P., *Fundamentals of Management*, Pearson, India.
4. Kotler Philip & Keller Kevin Lane: *Marketing Management* 12/e, PHI, 2007
5. Koontz & Weihrich: *Essentials of Management*, 6/e, TMH, 2007
6. Kanishka Bedi, *Production and Operations Management*, Oxford University Press, 2007.

**Course Outcomes:**

- After completion of the Course the student will acquire the knowledge on management functions, global leadership and organizational structure.
- Will familiarize with the concepts of functional management that is HR and Marketing of new product developments.
- The learner is able to think strategically through contemporary management practices.
- The learner can develop positive attitude through personality development and can equip with motivational theories.
- The student can attain the group performance and grievance handling in managing the organizational culture.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>ELECTRONIC CIRCUIT ANALYSIS LAB</b>					

**Note:** The students are required to design the circuit and perform the simulation using Multisim/ Equivalent Industrial Standard Licensed simulation software tool. Further they are required to verify the result using necessary hardware equipment.

**List of Experiments: (Minimum of Ten Experiments has to be performed)**

1. Determination of  $f_{Tofa}$  given transistor.
2. Voltage-Series Feedback Amplifier
3. Current-Shunt Feedback Amplifier
4. RC Phase Shift/Wien Bridge Oscillator
5. Hartley/Colpitt's Oscillator
6. Two Stage RC Coupled Amplifier
7. Darlington Pair Amplifier
8. Boots trapped Emitter Follower
9. Class A Series-fed Power Amplifier
10. Transformer-coupled Class A Power Amplifier
11. Class B Push-Pull Power Amplifier
12. Complementary Symmetry Class B Push-Pull Power Amplifier
13. Single Tuned Voltage Amplifier
14. Double Tuned Voltage Amplifier

**Equipment required: Software:**

- i. Multisim/Equivalent Industrial Standard Licensed simulation software tool.
- ii. Computer Systems with required specifications

**Hardware Required:**

1. Regulated Power supplies
2. Analog/Digital Storage Oscillo scopes
3. Analog/Digital Function Generators
4. Digital Multimeters
5. Decade Résistance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Ammeters (Analog or Digital)
8. Voltmeters (Analog or Digital)
9. Active & Passive Electronic Components



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>ANALOG COMMUNICATIONS LAB</b>					

**List of Experiments:**

(Twelve experiments to be done- **The students have to calculate the relevant parameters**) –  
 (a. Hardware, b. MATLAB Simulink, c. MATLAB Communication tool box)

- A. Amplitude Modulation - Modulation & Demodulation
- B. AM – DSBSC - Modulation & Demodulation
- C. Spectrum Analysis of Modulated signal using Spectrum Analyzer
- D. Diode Detector
- E. Pre-emphasis & De-emphasis
- F. Frequency Modulation–Modulation & Demodulation
- G. AGC Circuits
- H. Verification of Sampling Theorem
- I. Pulse Amplitude Modulation & Demodulation
- J. PWM, PPM–Modulation & Demodulation
- K. PLLIC-565 as FM demodulator
- L. Radio receiver characteristics
- M. Radio Receiver/TV Receiver Demokits or Trainees.

Note: All the above experiments are to be executed/completed using hardware boards and also to be simulated on Mat lab.

**Equipment & Software required: Software:**

- i) Computer Systems with latest specifications
- ii) Connected in LAN (Optional)
- iii) Operating system (Windows/Linux software)
- iv) Simulations software (Simulink & MATLAB)

**Equipment:**

1. RPS - 0 –30V
2. CRO - 0– 20M Hz.
3. Function Generators - 0 – 1 MHz
4. Components and Bread boards
5. Multimeters and other meters
6. Spectrum Analyzer





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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>DIGITAL IC DESIGN LAB</b>					

Note: The students are required to design and draw the internal logical structure of the following Digital Integrated Circuits and to develop VHDL/Verilog HDL Source code, perform simulation using relevant simulator and analyze the obtained simulation results using necessary synthesizer. All the experiments are required to verify and implement the logical operations on the latest FPGA Hardware in the Laboratory.

List of Experiments: (Minimum of Ten Experiments has to be performed)

1. Realization of Logic Gates
2. Design of Full Adder using 3 modeling systems
3. 3 to 8 Decoder-74138
4. 8 to 3 Encoder (with and without parity)
5. 8x1 Multiplexer-74151 and 2x4 De-multiplexer-74155
6. 4-Bit comparator-7485
7. D Flip-Flop-7474
8. Decade counter -7490
9. Shift registers-7495
10. 8-bit serial in-parallel out and parallel in-serial out
11. Fast In & Fast Out (FIFO)
12. MAC (Multiplier & Accumulator)
13. ALU Design.



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		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>SOFT SKILLS (SKILL ORIENTED COURSE)</b>					

**Course Outcomes:**

At the end of the Course, the Student will be able to:

CO1 Use language fluently, accurately and appropriately in debates and group discussions  
 CO2 Use their skills of listening comprehension to communicate effectively in cross-cultural contexts.

CO3 Learn and use new vocabulary.

CO 4 Write resumes, project reports and reviews.

CO5 Exhibit interview skills and develop soft skills.

1. Group Discussion—dynamics of group discussion, Lateral thinking, Brain storming.
2. Interview Skills— concept and process, pre-interview planning, opening strategies, answering strategies, interview through teleand video-conferencing.
3. Meetings-making meeting effective, chairing a meeting, decision-making, seeking opinions, interrupting and handling interruptions, clarifications, closure, Negotiation skills.
4. Listening comprehension – Achieving ability to comprehend material delivered at relatively fast speed; comprehending spoken material in Standard Indian English, British English, and American English.
5. Cross-Cultural Communication / Non-Verbal Communication, Problems of Language, Lack of Language equivalency/ difficulties in using English.
6. Vocabulary building, Creativity in using Advertisements, Case Studies etc.
7. Personality Development: Decision-Making, Problem Solving, Goal Setting, Time Management & Positive Thinking.
8. Resume writing –structure and presentation, planning, defining the career objective.
9. Writing Skills—Letter writing, Email etiquette; Essays for competitive examinations, Analyzing news paper articles.
10. Technical Report Writing/Project Proposals—Types of format and styles, subject matter—organization, clarity,
11. Coherence and style, planning, data-collection, tools, analysis- Progress and Project Reports.



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**REFERENCES:**

1. M.Ashraf Rizvi, “Effective Technical Communication”, Tata McGraw-Hill Publishing Company Ltd. 2005.
2. Andrea J.Rutherford, “Basic Communication Skills for Technology”, 2<sup>nd</sup> Edition, Pearson Education, 2007.
3. Meenakshi Raman & Sangeeta Sharma, “Technical Communication”, Oxford University Press, 2011.
4. DELTA 'skey to the Next Generation TOEFL Test: “Advanced Skill Practice,” New Age



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<b>III Year – I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ANALOG ICs AND APPLICATIONS</b>					

**Unit – I**

OP-Amp Block Diagram (Symbolic Representation), Characteristics of Op-Amp, Ideal and Practical Op-Amp specifications, DC and AC Characteristics, Definitions of Input and Output Off-set voltage and currents slow rate, CMRR, PSRR. Measurements of Op-Amp Parameters, Three-Terminal Voltage Regulators 78xx & 79xx Series, current Booster, adjustable voltage, Dual Power Supply with 78xx & 79xx

**Unit – II**

**OP-AMPS Applications:** Introduction, Basic Op-Amp Applications, Instrumentation Amplifier, AC Amplifier, V to I and I to V Converter, Sample and Hold Circuit, Log and Antilog Amplifier, Multiplier and Divider, Differentiator, integrator.

Comparators and Waveform Generators: Introduction, Comparator, Square Wave Generator, Monostable Multivibrator, Triangular Wave Generator, Sine Wave Generators.

**Unit – III****Active Filters:**

Design & Analysis of Butterworth active filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and all pass filters.

**Unit – IV**

**Timers:** Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger.

**Phase Locked Loops:** Introduction, block schematic, principles and description of individual blocks, 565 PLL, Applications of PLL – frequency multiplication, frequency translation, AM, FM & FSK demodulators. Applications of VCO (566)

**Unit – V**

**Digital To Analog And Analog To Digital Converters:** Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A-D Converters – parallel Comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC. DAC and ADC Specifications.

**Text Books:**

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition 2003.
2. Operational Amplifiers & Linear Integrated Circuits – Sanjay Sharma ;SK Kataria & Sons; 2<sup>nd</sup> Edition, 2010

**References:**

1. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI, 1993.
2. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition.



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**Course Outcomes:** At the end of the course, student will be able to

1. Describe the Op-Amp and internal Circuitry: 555 Timer, PLL
2. Discuss the Applications of Operational amplifier: 555 Timer, PLL
3. Design the Active filters using Operational Amplifier
4. Use the Op-Amp in A to D & D to A Converters



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<b>III Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ELECTROMAGNETIC WAVES AND TRANSMISSION LINES</b>					

**UNIT I:**

**Transmission Lines-I:** Types, Parameters, T& $\pi$  Equivalent Circuits, Transmission Line Equations, Primary&Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line, Lossless lines, distortion less lines, Illustrative Problems.

**UNIT II:**

**Transmission Lines – II:** Input Impedance Relations, SC and OC Lines, Reflection Coefficient, VSWR. Low loss radio frequency lines and UHF Transmission lines, UHF Lines as Circuit Elements; Impedance Transformations,  $\lambda/8, \lambda/4$  and  $\lambda/2$  Lines –. Smith Chart – Construction and Applications, Quarter wave transformer, Single Stub Matching, Illustrative Problems.

**UNIT III:**

Review of Co-ordinate Systems, **Electrostatics:** Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss Law and Applications, Electric Potential, Maxwell's Two Equations for Electrostatic Fields, Energy Density, Illustrative Problems. Convection and Conduction Currents, Dielectric Constant, Poisson's and Laplace's Equations; Capacitance – Parallel Plate, Coaxial Capacitors, Illustrative Problems

**UNIT IV:**

**Magneto Statics:** Biot-Savart Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Maxwell's Two Equations for Magneto static Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Ampere's Force Law, Inductances and Magnetic Energy. Illustrative Problems,

**Maxwell's Equations (Time Varying Fields):** Faraday's Law and Transformer EMF, Inconsistency of Ampere's Law and Displacement Current Density, Maxwell's Equations in Different Final Forms and Word Statements, Conditions at a Boundary Surface, Illustrative Problems.

**UNIT V:**

**EM Wave Characteristics:** Wave Equations for Conducting and Perfect Dielectric Media Uniform Plane Waves – Definition, All Relations Between E & H, Sinusoidal Variations, Wave Propagation in Lossy dielectrics, lossless dielectrics, free space, wave propagation in good conductors, skin depth, Polarization & Types, Illustrative Problems. Reflection and Refraction of Plane Waves – Normal and Oblique Incidences, for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance, Poynting Vector and Poynting Theorem, Illustrative Problems.

**TEXTBOOKS:**

1. Elements of Electromagnetic – Matthew N.O. Sadiku, Oxford Univ. Press, 3rd ed., 2001.
2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd Edition, 2000.



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**REFERENCEBOOKS:**

1. Electromagnetic Field Theory and Transmission Lines–SNRaju, Pearson Education 2006
2. Engineering Electromagnetic –William H. Hayt Jr. and John A.Buck, TMH, 7<sup>th</sup> ed., 2006.
3. Electromagnetic Field Theory and Transmission Lines : G Sasi Bhushana Rao, WileyIndia2013.

**Course Outcomes:**

At the end of this course the student can able to

1. Determine E and H using various laws and applications of electric & magnetic fields
2. Apply the Maxwell equations to analyze the time varying behavior of EM waves
3. Gain the knowledge in uniform plane wave concept and characteristics of uniform plane wave in various media
4. Calculate Brewster angle, critical angle and total internal reflection
5. Derive and Calculate the expressions for input impedance of transmission lines, reflection coefficient, VSWR etc. using smith chart



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL COMMUNICATIONS</b>					

**UNIT I:**

**PULSE DIGITAL MODULATION:** Elements of digital communication systems, advantages of digital communication systems, Elements of PCM: Sampling, Quantization & Coding, Quantization error, Companding in PCM systems. Differential PCM systems (DPCM), Delta modulation, its draw backs, adaptive delta modulation, comparison of PCM and DM systems, noise in PCM and DM systems

**UNIT II:**

**DIGITAL MODULATION TECHNIQUES:** Introduction, ASK, FSK, PSK, DPSK, DEPSK, QPSK, M-ary PSK, ASK, FSK, similarity of BFSK and BPSK.

**UNIT III:**

**DATA TRANSMISSION:** Base band signal receiver, probability of error, the optimum filter, matched filter, probability of error using matched filter, coherent reception, non-coherent detection of FSK, calculation of error probability of ASK, BPSK, BFSK, QPSK.

**UNIT IV:**

**INFORMATION THEORY:** Discrete messages, concept of amount of information and its properties. Average information, Entropy and its properties, Information rate, Mutual information and its properties

**SOURCE CODING:** Introductions, Advantages, Shannon's theorem, Shannon-Fano coding, Huffman coding, efficiency calculations, channel capacity of discrete and analog Channels, capacity of a Gaussian channel, bandwidth-S/N trade off.

**UNIT V:**

**LINEAR BLOCK CODES:** Introduction, Matrix description of Linear Block codes, Error detection and error correction capabilities of Linear block codes, Hamming codes, Binary cyclic codes, Algebraic structure, encoding, syndrome calculation, BCH Codes.

**CONVOLUTION CODES:** Introduction, encoding of convolution codes, time domain approach, transform domain approach. Graphical approach: state, tree and trellis diagram decoding using Viterbi algorithm.

**TEXTBOOKS:**

1. Digital communications- Simon Haykin, John Wiley, 2005
2. Digital and Analog Communication Systems -Sam Shanmugam, John Wiley, 2005.

**REFERENCES:**

1. Principles of Communication Systems–H. Taub and D. Schilling, TMH, 2003
2. Digital Communications–John Proakis, TMH, 1983.
3. Communication Systems Analog & Digital– Singh & Sapre, TMH, 2004.
4. Modern Digital and Analog Communication Systems–B.P. Lathi, Zhi Ding, Hari Mohan Gupta, Oxford University Press, 4<sup>th</sup> Edition, 2017





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***Course Outcomes:***

After going through this course the student will be able to

1. Analyze the performance of a Digital Communication System for probability of error and are able to design a digital communication system.
2. Analyze various source coding techniques.
3. Compute and analyze Block codes, cyclic codes and convolution codes.
4. Design a coded communication system.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ANTENNA AND WAVE PROPAGATION (PE1)</b>					

**UNIT I:**

**ANTENNA FUNDAMENTALS:** Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Patterns in Principal Planes, Main Lobe and Side Lobes, Beam widths, Polarization, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency, Effective Height, illustrated Problems.

**UNIT II:**

**THIN LINEAR WIRE ANTENNAS:** Retarded Potentials, Radiation from Small Electric Dipole, Quarter wave Monopole and Half wave Dipole – Current Distributions, Evaluation of Field Components, Power Radiated, Radiation Resistance, Beamwidths, Directivity, Effective Area and Effective Height. Natural current distributions, fields and patterns of Thin Linear Center-fed Antennas of different lengths, Radiation Resistance at a point which is not current maximum, Antenna Theorems – Applicability and Proofs for equivalence of directional characteristics, Loop Antennas: Small Loops - Field Components, Comparison of far fields of small loop and short dipole, Concept of short magnetic dipole, D and R<sub>r</sub> relations for small loops.

**UNIT III:**

**ANTENNA ARRAYS :** 2 element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity, Derivation of their characteristics and comparison; Concept of Scanning Arrays. Directivity Relations (no derivations), Related Problems, Binomial Arrays, Effects of Uniform and Non-uniform Amplitude Distributions, Design Relations, Arrays with Parasitic Elements, Yagi-Uda Arrays, Folded Dipoles and their characteristics

**UNIT IV:**

**NON-RESONANT RADIATORS :** Introduction, Traveling wave radiators – basic concepts, Long wire antennas – field strength calculations and patterns, Microstrip Antennas- Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas – Geometry and Parameters, Impact of different parameters on characteristics. Broadband Antennas: Helical Antennas – Significance, Geometry, basic properties; Design considerations for monofilar helical antennas in Axial Mode and Normal Modes (Qualitative Treatment).

**UNIT V:**

**VHF, UHF AND MICROWAVE ANTENNAS:** Reflector Antennas : Flat Sheet and Corner Reflectors. Paraboloidal Reflectors – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking, Off-set Feeds, Cassegrain Feeds. Horn Antennas – Types, Optimum Horns, Design Characteristics of Pyramidal Horns; Lens Antennas – Geometry, Features, Dielectric Lenses and Zoning, Applications, Antenna Measurements – Patterns Required, Set Up, Distance Criterion, Directivity and Gain Measurements (Comparison, Absolute and 3-Antenna Methods).



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**WAVE PROPAGATION:** Concepts of Propagation – frequency ranges and types of propagations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF and Skip Distance – Space Wave Propagation – Mechanism, LOS and Radio Horizon.– Radius of Curvature of path, M-curves and Duct Propagation,.

**TEXT BOOKS**

1. Antennas for All Applications – John D. Kraus and Ronald J. Marhefka, 3<sup>rd</sup> Edition, TMH, 2003.
2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2<sup>nd</sup> Edition, 2000.

**REFERENCES**

1. Antenna Theory - C.A. Balanis, John Wiley and Sons, 2<sup>nd</sup> Edition, 2001.
2. Antennas and Wave Propagation – K.D. Prasad, Satya Prakashan, Tech India Publications, New Delhi, 2001.

**Course Outcomes:**

After going through this course the student will be able to

1. Identify basic antenna parameters.
2. Design and analyze wire antennas, loop antennas, reflector antennas, lens antennas, horn antennas and micro-strip antennas
3. Quantify the fields radiated by various types of antennas
4. Design and analyze antenna arrays
5. Analyze antenna measurements to assess antenna's performance
6. Identify the characteristics of radio wave propagation



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ELECTRONIC MEASUREMENTS AND INSTRUMENTATION (PE1)</b>					

**UNIT I:**

**Performance characteristics of instruments, Static characteristics:** Accuracy, Resolution, Precision, Expected value, Error, Sensitivity. Dynamic Characteristics; speed of response, Fidelity, Lag and Dynamic error, Types of errors in measurements and their analysis, Design of multi-range AC, DC meters (voltmeter & ammeter) and ohmmeter (series & shunt type) using D'Arsonval movement. True rms meter.

**UNIT II:**

**Specifications and designing aspects of Signal Generators** – AF sine and square wave signal generators, Function Generators, Random noise generators, Arbitrary waveform generators. Wave Analyzers, Harmonic Distortion Analyzers, Spectrum Analyzers, Digital Fourier Analyzers.

**UNIT III:**

**Oscilloscopes**- general purpose CROs, block diagram, functions and implementation of various blocks, specifications, various controls and their functions, types of probes used in CROs, Measurement of frequency and phase difference using Lissajous patterns  
 Special purpose CROs; sampling oscilloscope, analog storage oscilloscope, digital storage oscilloscope

**UNIT IV:**

**Bridge circuits**- Wheat stone bridge, measurement of very low resistance, Measurement of inductance- Maxwell's bridge, Anderson bridge. Measurement of capacitance- Schering Bridge, Wien Bridge, Errors and precautions in using bridges  
 Q-meter, principle of operation, measurement methods and sources of errors  
 Counters : principle of operation - modes of operation- totalizing mode, frequency mode and time period mode- sources of errors.

**UNIT V:**

**Transducers**- active & passive transducers: Resistance, Capacitance, inductance, Strain gauges, LVDT, Piezo Electric transducers.  
 Measurement of physical parameters temperature, force, pressure, velocity, acceleration and displacement

**TEXT BOOKS:**

1. Electronic instrumentation, second edition-H.S.Kalsi, Tata McGraw Hill, 2004.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrick and W.D. Cooper, PHI, 5<sup>th</sup> Edition, 2002.

**REFERENCES:**

1. Electronic Instrumentation & Measurements - David A. Bell, PHI, 3<sup>rd</sup> Edition, 2013.



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**Course Outcomes:**

After going through this course the student will be able to

1. Select the instrument to be used based on the requirements.
2. Understand and analyze different signal generators and analyzers.
3. Understand the design of oscilloscopes for different applications.
4. Design different transducers for measurement of different parameters.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>COMPUTER ARCHITECTURE &amp; ORGANIZATION</b>					
<b>(PE1)</b>					

**UNIT -I:**

**Basic Structure Of Computers:** Functional unit, Basic Operational concepts, Bus structures, System Software, Performance, The history of computer development.

**Machine Instruction and Programs:**

Instruction and Instruction Sequencing: Register Transfer Notation, Assembly Language Notation, Basic Instruction Types,

**UNIT -II:**

Addressing Modes, Basic Input/output Operations, The role of Stacks and Queues in computer programming equation. Component of Instructions: Logic Instructions, shift and Rotate Instructions

**Type of Instructions:** Arithmetic and Logic Instructions, Branch Instructions, Addressing Modes, Input/output Operations

**UNIT -III:**

**INPUT/OUTPUT ORGANIZATION:** Accessing I/O Devices, Interrupts: Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Direct Memory Access,

Buses: Synchronous Bus, Asynchronous Bus, Interface Circuits, Standard I/O Interface: Peripheral Component Interconnect (PCI) Bus, Universal Serial Bus (USB)

**UNIT -IV:**

**The MEMORY SYSTEMS:** Basic memory circuits, Memory System Consideration, Read-Only Memory: ROM, PROM, EPROM, EEPROM, Flash Memory,

Cache Memories: Mapping Functions, INTERLEAVING

**Secondary Storage:** Magnetic Hard Disks, Optical Disks,

**UNIT -V:**

**Processing Unit:** Fundamental Concepts: Register Transfers, Performing an Arithmetic Or Logic Operation, Fetching A Word From Memory, Execution of Complete Instruction, Hardwired Control,

**Micro programmed Control:** Microinstructions, Micro program Sequencing, Wide Branch Addressing Microinstructions with next –Address Field

**TEXTBOOKS:**

1. Computer Organization, Carl Hamacher, Zvonks Vranesic, Safea Zaky, 5<sup>th</sup> Edition, McGraw Hill, 2011.
2. Computer Architecture and Organization, John P. Hayes, 3<sup>rd</sup> Edition, McGraw Hill, 2002.



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**REFERENCE BOOKS:**

1. Computer Organization and Architecture – William Stallings Sixth Edition, Pearson/PHI
2. Structured Computer Organization – Andrew S. Tanenbaum, 4th Edition PHI/Pearson, 2012.
3. Fundamentals of Computer Organization and Design, - Sivarama Dandamudi Springer Int. Edition, 2003.
4. “Computer Organization and Design: The Hardware/Software Interface” by David A. Patterson and John L. Hennessy, 1998.
5. J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.

**Course Outcomes:**

After going through this course the student will be able to

1. Students can understand the architecture of modern computer.
2. They can analyze the Performance of a computer using performance equation
3. Understanding of different instruction types.
4. Students can calculate the effective address of an operand by addressing modes
5. They can understand how computer stores positive and negative numbers.
6. Understand the concepts of I/O Organization and Memory systems.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>ANALOG ICs AND APPLICATIONS LAB</b>					

**Minimum Twelve Experiments to be conducted:**

1. Study of ICs – IC 741, IC 555, IC 565, IC 566, IC 1496 – functioning, parameters and Specifications
2. OP AMP Applications – Adder, Subtractor, Comparator Circuits.
3. Integrator and Differentiator Circuits using IC 741.
4. Active Filter Applications – LPF, HPF (first order)
5. Active Filter Applications – BPF, Band Reject (Wideband) and Notch Filters.
6. IC 741 Oscillator Circuits – Phase Shift and Wien Bridge Oscillators.
7. Function Generator using OP AMPs.
8. IC 555 Timer – Monostable Operation Circuit.
9. IC 555 Timer – Astable Operation Circuit.
10. Schmitt Trigger Circuits – using IC 741 and IC 555.
11. IC 565 – PLL Applications.
12. IC 566 – VCO Applications.
13. 4 bit DAC using OP AMP.

**Equipment required for Laboratories:**

1. RPS
2. CRO
3. Function Generator
4. Multi Meters
5. IC Trainer Kits (Optional)
6. Bread Boards
7. Components:- IC741, IC555, IC565, IC1496, IC723, 7805, 7809, 7912 and other essential components.
8. Analog IC Tester





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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>DIGITAL COMMUNICATIONS LAB</b>					

**List of Experiments:** Minimum Twelve Experiments to be conducted:

1. Time division multiplexing.
2. Pulse code modulation.
3. Differential pulse code modulation.
4. Delta modulation.
5. Frequency shift keying.
6. Phase shift keying.
7. Differential phase shift keying.
8. Companding
9. Source Encoder and Decoder
10. Linear Block Code-Encoder and Decoder
11. Binary Cyclic Code-Encoder and Decoder
12. Convolution Code –Encoder and Decoder
13. BCH Codes

***Equipment required for Laboratories:***

1. RPS-0–30V
2. CRO-0 –20 MHz.
3. FunctionGenerators-0–1MHz
4. RFGenerators-0–1000M Hz./0–100MHz.
5. Rated Voltmeters and Ammeters
6. Lab Experimental kits for Digital Communication
7. Components
8. Bread boards and Multi-meters
9. Spectrum Analyzer



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<b>III Year – I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>DATA STRUCTURES USING JAVA LAB</b>					

1. Write Java programs that use both recursive and non-recursive functions for implementing the following searching methods:
  - (a) Linear search
  - (b) Binary search
2. Write Java programs to implement the List ADT using arrays and linked lists.
3. Write Java programs to implement the following using an array.
  - (a) Stack ADT
  - (b) Queue ADT
4. Write a java program that reads an infix expression, converts the expression to postfix form and then evaluates the postfix expression (use stack ADT).
5. Write Java programs to implement the following using a singly linked list.
  - (a) Stack ADT
  - (b) Queue ADT
6. Write Java programs to implement the deque (double ended queue) ADT using
  - (a) Array
  - (b) Doubly linked list.
7. Write a Java program to implement priority queue ADT.
8. Write Java programs that use recursive and non-recursive functions to traverse the given binary tree in
  - (a) Preorder
  - (b) In order and
  - (c) Post order.
9. Write a Java program that displays node values in a level order traversal (Traverse the tree one level at a time, starting at the root node) for a binary tree.
10. Write a Java program that uses recursive functions.
  - (a) To create a binary search tree.
  - (b) To count the number of leaf nodes.
  - (c) To copy the above binary search tree.
11. Write Java programs for the implementation of bfs and dfs for a given graph.
12. Write Java programs for implementing the following sorting methods:
  - (a) Bubble sort
  - (b) Selection sort
  - (c) Insertion sort
  - (d) Radix sort
13. Write a Java program for implementing KMP pattern matching algorithm.



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<b>III Year – II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>3</b>
<b>MICROPROCESSOR AND MICROCONTROLLERS</b>					

**UNIT-I**

**Introduction:** Basic Microprocessor architecture, Harvard and Von Neumann architectures with examples, Microprocessor Unit versus Microcontroller Unit, CISC and RISC architectures.

**8086 Architecture:** Main features, pin diagram/description, 8086 microprocessor family, internal architecture, bus interfacing unit, execution unit, interrupts and interrupt response, 8086 system timing, minimum mode and maximum mode configuration.

**UNIT-II**

**8086 Programming:** Program development steps, instructions, addressing modes, assembler directives, writing simple programs with an assembler, assembly language program development tools.

**UNIT-III**

**8086 Interfacing:** Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDs, Interfacing seven segment displays, software and hardware interrupt applications, Intel 8251 USART architecture and interfacing, Intel 8237a DMA controller, stepper motor, A/D and D/A converters, Need for 8259 programmable interrupt controllers.

**UNIT-IV****Intel 8051 MICROCONTROLLER**

Architecture, Hardware concepts, Input/output ports and circuits, external memory, counters/timers, serial data input/output, interrupts. Assembly language programming: Instructions, addressing modes, simple programs. Interfacing to 8051: A/D and D/A Convertors, Stepper motor interface, keyboard, LCD Interfacing, Traffic light controls.

**UNIT-V**

**ARM Architectures and Processors:** ARM Architecture, ARM Processors Families, ARM Cortex-M Series Family, ARM Cortex-M3 Processor Functional Description, functions and interfaces, Programmers Models, ARM Cortex-M3 programming – Software delay, Programming techniques, Loops, Stack and Stack pointer, subroutines and parameter passing, parallel I/O, Nested Vectored Interrupt Controller – functional description and NVIC programmers' model.

**TEXTBOOKS:**

1. A.K Ray, K.M.Bhurchandhi, Advanced Microprocessor and Peripherals”, Tata McGraw Hill Publications, 2000.
2. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2-Edition, 2011.
3. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors by Joseph You.



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**REFERENCE BOOKS:**

1. Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach in English, by Dr. Alexander G. Dean, Published by Arm Education Media, 2017.
2. Microprocessors and Interfacing – Programming and Hardware by Douglas V Hall, SSSP Rao, Tata McGraw Hill Education Private Limited, 3<sup>rd</sup> Edition, 1994.
3. Cortex -M3 Technical Reference Manual.

**Course Outcomes:**

At the end of this course the student will be able to:

1. Understand the architecture of microprocessor/ microcontroller and their operation.
2. Demonstrate programming skills in assembly language for processors and Controllers.
3. Analyze various interfacing techniques and apply them for the design of processor / Controller based systems.



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<b>III Year – II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>VLSI DESIGN</b>					

**UNIT-I:****INTRODUCTION AND BASIC ELECTRICAL PROPERTIES OF MOS CIRCUITS:**

VLSI Design Flow, Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS.  $I_{ds}$  versus  $V_{ds}$  Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and BiCMOS technology, MOS Layers, Stick Diagrams, Design Rules and Layout, Layout Diagrams for MOS circuits

**UNIT-II:**

**BASIC CIRCUIT CONCEPTS:** Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, some area Capacitance Calculations, The Delay Unit, Inverter Delays, driving large capacitive loads, Propagation Delays, Wiring Capacitances, Choice of layers.

**SCALING OF MOS CIRCUITS:** Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density. Switch logic, Gate logic.

**UNIT-III:**

**BASIC BUILDING BLOCKS OF ANALOG IC DESIGN:** Regions of operation of MOSFET, Modelling of transistor, body bias effect, biasing styles, single stage amplifier with resistive load, single stage amplifier with diode connected load, Common Source amplifier, Common Drain amplifier, Common Gate amplifier, current sources and sinks.

**UNIT-IV:****CMOS COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUIT DESIGN:**

**Static CMOS Design:** Complementary CMOS, Rationed Logic, Pass-Transistor Logic.

**Dynamic CMOS Design:** Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Choosing a Logic Style, Gate Design in the Ultra Deep-Submicron Era, Latch Versus Register, Latch based design, timing decimation, positive feedback, in stability, Meta stability, multiplexer based latches, Master-Slave Based Edge Triggered Register, clock to q delay, setup time, hold time, reduced clock load master slave registers, Clocked CMOS register. Cross coupled NAND and NOR, SR Master Slave register, Storage mechanism, pipelining.

**UNIT-V:**

**FPGA DESIGN:** FPGA design flow, Basic FPGA architecture, FPGA Technologies, Introduction to FPGA Families.

**INTRODUCTION TO ADVANCED TECHNOLOGIES:** Giga-scale dilemma, Short channel effects, High-k, Metal Gate Technology, Fin-FET, TFET.



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**TEXTBOOKS:**

1. Essentials of VLSI Circuits and Systems – Kamran Eshraghian, Douglas and A.Pucknell and Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. Design of Analog CMOS Integrated Circuits by Behzad Razavi, McGraw Hill, 2003
3. Digital Integrated Circuits, Jan M.Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2<sup>nd</sup> edition, 2016.

**REFERENCES:**

1. “Introduction to VLSI Circuits and Systems”, John P.Uyemura, John Wiley&Sons, reprint 2009.
2. Integrated Nano electronics: Nano scale CMOS, Post-CMOS and Allied Nano technologies Vinod Kumar Khanna, Springer India, 1<sup>st</sup>edition, 2016.
3. Fin-FETs and other multi-gate transistors, Colinge JP, Editor NewYork, Springer, 2008.

**Course Outcomes:**

**At the end of this course the student will be able to:**

1. Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
2. Apply the design Rules and draw layout of a given logic circuit.
3. Design basic building blocks in Analog IC design.
4. Analyze the behavior of amplifier circuits with various loads.
5. Design various CMOS logic circuits for design of Combinational logic circuits.
6. Design MOSFET based logic circuits using various logic styles like static and dynamic CMOS.
7. Design various applications using FPGA.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL SIGNAL PROCESSING</b>					

**UNIT I**

**INTRODUCTION:** Introduction to Digital Signal Processing: Discrete time signals & sequences, Classification of Discrete time systems, stability of LTI systems, Invertability, Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations, Frequency domain representation of discrete time signals and systems, Review of Z-transforms, solution of difference equations using Z-transforms, System function.

**UNIT II**

**DISCRETE FOURIER SERIES & FOURIER TRANSFORMS:** Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

**UNIT III**

**DESIGN OF IIR DIGITAL FILTERS & REALIZATIONS:** Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms.

**UNIT IV****DESIGN OF FIR DIGITAL FILTERS & REALIZATIONS:**

Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique, Comparison of IIR & FIR filters, Basic structures of FIR systems, *Lattice structures*, *Lattice-ladder structures*

**UNIT V**

**INTRODUCTION TO DSP PROCESSORS:** Introduction to programmable DSPs: Multiplier and Multiplier Accumulator, Modified bus structures and memory access schemes in P-DSPs, Multiple Access Memory, Multi ported memory, VLIW architecture, Pipelining, Special addressing modes, On-Chip Peripherals.

**Architecture of TMS320C5X:** Introduction, Bus Structure, Central Arithmetic Logic Unit, Auxiliary Register ALU, Index Register, Block Move Address Register, Parallel Logic Unit, Memory mapped registers, program controller, some flags in the status registers, On-chip memory, On-chip peripherals

**TEXT BOOKS:**

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing – A.V. Oppenheim and R.W. Schaffer, PHI



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**Reference Books:**

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006
2. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.
3. Digital Signal Processors – Architecture, Programming and Applications, B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002

**Course Outcomes:**

After going through this course the student will be able to

1. Apply the difference equations concept in the analysis of Discrete time systems
2. Use the FFT algorithm for solving the DFT of a given signal
3. Design a Digital filter (FIR&IIR) from the given specifications
4. Realize the FIR and IIR structures from the designed digital filter.
5. Use the Multirate Processing concepts in various applications (eg: Design of phase shifters, Interfacing of digital systems
6. Apply the signal processing concepts on DSP Processor.





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MICROWAVE ENGINEERING (PE2)</b>					

**UNIT I**

**MICROWAVE TRANSMISSION LINES:** Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular Waveguides – TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Filter Characteristics, Dominant and Degenerate Modes, Sketches of TE and TM mode fields in the cross-section, Mode Characteristics – Phase and Group Velocities, Wavelengths and Impedance Relations, Impossibility of TEM mode. Related Problems

**MICROSTRIP LINES**– Introduction,  $Z_0$  Relations, Effective Dielectric Constant, Losses, Q factor

**UNIT II**

**MICROWAVE TUBES:** Limitations and Losses of conventional tubes at microwave frequencies, Re-entrant Cavities, Microwave tubes – O type and M type classifications, O-type tubes :2 Cavity Klystrons – Structure, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory –, Applications, Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Electronic Admittance; Oscillating Modes and output Characteristics, Electronic and Mechanical Tuning, Applications,

**UNIT - III**

**HELIX TWTS:** Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT and Suppression of Oscillations,

**M-type Tubes**

Introduction, Cross-field effects, Magnetrons – Different Types, 8-Cavity Cylindrical Travelling Wave Magnetron – Hull Cut-off Condition, Modes of Resonance and PI-Mode Operation, Separation of PI-Mode, o/p characteristics

**UNIT IV**

**WAVEGUIDE COMPONENTS AND APPLICATIONS - I:** Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities – Waveguide irises, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Resistive Card, Rotary Vane types; Waveguide Phase Shifters – Dielectric, Rotary Vane types, Scattering Matrix– Significance, Formulation and Properties, S-Matrix Calculations for – 2 port Junction, E-plane and H-plane Tees, Magic Tee, Hybrid Ring; Directional Couplers – 2Hole, Bethe Hole types, Ferrite Components– Faraday Rotation, S-Matrix Calculations for Gyrator, Isolator, Circulator, Related Problems.

**UNIT V**

**MICROWAVE SOLID STATE DEVICES:** Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes

**MICROWAVE MEASUREMENTS:** Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement – Bolometer Method. Measurement of Attenuation, Frequency, Q- factor, Phase shift, VSWR, Impedance Measurement



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**TEXT BOOKS:**

1. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley, 2nd Edition, 2002.
2. Microwave Engineering- Annapurna Das and Sisir K.Das, Mc Graw Hill Education, 3<sup>rd</sup> Edition.

**REFERENCES:**

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition, 1994.
2. Microwave Engineering – G S N Raju , I K International
3. Microwave and Radar Engineering-M.Kulkarni, Umesh Publications, 3<sup>rd</sup> Edition

**Course Outcomes:** After going through this course the student will be able to

1. Design different modes in waveguide structures
2. Calculate S-matrix for various waveguide components and splitting the microwave energy in a desired direction
3. Distinguish between Microwave tubes and Solid State Devices, calculation of efficiency of devices.
4. Measure various microwave parameters using a Microwave test bench



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MOBILE &amp; CELLULAR COMMUNICATION (PE2)</b>					

**UNIT I**

**CELLULAR MOBILE RADIO SYSTEMS:** Introduction to Cellular Mobile System, uniqueness of mobile radio environment, operation of cellular systems, consideration of the components of Cellular system, Hexagonal shaped cells, Analog and Digital Cellular systems.

**CELLULAR CONCEPTS:** Evolution of Cellular systems, Concept of frequency reuse, frequency reuse ratio, Number of channels in a cellular system, Cellular traffic: trunking and blocking, Grade of Service; Cellular structures: macro, micro, pico and femto cells; Cell splitting, Cell sectoring.

**UNIT II**

**INTERFERENCE:** Types of interferences, Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, Co-channel Interference Reduction Factor, desired C/I from a normal case in a omni-directional Antenna system, design of Antenna system, antenna parameters and their effects, diversity receiver, non-co-channel interference-different types.

**UNIT III**

**FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT:** Numbering and grouping, setup access and paging channels, channel assignments to cell sites and mobile units: fixed channel and non-fixed channel assignment, channel sharing and borrowing, overlaid cells. **CELL COVERAGE FOR SIGNAL AND TRAFFIC:** Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long distance propagation, antenna height gain, form of a point to point model.

**UNIT IV****HANDOFF STRATEGIES:**

Concept of Handoff, types of handoff, handoff initiation, delaying handoff, forced handoff, mobile assigned handoff, intersystem handoff, soft and hard hand offs, vehicle locating methods, dropped call rates and their evaluation.

**UNIT V**

**DIGITAL CELLULAR NETWORKS:** GSM architecture, GSM channels, multiple access schemes; TDMA, CDMA, OFDMA. 3G and 4G Wireless Standards GSM, GPRS, WCDMA, LTE, Wi-MAX, Introduction to 5G standards.

**TEXT BOOKS:**

1. Mobile Cellular Telecommunications – W.C.Y. Lee, Tata McGraw Hill, 2nd Edn., 2006.
2. Principles of Mobile Communications – Gordon L. Stuber, Springer International 2<sup>nd</sup> Edition, 2007.
3. Advanced Wireless Communications-4G By. Savo G Glisic, John Wiley & Sons Publication 2<sup>nd</sup> Edition



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**REFERENCES:**

1. Wireless Communications – Theodore. S. Rapport, Pearson education, 2nd Edn.,2002.
2. Fundamentals of Wireless Communication By. David Tse and Pramod Viswanath, Cambridge University Press

**Course Outcomes:**

At the end of this course the student can able to:

1. Identify the limitations of conventional mobile telephone systems; understand the concepts of cellular systems.
2. Understand the frequency management, channel assignment strategies and antennas in cellular systems.
3. Understand the concepts of handoff and architectures of various cellular systems.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>EMBEDDED SYSTEMS (PE2)</b>					

**UNIT-I**

**INTRODUCTION:** Embedded system-Definition, history of embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded firmware, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

**UNIT-II**

**EMBEDDED HARDWARE DESIGN:** Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock.

**UNIT-III**

**EMBEDDED FIRMWARE DESIGN:** Embedded Firmware design approaches, Embedded Firmware development languages, ISR concept, Interrupt sources, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C and Compiler versus Cross-compiler.

**UNIT-IV**

**REAL TIME OPERATING SYSTEM:** Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.  
**HARDWARE SOFTWARE CO-DESIGN:** Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

**UNIT-V:**

**EMBEDDED SYSTEM DEVELOPMENT, IMPLEMENTATION AND TESTING:** The integrated development environment, Types of files generated on cross-compilation, De-assembler/ De-compiler, Simulators, Emulators and Debugging, Target hardware debugging, Embedded Software development process and tools, Interpreters, Compilers and Linkers, debugging tools, Quality assurance and testing of the design, Testing on host machine, Simulators, Laboratory Tools.

**Case Study:** digital camera hardware and software architecture, embedded systems in automobile, embedded system for a smart card, mobile phone software for key inputs.

**Text Books:**

1. Embedded Systems Architecture- By Tammy Noergaard, Elsevier Publications, 2013.
2. Embedded Systems-By Shibu. K.V-Tata McGraw Hill Education Private Limited, 2013.



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**References:**

1. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications, 2013.
2. Embedded Systems-Lyla B.Das-Pearson Publications,2013.

**Course Outcomes:**

At the end of this course the student can able to:

1. Understand the basic concepts of an embedded system and able to know an embedded system design approach to perform a specific function.
2. The hardware components required for an embedded system and the design approach of an embedded hardware.
3. The various embedded firmware design approaches on embedded environment.
4. Understand how to integrate hardware and firmware of an embedded system using real time operating system.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>CMOS ANALOG IC DESIGN (PE2)</b>					

**UNIT -I**

Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models, Single Stage Amplifiers –Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage

**UNIT -II:**

Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors– Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors

**UNIT -III:**

Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair, Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs

**UNIT -IV:**

Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading, Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation

**UNIT -V:**

Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators

**Text Books:**

1. B.Razavi, “Design of Analog CMOS Integrated Circuits”, 2nd Edition, McGraw Hill Edition 2016.
2. Paul. R.Gray & Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5th Edition, 2009.

**Reference Books:**

1. T. C. Carusone, D. A. Johns & K. Martin, “Analog Integrated Circuit Design”, 2<sup>nd</sup> Edition, Wiley, 2012.
2. P.E.Allen & D.R. Holberg, “CMOS Analog Circuit Design”, 3<sup>rd</sup> Edition, Oxford University Press, 2011.
3. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3<sup>rd</sup> Edition, Wiley, 2010.



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**Course Outcomes:**

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

1. Design MOSFET based analog integrated circuits.
2. Analyze analog circuits at least to the first order.
3. Appreciate the trade-offs involved in analog integrated circuit design.
4. Understand and appreciate the importance of noise and distortion in analog circuits.
5. Analyze complex engineering problems critically in the domain of analog IC design for conducting research.





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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>MICROPROCESSOR AND MICROCONTROLLERS LAB</b>					

***List of Experiments:***

**PART- A:** (Minimum of 5 Experiments has to be performed) 8086 Assembly Language Programming and Interfacing

1. Programs for 16 -bit arithmetic operations (using Various Addressing Modes).
  - a. Addition of n-BCD numbers.
  - b. Multiplication and Division operations.
2. Program for sorting an array.
3. Program for Factorial of given n-numbers.
4. Interfacing ADC to8086
5. Interfacing DAC to8086.
6. Interfacing stepper motor to8086.

**PART-B:** (Minimum of 5 Experiments has to be performed) 8051 Assembly Language Programming and Interfacing

1. Finding number of 1's and number of 0's in a given 8-bit number
2. Average of n-numbers.
3. Program and verify Timer/ Counter in8051.
4. Interfacing Traffic Light Controller to8051.
5. UART operation in8051
6. Interfacing LCD to8051.

***PART-C (Minimum of 2 Experiments has to be performed) Conduct the following experiments using ARM CORTEX M3 PROCESSOR USING KEIL MDK ARM***

1. Write an assembly program to multiply of 2 16-bit binary numbers.
2. Write an assembly program to find the sum of first 10 integers numbers.
3. Write a program to toggle LED every second using timer interrupt.

***Equipment Required:***

1. Regulated Power supplies
2. Analog/Digital Storage Oscilloscopes
3. 8086 Microprocessor kits
4. 8051 microcontroller kits
5. ADC module, DAC module
6. Stepper motor module
7. Key board module
8. LED, 7-SegmentUnits
9. Digital Multi-meters
10. ROM/RAM Interface module
11. Bread Board etc.
12. ARM CORTEX M3
13. KEIL MDKARM, Digital Multi-meters



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>VLSI DESIGN LAB</b>					

### List of Experiments

#### **PART (A): FPGA Level Implementation (Any Seven Experiments)**

**Note 1:** The students need to develop Verilog /VHDL Source code, perform simulation using relevant simulator and analyze the obtained simulation results using necessary Synthesizer

**Note 2:** All the experiments need to be implemented on the latest FPGA/CPLD Hardware in the Laboratory

1. Realization of Logic gates

#### **Design and Implementation of the following:**

2. 4-bit ripple carry and carry look ahead adder using behavioral, dataflow and structural modeling
3. a) 16:1 mux through 4:1 mux  
b) 3:8 decoder realization through 2:4 decoder
4. 8:3 encoder
5. 8-bit parity generator and checker
6. Flip-Flops
7. 8-bit synchronous up-down counter
8. 4-bit sequence detector through Mealy and Moore state machines.

#### **EDA Tools/Hardware Required:**

1. EDA Tool that supports FPGA programming including Xilinx Vivado/Altera(Intel)/Cypress/Equivalent Industry standard tool along with corresponding FPGA hardware.
2. Desktop computer with appropriate Operating System that supports the EDA tools.

#### **PART (B): Back-end Level Design and Implementation (Any Five Experiments)**

**Note:** The students need to design the following experiments at schematic level using CMOS logic and verify the functionality. Further students need to draw the corresponding layout and verify the functionality including parasites. Available state of the art technology libraries can be used while simulating the designs using Industry standard EDA Tools.

#### **Design and Implementation of the following**

- 1a. Universal Gates
- 1b. An Inverter
2. Full Adder
3. Full Subtractor
4. Decoder
5. D-Flip-flop



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**EDA Tools/Hardware Required:**

- Mentor Graphics Software / Cadence/Synopsys/Tanner or Equivalent Industry Standard/CAD Tool.
- Desktop computer with appropriate Operating System that supports the EDA tools.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>DIGITAL SIGNAL PROCESSING LAB</b>					

(Note: Students have to perform at least FOUR experiments from each part.)

**PART-A**

List of the Experiments

1. Generation of DT signals.
2. Verify the Linear Convolution of two DT signals
  - a) Using MATLAB
  - b) Using Code Composer Studio(CCS)
3. Verify the Circular Convolution of two DT signals
  - a) Using MATLAB
  - b) Using Code Composer Studio(CCS)
4. Find the sum of DT sinusoidal signals.
5. Computation of Discrete Fourier Transform(DFT) and Inverse Discrete Fourier Transform (IDFT)
  - a) Using MATLAB
  - b) Using Code Composer Studio(CCS)
6. Transfer Function Stability Analysis: using pole-zero plot, bode Plot and Nyquist plot.

**PART-B**

Following Experiments are to be done using a TIDSP Starter Kit.

7. Generation of a sinusoidal signal.
8. Linear and circular convolution of DT sequences.
9. Compute N-point DFT of a given DT sequence.
10. Design and implementation of FIR filters.
11. Design and implementation of IIR filters.

**PART-C**

Following Experiments are to be done using Cypress FM4 Starter Kit.

12. Verification of sampling theorem.
13. Implementation of FFT algorithm.
14. Implementation of FIR filters.
15. Implementation of IIR filters.



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<b>III Year – II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>1</b>	<b>0</b>	<b>2</b>	<b>2</b>
<b>ARM BASED/ AURDINO BASED PROGRAMMING</b>					

**LIST OF EXPERIMENTS:**

1. Measure Analog signal from Temperature Sensor
2. Generate PWM output
3. Drive single character generation on Hyper Terminal
4. Drive a given string on Hyper Terminal
5. Full duplex Link establishment using Hyper terminal
6. Drive a given value on a 8 bit DAC consisting of SPI
7. Drive Stepper motor using Analog GPIOs
8. Drive Accelerometer and Display the readings on Hyper Terminal

**COMPONENTS/ BOARDS :**

1. Arduino Duemilanove Board
2. Arduino Software IDE

**Course Outcomes:**

At the end of the Course, the Student will be able to:

1. Comprehend Microcontroller-Transducers Interface techniques
2. Establish Serial Communication link with Arduino
3. Analyze basics of SPI interface.
4. Interface Stepper Motor with Arduino
5. Analyze Accelerometer interface techniques



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<b>IV Year – I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>OPTICAL COMMUNICATION</b>					
<b>(PE-3)</b>					

**UNIT I**

Overview of optical fiber communication - Historical development, The general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection, Acceptance angle, Numerical Aperture, Skew rays, Cylindrical fibers- Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index, Related problems.

**UNIT II**

Fiber materials:- Glass, Halide, Active glass, Chalcogenide glass, Plastic optical fibers. Signal distortion in optical fibers-Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay, Types of Dispersion:- Material dispersion, Wave-guide dispersion, Polarization-Mode dispersion, Intermodal dispersion, Pulse broadening in Graded index fiber, Related problems.

**UNIT III**

Optical fiber Connectors-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints.

**UNIT IV**

Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED&ILD, Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors, Related problems.

**UNIT V**

Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling, Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit, Analog receivers.

Optical system design - Point-to- point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links, WDM, Necessity, Principles, Measurement of Attenuation and Dispersion, Eye pattern.

**TEXT BOOKS :**

1. Optical Fiber Communications – Gerd Keiser, Mc Graw-Hill International edition, 3<sup>rd</sup> Edition, 2000.
2. Optical Fiber Communications – John M. Senior, PHI, 2nd Edition, 2002.



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**REFERENCES:**

1. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education, 2005.
2. Fiber Optic Communications – Joseph C. Palais, 4th Edition, Pearson Education, 2004.

**Course Outcomes:**

After going through this course the student will be able to

1. Choose necessary components required in modern optical communications systems .
2. Design and build optical fiber experiments in the laboratory, and learn how to calculate electromagnetic modes in waveguides, the amount of light lost going through an optical system, dispersion of optical fibers.
3. Use different types of photo detectors and optical test equipment to analyze optical fiber and light wave systems.
4. Choose the optical cables for better communication with minimum losses
5. Design, build, and demonstrate optical fiber experiments in the laboratory.



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<b>IV Year – I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL IMAGE PROCESSING</b>					
<b>(PE-3)</b>					

**UNIT I**

**Introduction:** Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.

**Image Transforms:** Need for image transforms, Discrete Fourier transform (DFT) of one variable, Extension to functions of two variables, some properties of the 2-D Discrete Fourier transform, Importance of Phase, Walsh Transform. Hadamard transform, Haar Transform, Slant transform, Discrete Cosine transform, KL Transform, SVD and Radon Transform, Comparison of different image transforms

**UNIT II**

**Intensity Transformations and Spatial Filtering:** Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, Combining spatial enhancement methods

**Filtering in the Frequency Domain:** Preliminary concepts, The Basics of filtering in the frequency domain, image smoothing using frequency domain filters, Image Sharpening using frequency domain filters, Selective filtering

**UNIT III**

**Image Restoration and Reconstruction:** A model of the image degradation / Restoration process, Noise models, restoration in the presence of noise only-Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position –Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering, constrained least squares filtering, geometric mean filter, image reconstruction from projections.

**UNIT IV**

**Image compression:** Fundamentals, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Symbol-Based coding, Bit-Plane coding, Block Transform coding, Predictive coding

**Wavelets and Multiresolution Processing:** Image pyramids, subband coding, Multiresolution expansions, wavelet transforms in one dimensions & two dimensions, Wavelet coding.

**UNIT V**

**Image segmentation:** Fundamentals, point, line, edge detection, thresholding, region –based segmentation.

**Morphological Image Processing:** Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds.





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**Color image processing:** color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening. Image segmentation based on color, noise in color images, color image compression.

**Text Books**

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3<sup>rd</sup> edition, Prentice Hall, 2008.
2. Jayaraman, S. Esakkirajan, and T. Veerakumar, ” Digital Image Processing”, Tata McGraw-Hill Education, 2011.

**Reference Books**

1. Anil K.Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India, 9<sup>th</sup> Edition, Indian Reprint, 2002.
2. B.Chanda, D.Dutta Majumder, “Digital Image Processing and Analysis”, PHI, 2009.

**Course Outcomes:**

After undergoing the course students will be able to

1. Perform image manipulations and different digital image processing techniques
2. Perform basic operations like – Enhancement, segmentation, compression, Image transforms and restoration techniques on image.
3. Analyze pseudo and full color image processing techniques.
4. Apply various morphological operators on images



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>LOW POWER VLSI DESIGN</b>					
<b>(PE-3)</b>					

**UNIT-I: Sources of Power Dissipation**

Introduction, Short-Circuit Power Dissipation, Switching Power Dissipation, Dynamic Power for a Complex Gate, Reduced Voltage Swing, Switching Activity, Leakage Power Dissipation, p–n Junction Reverse-Biased Current, Band-to-Band Tunneling Current, Subthreshold Leakage Current, Short-Channel Effects

**UNIT 2: Supply Voltage Scaling for Low Power**

Device Feature Size Scaling, Constant-Field Scaling, Constant-Voltage Scaling, Architectural-Level Approaches: Parallelism for Low Power, Pipelining for Low Power, Combining Parallelism with Pipelining, Voltage Scaling Using High-Level Transformations: Multilevel Voltage Scaling Challenges in MVS Voltage Scaling Interfaces, Static Timing Analysis Dynamic Voltage and Frequency Scaling

**UNIT-3: Switched Capacitance Minimization**

Probabilistic Power Analysis: Random logic signals, probability and frequency, probabilistic power analysis techniques, signal entropy, Bus Encoding: Gray Coding, One-Hot Coding, Bus-Inversion, T0 Coding, Clock Gating, Gated-Clock FSMs FSM State Encoding, FSM Partitioning, Precomputation, Glitching Power Minimization

**UNIT 4: Leakage Power Minimization**

Fabrication of Multiple Threshold Voltages, Multiple Channel Doping, Multiple Oxide CMOS, Multiple Channel Length, Multiple Body Bias, VTCMOS Approach, MTCMOS Approach, Power Gating, Clock Gating Versus Power Gating, Power-Gating Issues, Isolation Strategy, State Retention Strategy, Power-Gating Controller, Power Management, Combining DVFS and Power Management

**UNIT 5:Low power clock distribution& Simulation Power Analysis**

Low power clock distribution: Power dissipation in clock distribution, single driver versus distributed buffers, Zero skew versus tolerable skew, chip and package co design for clock network.

Simulation Power Analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, architecture level analysis, data correlation analysis of DSP systems, Monte Carlo Simulation

Special Techniques: Power Reduction in Clock networks, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.

**TEXT BOOKS:**

1. Low-Power VLSI Circuits and Systems, Ajit Pal, SPRINGER PUBLISHERS
2. PRACTICAL LOW POWER DIGITAL VLSI DESIGN , Gary Yeap Motorola, SPRINGER SCIENCE+BUSINESS MEDIA, LLC.

**REFERENCE BOOKS:**

1. Low Power CMOS Design – Anantha Chandrakasan, IEEE Press/Wiley International, 1998. 2
2. Massoud Pedram, Jan M. Rabaey , “Low power design methodologies “, Kluwer Academic Publishers.
3. Low Power CMOS VLSI Circuit Design – A. Bellamour, M. I. Elamasri, Kluwer Academic Press, 1995.



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**Course Outcomes:**

1. Capability to recognize advanced issues in VLSI systems, specific to the deep-submicron silicon Technologies.
2. Students able to understand deep submicron CMOS technology and digital CMOS design styles.
3. To design chips used for battery-powered systems and high performance circuits.
4. Learn the design of various CMOS dynamic logic circuits.
5. Learn the design techniques low voltage and low power CMOS circuits for various applications.
6. Learn the different types of memory circuits and their design.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SATELLITE COMMUNICATION</b>					
<b>(PE-4)</b>					

**UNIT I**

**INTRODUCTION:** Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications.

**ORBITAL MECHANICS AND LAUNCHERS:** Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.

**UNIT II**

**SATELLITE SUB SYSTEMS:** Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification.

**UNIT III**

**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 example.

**UNIT IV**

**MULTIPLE ACCESS:** Frequency division multiple access (FDMA) Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, link design using TDMA, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA), Spread spectrum transmission and reception.

**EARTH STATION TECHNOLOGY:** Introduction, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods.

**UNIT V**

**LOW EARTH ORBIT AND GEO-STATIONARY SATELLITE SYSTEMS:** Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs

**SATELLITE NAVIGATION & THE 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, GPS C/A code accuracy, Differential GPS.

**TEXT BOOKS:**

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003.
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G. Suyderhoud, 2nd Edition, Pearson Publications, 2003.
3. Digital satellite communication by TRI T HA .....TMH



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**REFERENCES:**

1. Satellite Communications : Design Principles – M. Richharia, BS Publications, 2<sup>nd</sup> Edition, 2003.
2. Satellite Communication - D.C Agarwal, Khanna Publications, 5th Ed.
3. Fundamentals of Satellite Communications – K.N. Raja Rao, PHI, 2004
4. Satellite Communications – Dennis Roddy, McGraw Hill, 2nd Edition, 1996.

**Course Outcomes:**

**At the end of this course the student can able to:**

1. Understand the concepts, applications and subsystems of Satellite communications.
2. Derive the expression for G/T ratio and to solve some analytical problems on satellite link design.
3. Understand the various types of multiple access techniques and architecture of earth station design.
4. Understand the concepts of GPS and its architecture.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SOFT COMPUTING TECHNIQUES</b>					
<b>(PE-4)</b>					

**UNIT I:** Introduction: Approaches to intelligent control, Architecture for intelligent control, Symbolic reasoning system, Rule-based systems, the AI approach, Knowledge representation - Expert systems.

**UNIT II:** Artificial Neural Networks: Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron, Learning and Training the neural network, Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations, Hopfield network, Self-organizing network and Recurrent network, Neural Network based controller.

**UNIT III:** Fuzzy Logic System: Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning, Introduction to fuzzy logic modeling and control, Fuzzification, inferencing and defuzzification, Fuzzy knowledge and rule bases, Fuzzy modeling and control schemes for nonlinear systems, Self-organizing fuzzy logic control, Fuzzy logic control for nonlinear time delay system.

**UNIT IV:** Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, Adjustment of free parameters, Solution of typical control problems using genetic algorithm, Concept on some other search techniques like Tabu search and ant D-colony search techniques for solving optimization problems.

**UNIT V:** Applications: GA application to power system optimization problem, Case studies: Identification and control of linear and nonlinear dynamic systems using MATLAB-Neural Network toolbox, Stability analysis of Neural Network interconnection systems, Implementation of fuzzy logic controller using MATLAB fuzzy-logic toolbox, Stability analysis of fuzzy control systems.

**TEXT BOOKS:**

1. Introduction to Artificial Neural Systems - Jacek.M.Zurada, Jaico Publishing House, 1999.
2. Neural Networks and Fuzzy Systems - Kosko, B., Prentice-Hall of India Pvt. Ltd., 1994.

**REFERENCE BOOKS:**

1. Fuzzy Sets, Uncertainty and Information - Klir G.J. & Folger T.A., Prentice-Hall of India Pvt. Ltd., 1993.
2. Fuzzy Set Theory and Its Applications - Zimmerman H.J. Kluwer Academic Publishers, 1994. Introduction to Fuzzy Control - Driankov, Hellendroon, Narosa Publishers.
3. Artificial Neural Networks - Dr. B. Yagananarayana, 1999, PHI, New Delhi.



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4. Elements of Artificial Neural Networks - Kishan Mehrotra, Chelkuri K. Mohan, Sanjay Ranka, Penram International.
5. Artificial Neural Network –Simon Haykin, 2nd Ed., Pearson Education.
6. Introduction Neural Networks Using MATLAB 6.0 - S.N. Shivanandam, S. Sumati, S. N. Deepa, 1/e, TMH, New Delhi

**Course Outcomes:**

1. Develop intelligent systems leveraging the paradigm of soft computing techniques.
2. Implement, evaluate and compare solutions by various soft computing approaches for finding the optimal solutions.
3. Recognize the feasibility of applying a soft computing methodology for a particular problem
4. Design the methodology to solve optimization problems using fuzzy logic, genetic algorithms and neural networks.
5. Design hybrid system to revise the principles of soft computing in various application



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL IC DESIGN USING CMOS</b>					
<b>(PE-4)</b>					

**UNIT-I:**

**MOS Design:** Pseudo NMOS Logic – Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

**UNIT-II:**

**Combinational MOS Logic Circuits:** MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

**UNIT-III:**

**Sequential MOS Logic Circuits:** Behaviour of bistable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.

**UNIT-IV:**

**Dynamic Logic Circuits:** Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits.

**UNIT-V:**

**Interconnect:** Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques.

**Semiconductor Memories:** Memory Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NAND flash.

Designing Memory and Array Structures: Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read Only Memories, Non-volatile Read-Write Memories, Read-Write Memories (RAM), Contents Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control.

**Text Books:**

1. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2<sup>nd</sup> Ed., PHI.
2. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.

**References:**

1. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3<sup>rd</sup> Ed., 2011.
2. CMOS VLSI Design – Neil H.E Weste, David harris, Ayan Banerjee 3<sup>rd</sup> Edition, Pearson





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**Course Outcomes:**

After going through this course the student will be able to

1. Understand the concepts of MOS Design.
2. Design and analysis of Combinational and Sequential MOS Circuits.
3. Extend the Digital IC Design to Different Applications.
4. Understand the Concepts of Semiconductor Memories, Flash Memory, RAM array organization.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>RADAR ENGINEERING</b>					
<b>(PE-5)</b>					

**UNIT-I:**

**Basics of Radar:** Introduction, Maximum Unambiguous Range, simple Radar range Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Illustrative Problems

**Radar Equation :** Modified Radar Range Equation, SNR, probability of detection, probability of False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Creeping Wave, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.

**UNIT-II:**

**CW and Frequency Modulated Radar :** Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. Illustrative Problems

**FM-CW Radar:** Range and Doppler Measurement, Block Diagram and Characteristics, FM-CW altimeter, Multiple Frequency CW Radar.

**UNIT-III:**

**MTI and Pulse Doppler Radar:** Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation,  $N^{\text{th}}$  Cancellation Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar.

**UNIT –IV:**

**Tracking Radar:** Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers.

**UNIT –V:**

**Detection of Radar Signals in Noise :** Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation detection and Cross-correlation Receiver, Efficiency of Non-matched Filters, Matched Filter with Non-white Noise, Noise Figure and Noise Temperature.

**Radar Transmitters & Receivers** –Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Series versus parallel feeds, Applications, Advantages and Limitations. Radomes Modulators, solid state



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**TEXT BOOKS:**

1. Introduction to Radar Systems – Merrill I. Skolnik, TMH Special Indian Edition, 2<sup>nd</sup> Ed., 2007.

**REFERENCE BOOKS:**

1. Radar: Principles, Technology, Applications – Byron Edde, Pearson Education, 2004.
2. Radar Principles – Peebles, Jr., P.Z., Wiley, New York, 1998.
3. Principles of Modern Radar: Basic Principles – Mark A. Richards, James A. Scheer, William A. Holm, Yesdee, 2013
4. Radar Engineering – GSN Raju, IK International.

**Course Outcomes:**

**After going through this course the student will be able to:**

1. Derive the radar range equation and to solve some analytical problems.
2. Understand the different types of radars and its applications.
3. Understand the concept of tracking and different tracking techniques.
4. Understand the various components of radar receiver and its performance.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>PATTERN RECOGNITION &amp; MACHINE LEARNING</b>					
<b>(PE-5)</b>					

**Unit I**

**Introduction to Pattern Recognition:** Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bays rule, discriminate functions, loss functions and Bayesian error analysis

**Unit II**

**Linear models:** Linear Models for Regression, linear regression, logistic regression  
 Linear Models for Classification

**Unit III**

**Neural Network:** perception, multi-layer perception, back propagation algorithm, error surfaces, practical techniques for improving back propagation, additional networks and training methods, Adboost, Deep Learning

**Unit IV**

**Linear discriminate functions** - decision surfaces, two-category, multi-category, minimum-squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine

**Unit V**

Algorithm independent machine learning – lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers  
 Unsupervised learning and clustering – k-means clustering, fuzzy k-means clustering, hierarchical clustering

**TEXT BOOKS:**

1. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, 2nd Edition John Wiley & Sons,2001.
2. Machine learning by Saikat Dutt, S. Chandramouli and A.K.Das Pearso publishing, 2018.

**REFERENCE BOOKS:**

1. C. Bishop, “Pattern Recognition and Machine Learning”, Springer,2006
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, “The Elements of Statistical Learning”, 2nd Edition, Springer,2009.

**Course Outcomes:**

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

1. Study the parametric and linear models for classification
2. Design neural network and SVM for classification
3. Develop machine independent and unsupervised learning techniques.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>INTERNET OF THINGS</b>					
<b>(PE-5)</b>					

**UNIT I:** Introduction to IoT Introduction to IoT, Architectural Overview, Design principles and needed capabilities, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.

**UNIT II:** Elements of IoT Hardware Components- Computing- Arduino, Raspberry Pi, ARM Cortex-A class processor, Embedded Devices – ARM Cortex-M class processor, Arm Cortex-M0 Processor Architecture, Block Diagram, Cortex-M0 Processor Instruction Set, ARM and Thumb Instruction Set.

**UNIT III:** IoT Application Development Communication, IoT Applications, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, CoAP, UDP, TCP, Bluetooth. Bluetooth Smart Connectivity Bluetooth overview, Bluetooth Key Versions, Bluetooth Low Energy (BLE) Protocol, Bluetooth, Low Energy Architecture, PSoC4 BLE architecture and Component Overview.

**UNIT IV:** Solution framework for IoT applications Implementation of Device integration, Data acquisition and integration, Device data storage Unstructured data storage on cloud/local server, Authentication, authorization of devices.

**UNIT V:** IoT Case Studies IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.  
 Cloud Analytics for IoT Application: Introduction to cloud computing, Difference between Cloud Computing and Fog Computing: The Next Evolution of Cloud Computing, Role of Cloud Computing in IoT, Connecting IoT to cloud, Cloud Storage for IoT Challenge in integration of IoT with Cloud.

**Text Books:**

1. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017.
2. The Definitive Guide to the ARM Cortex-M0 by Joseph Yiu, 2011.
3. Vijay Madiseti, ArshdeepBahga, Internet of Things, "A Hands on Approach", University Press, 2015.

**References:**

1. Cypress Semiconductor/PSoC4 BLE (Bluetooth Low Energy) Product Training Modules.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.



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**Course Outcomes:**

The student will be able to:

1. Understand internet of Things and its hardware and software components.
2. Interface I/O devices, sensors & communication modules.
3. Remotely monitor data and control devices.
4. Design real time IoT based applications



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<b>BASICS OF SIGNALS AND SYSTEMS</b>					
<b>(OE)</b>					

**Unit I:**

Introduction: Definitions of a signal and a system, classification of signals, basic Operations on signals, elementary signals, Systems viewed as Interconnections of operations, properties of systems.

**Unit II:**

Time-domain representations for LTI systems: Convolution, impulse response representation, Convolution Sum and Convolution Integral. Properties of impulse response representation, Differential and difference equation Representations, Block diagram representations.

**UNIT III:**

Frequency-domain representation for signals: Introduction, Discrete-time and continuous-time Fourier series (derivation of series excluded) and their properties. Discrete-time and continuous-time Fourier transforms (derivations of transforms are excluded) and their properties.

**Unit IV:**

Applications of Fourier representations: Introduction, Frequency response of LTI systems, Fourier transform representation of periodic signals, Fourier transform representation of discrete time signals.

**Unit V:**

**LAPLACE & Z-TRANSFORMS:** Introduction, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Inverse Laplace transform, Relation between L.T's, and F.T. of a signal.

Z-Transforms: Introduction, Z-transform, properties of ROC, properties of Z – transforms, inversion Z-transforms. Z-Transform analysis of LTI Systems, unilateral Z-Transform and its application to solve difference equations

**TEXT BOOKS:**

1. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, “Signals and Systems”, Pearson, 2<sup>nd</sup> Edn.
2. B. P. Lathi, “Linear Systems and Signals”, Second Edition, Oxford University Press,
3. Simon Haykin and Van Veen, “Signals & Systems”, Wiley, 2nd Edition.

**Reference Books:**

1. Michel J. Robert, “Fundamentals of Signals and Systems”, MGH International Edition, 2008.
2. Ramakrishna Rao, “Signals and Systems”, 2008, TMH



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**Course Outcomes:**

1. Understand linear time invariant systems.
2. Apply the concepts of Fourier series representations to analyze continuous and discrete time periodic signals.
3. Understand and apply the continuous time Fourier transform, discrete time Fourier transform,
4. Apply the concepts of Laplace transform, and z-Transform to the analysis and description of LTI continuous and discrete-time systems





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<b>ELECTRONIC MEASUREMENTS AND INSTRUMENTATION</b>					
<b>(OE)</b>					

**UNIT I**

**Performance characteristics of instruments, Static characteristics;** Accuracy, Resolution, Precision, Expected value, Error, Sensitivity, Dynamic Characteristics, speed of response, Fidelity, Lag and Dynamic error. Types of errors in measurements and their analysis, Design of multi-range AC , DC meters (voltmeter &ammeter) and ohmmeter(series &shunt type) using D’arsonval movement. True rms meter.

**UNIT II**

**Specifications and designing aspects of Signal Generators** – AF sine and square wave signal generators, Function Generators, Random noise generators, Arbitrary waveform generators. Wave Analyzers, Harmonic Distortion Analyzers, Spectrum Analyzers, Digital Fourier Analyzers.

**UNIT III**

**Oscilloscopes-** general purpose CROs; block diagram , functions and implementation of various blocks, specifications, various controls and their functions , types of probes used in CROs. Measurement of frequency and phase difference using Lissajous patterns, Special purpose CROs; sampling oscilloscope, analog storage oscilloscope, digital storage oscilloscope

**UNIT IV**

**Bridge circuits-** Wheat stone bridge, measurement of very low resistance, Measurement of inductance- Maxwell’s bridge, Anderson bridge, Measurement of capacitance-Schearing Bridge. Wien Bridge, Errors and precautions in using bridges, Q-meter; principle of operation, measurement methods and sources of errors, Counters: principle of operation -modes of operation- totalizing mode, frequency mode and time period mode- sources of errors.

**UNIT V**

**Transducers-** active & passive transducers: Resistance, Capacitance, inductance; Strain gauges, LVDT, Piezo Electric transducers. Measurement of physical parameters temperature, force, pressure, velocity, acceleration and displacement

**TEXT BOOKS:**

1. Electronic instrumentation, second edition - H.S. Kalsi, Tata McGrawHill, 2004.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. HelfrickandW.D. Cooper, PHI, 5th Edition, 2002.

**REFERENCES:**

1. Electronic Instrumentation & Measurements - David A. Bell, PHI, 3<sup>rd</sup> Edition,2013.
2. Electrical and Electronic Measurement and Instrumentation A.K. Sawhney. Dhanpat Rai & Co, 12<sup>th</sup>Edition,2002.

**Course Outcomes:**

The student will be able to

1. Select the instrument to be used based on the requirements.
2. Understand and analyze different signal generators and analyzers.
3. Understand the design of oscilloscopes for different applications.
4. Design different transducers for measurement of different parameters.



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<b>PRINCIPLES OF SIGNAL PROCESSING</b>					
<b>(OE)</b>					

**Unit I:**

Discrete Signals and Systems- A Review – Introduction to DFT – Properties of DFT – Circular Convolution – Filtering methods based on DFT – FFT Algorithms – Decimation in time Algorithms, Decimation in frequency Algorithms – Use of FFT in Linear Filtering.

**Unit II:**

Structures of IIR filters – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation.

**Unit III:**

Structures of FIR filters – Linear phase FIR filter – Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques

**Unit IV:**

Multirate signal processing: Basic building blocks of multirate DSP, Decimation, Interpolation, Sampling rate conversion by a rational factor, Multistage Sampling Rate Converters.

**Unit V:**

Adaptive Filters: Introduction, LMS and RLS Adaptation Algorithms, Applications of adaptive filtering to equalization, noise cancellation.

**TEXT BOOKS:**

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing – A.V. Oppenheim and R.W. Schaffer, PHI

**Reference Books:**

1. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.
2. Understanding Digital Signal Processing 2<sup>nd</sup> Edition by Richard G. Lyons

**Course Outcomes:**

1. Use the FFT algorithm for solving the DFT of a given signal
2. Design a Digital filter (FIR&IIR) from the given specifications
3. Realize the FIR and IIR structures from the designed digital filter.
4. Use the Multirate Processing concepts in various applications
5. Apply the Adaptive signal processing concepts to various signal processing applications



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<b>INDUSTRIAL ELECTRONICS</b>					
<b>(OE)</b>					

**UNIT - I**

DC Amplifiers: Need for DC amplifiers, DC amplifiers - Drift, Causes, Darlington Emitter Follower, Cascode amplifier, Stabilization, Differential amplifiers - Chopper stabilization, Operational Amplifiers, Ideal specifications of Operational Amplifiers, Instrumentation Amplifiers.

**UNIT - II**

Regulated Power Supplies: Block diagram, Principle of voltage regulation, Series and Shunt type Linear Voltage Regulators, Protection Techniques - Short Circuit, Over voltage and Thermal Protection. Switched Mode & IC Regulators: Switched Mode voltage regulator, Comparison of Linear and Switched Mode Voltage Regulators, Servo Voltage Stabilizer, monolithic voltage regulators Fixed and Adjustable IC Voltage regulators, 3-terminal Voltage regulators - Current boosting .

**UNIT - III** SCR and Thyristor: Principles of operation and characteristics of SCR, Triggering of Thyristors, Commutation Techniques of Thyristors - Classes A, B, C, D, E and F, Ratings of SCR.

**UNIT - IV** Applications of SCR in Power Control: Static circuit breaker, Protection of SCR, Inverters - Classification, Single Phase inverters, Converters –single phase Half wave and Full wave. DIAC, TRIAC and Thyristor Applications: Chopper circuits – Principle, methods and Configurations, DIAC AND TRIAC, TRIACS – Triggering modes, Firing Circuits, Commutation.

**UNIT – V** Industrial Applications –

I: Industrial timers -Classification, types, Electronic Timers – Classification, RC and Digital timers, Time base Generators. Electric Welding Classification, types and methods of Resistance and ARC welding, Electronic DC Motor Control. Industrial Applications –  
 II: High Frequency heating – principle, merits, applications, High frequency Source for Induction heating. Dielectric Heating – principle, material properties, Electrodes and their Coupling to RF generator, Thermal losses and Applications. Ultrasonics – Generation and Applications.

**TEXTBOOKS:**

1. Industrial and Power Electronics – G. K. Mithal and Maneesha Gupta, Khanna Publishers, 19<sup>th</sup> Ed., 2003.
2. Integrated Electronics – J. Millman and C.C Halkias, McGraw Hill, 1972

**REFERENCE BOOKS:**

1. Electronic Devices and circuits – Theodore. H. Bogart, Pearson Education, 6<sup>th</sup> Edn., 2003.
2. Thyristors and applications – M. Rammurthy, East-West Press, 1977.
3. Integrated Circuits and Semiconductor Devices – Deboo and Burroughs, ISE



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**Course Outcomes:**

1. Understand the concept of DC amplifiers.
2. Analyze and design different voltage regulators for real time applications
3. Describe the basis of SCR and Thyristor
4. Determine the performance of DIAC and TRIAC
5. Develop real time application using electronics



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<b>CONSUMER ELECTRONICS</b>					
<b>(OE)</b>					

**Unit I:**

**Audio Systems:** Microphones and Loudspeakers: Carbon, moving coil, cordless microphone, Direct radiating and horn loudspeaker, Multi-speaker system, Hi-Fi stereo and dolby system. Concept to fidelity, Noise and different types of distortion in audio system

**Unit II:****Digital Audio Fundamentals:**

Audio as Data and Signal, Digital Audio Processes Outlined, Time Compression and Expansion.

**Unit III:**

**Television:** Basics of Television: Elements of TV communication system, Scanning and its need, Need of synchronizing and blanking pulses, VSB, Composite Video Signal, Colour Television: Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, NTSC, PAL, SECAM

**Unit IV:**

**Digital Transmission and Reception:** Digital satellite television, Direct-To-Home(DTH) satellite television, Introduction to :Video on demand, CCTV, High Definition(HD)-TV. Introduction to Liquid Crystal and LED Screen Televisions Basic block diagram of LCD and LED Television and their comparison

**Unit V:**

Introduction to different type of domestic/commercial appliances: Operation of Micro-wave oven, Food Processors, Digital Electronic Lock, Vacuum cleaner, Xerox Machine, Scanner

**Test Books:**

1. Modern Television Practice by R. R. Gulai; New Age International Publishers.
2. Audio Video Systems by R. G. Gupta; McGraw Hill Education System.
3. Audio Video Systems Principles Practices and Troubleshooting by Bali & Bali; Khanna Publishing Company
4. Consumer Electronics by S. P. Bali; Pearson Education, New Delhi

**Course Outcomes:**

1. Understand the various type of microphones and loud speakers.
2. To identify the various digital and analog signal.
3. Describe the basis of television and composite video signal.
4. Describe the various kind of colour TV standards and system.
5. Compare the various types of digital TV system.
6. Understand the various type of consumer goods.



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<b>FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS</b>					
<b>(OE)</b>					

**UNIT I****8085 PROCESSOR**

Hardware Architecture, pinouts — Functional Building Blocks of Processor — Memory organization — I/O ports and data transfer concepts, Interrupts.

**8086 Architecture:** Main features, pin diagram/description, 8086 microprocessor family, internal architecture, interrupts and interrupt response, 8086 system timing, minimum mode and maximum mode configuration

**UNIT II**

**8086 Programming:** Program development steps, instructions, addressing modes, assembler directives, writing simple programs with an assembler, assembly language program development tools.

**UNIT-III**

**8086 Interfacing:** Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDs, Interfacing seven segment displays, software and hardware interrupt applications, Intel 8251 USART architecture and interfacing, Intel 8237a DMA controller, stepper motor, A/D and D/A converters, Need for 8259 programmable interrupt controllers.

**UNIT IV****8051 MICRO CONTROLLER**

Hardware Architecture, pinouts — Functional Building Blocks of Processor — Memory organization — I/O ports and data transfer concepts– Timing Diagram — Interrupts- Data Transfer, Manipulation, Control Algorithms & I/O instructions, Comparison to Programming concepts with 8085.

**UNIT V****MICRO CONTROLLER PROGRAMMING & APPLICATIONS**

Simple programming exercises- key board and display interface –Control of servo motor stepper motor control- Application to automation systems.

**TEXTBOOKS:**

1. R.S. Gaonkar, Microprocessor Architecture Programming and Application, with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2. A.K Ray, K.M. Bhurchandhi, "Advanced Microprocessor and Peripherals", Tata McGraw Hill Publications, 2000.
3. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2-Edition, 2011.



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**REFERENCEBOOKS:**

1. Microprocessors and Interfacing – Programming and Hardware by Douglas V Hall, SSSP Rao, Tata Mc Graw Hill Education Private Limited, 3<sup>rd</sup> Edition, 1994

**Course Outcomes:**

At the end of this course the student will be able to:

1. Understand the architecture of microprocessor/microcontroller and their operation.
2. Demonstrate programming skills in assembly language for processors and controllers.
3. Analyze various interfacing techniques and apply them for the design of processor/Controller based systems.



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<b>TRANSDUCERS AND SENSORS</b>					
<b>(OE)</b>					

**UNIT – I**

Measurements and Instrumentation of Transducers: Measurements – Basic method of measurement – Generalized scheme for measurement systems – Units and standards – Errors – Classification of errors, error analysis – Statistical methods – Sensor – Transducer – Classification of transducers – Basic requirement of transducers.

**UNIT – II**

Characteristics of Transducers: Static characteristics – Dynamic characteristics – Mathematical model of transducer – Zero, first order and second order transducers – Response to impulse, step, ramp and sinusoidal inputs

**UNIT – III**

Resistive Transducers: Potentiometer –Loading effect – Strain gauge – Theory, types, temperature compensation – Applications – Torque measurement – Proving Ring – Load Cell – Resistance thermometer – Thermistors materials – Constructions, Characteristics – Hot wire anemometer

**UNIT – IV**

Inductive and Capacitive Transducer: Self inductive transducer – Mutual inductive transducers – Linear Variable Differential Transformer – LVDT Accelerometer – RVDT – Synchros – Microsyn – Capacitive transducer – Variable Area Type – Variable Air Gap type – Variable Permittivity type – Capacitor microphone.

**UNIT- V** Miscellaneous Transducers: Piezoelectric transducer – Hall Effect transducers – Smart sensors – Fiber optic sensors – Film sensors – MEMS – Nano sensors, Digital transducers

**TEXT BOOKS:**

1. Sawhney. A.K, “A Course in Electrical and Electronics Measurements and Instrumentation”, 18<sup>th</sup> Edition, Dhanpat Rai & Company Private Limited, 2007.
2. Patranabis. D, “Sensors and Transducers”, Prentice Hall of India, 2003.

**REFERENCE BOOKS:**

1. Renganathan. S, “Transducer Engineering”, Allied Publishers, Chennai, 2003.
2. Doebelin. E.A, “Measurement Systems – Applications and Design”, Tata McGraw Hill, New York, 2000
3. John. P, Bentley, “Principles of Measurement Systems”, III Edition, Pearson Education, 2000. 4. Murthy. D. V. S, “Transducers and Instrumentation”, Prentice Hall of India, 2001.
4. Sensor Technology Hand Book – Jon Wilson, Newne 2004.
5. Instrument Transducers – An Introduction to their Performance and design – by Herman K. P. Neubrat, Oxford University Press





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**Course Outcomes:**

At the end of the course, a student will be able to:

1. Use concepts in common methods for converting a physical parameter into an electrical quantity
2. Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
4. Predict correctly the expected performance of various sensors
5. Locate different type of sensors used in real life applications and paraphrase their importance
6. Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers
7. develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.



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<b>IOT AND APPLICATIONS</b>					
<b>(OE)</b>					

**UNIT I:**

**Introduction to IoT:** Introduction to IoT, Architectural Overview, Design principles and needed capabilities, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.

**UNIT II:**

**Elements of IoT:** Hardware Components- Computing- Arduino, Raspberry Pi, ARM Cortex-A class processor, Embedded Devices – ARM Cortex-M class processor, Arm Cortex-M0 Processor Architecture, Block Diagram, Cortex-M0 Processor Instruction Set, ARM and Thumb Instruction Set.

**UNIT III:**

**IoT Application Development:** Communication, IoT Applications, Sensing, Actuation, I/O interfaces.

Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, CoAP, UDP, TCP, Bluetooth.

**Bluetooth Smart Connectivity** Bluetooth overview, Bluetooth Key Versions, Bluetooth Low Energy (BLE) Protocol, Bluetooth, Low Energy Architecture, PSoC4 BLE architecture and Component Overview.

**UNIT IV:**

**Solution framework for IoT applications:** Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

**UNIT V:**

**IoT Case Studies:** IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation. Cloud Analytics for IoT Application :Introduction to cloud computing, Difference between Cloud Computing and Fog Computing: The Next Evolution of Cloud Computing, Role of Cloud Computing in IoT, Connecting IoT to cloud, Cloud Storage for IoT Challenge in integration of IoT with Cloud.

**Text Books:**

1. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1<sup>st</sup> Edition, McGraw Hill Education, 2017.
2. The Definitive Guide to the ARM Cortex-M0 by Joseph Yiu, 2011
3. Vijay Madiseti, Arshdeep Bahga, Internet of Things, "A Hands on Approach", University Press, 2015

**References:**

1. Cypress Semiconductor/PSoC4BLE(Bluetooth Low Energy) Product Training Modules.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.



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**Course Outcomes:**

The student will be able to:

1. Understand internet of Things and its hardware and software components.
2. Interface I/O devices, sensors & communication modules.
3. Remotely monitor data and control devices.
4. Design real time IoT based applications



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<b>SOFT COMPUTING TECHNIQUES</b>					
<b>(OE)</b>					

**UNIT –I:**

**Introduction to soft computing:** Introduction, Artificial Intelligence, Artificial Neural Networks, Fuzzy systems, Genetic Algorithm and Evolutionary programming, Swarm Intelligent systems, Expert systems, Comparison among Intelligent systems.

**UNIT –II:**

**Artificial Neural Networks:** Introduction to Artificial Neural Networks, Classification of ANNS, First generation neural networks, Perceptron network, Adaline, Madaline, Second generation neural networks, Back propagation neural networks, Hopfield Neural Network, Kohonen neural network, Hamming neural network, Radial basis function neural networks, spike neuron models.

**UNIT –III:**

**Fuzzy Logic System:** Introduction to fuzzy logic, classical sets and fuzzy sets, fuzzy set operations, fuzzy relations, fuzzy composition, natural language and fuzzy interpretations, fuzzy inference system, fuzzy controllers

**UNIT –IV:**

**Genetic Algorithm:** Introduction to Genetic algorithms, Genetic algorithms, procedures of Gas, working of Gas, Travelling sales man problem, Evolutionary programming, working principle of GA Machine learning classifier system

**UNIT –V:**

**Swarm Intelligent system:** Introduction to swarm intelligence, back ground, Ant colony system, working of ant colony optimization, Particle swarm intelligent systems, Artificial bee colony system, cuckoo search algorithm..

**TEXT BOOKS:**

1. Soft computing with MATLAB programming—N.P.Padhy, S.P.Simon, Oxford university press, 2015
2. Neural Networks and Fuzzy Systems - Kosko, B., Prentice-Hall of India Pvt. Ltd., 1994.
3. Introduction to Artificial Neural Systems-Jacek.M.Zurada, Jaico Publishing House,1999

**REFERENCE BOOKS:**

1. Fuzzy Sets, Uncertainty and Information - Klir G.J. & Folger T.A., Prentice-Hall of India Pvt. Ltd., 1993.
2. Fuzzy Set Theory and Its Applications - Zimmerman H.J. Kluwer Academic Publishers, 1994.
3. Introduction to Fuzzy Control - Driankov, Hellendroon, Narosa Publishers.
4. Artificial Neural Networks - Dr. B. Yagananarayana, 1999, PHI, New Delhi.
5. Elements of Artificial Neural Networks - Kishan Mehrotra, Chelkuri K. Mohan, Sanjay Ranka, Penram International.



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6. Artificial Neural Network –Simon Haykin, 2nd Ed., Pearson Education.
7. Introduction Neural Networks Using MATLAB 6.0 - S.N. Shivanandam, S. Sumati, S. N. Deepa,1/e, TMH, New Delhi.

**Course Outcomes:**

1. Develop intelligent systems leveraging the paradigm of soft computing techniques.
2. Implement, evaluate and compare solutions by various soft computing approaches for finding the optimal solutions.
3. Recognize the feasibility of applying a soft computing methodology for a particular problem
4. Design the methodology to solve optimization problems using fuzzy logic, genetic algorithms and neural networks.
5. Design hybrid system to revise the principles of soft computing in various application



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<b>IC APPLICATIONS</b>					
<b>(OE)</b>					

**Unit I:**

Ideal and Practical Op-Amp, Op-amp characteristics-DC and AC Characteristics, General Linear Applications of Op-Amp: Adder, Subtractor, Differentiators and Integrators, Active Filters and Oscillators, Non linear Applications of OPAMP: Comparators, Schmitt Trigger, Multivibrators

**Unit II:**

Introduction to 555 Timer, Functional Diagram, Monostable and Astable Operations and Applications, Schmitt Trigger, PLL- Introduction, Block Schematic, Principles and Description of individual Blocks of 565, VCO.

**Unit III:**

Introduction, Basic DAC Techniques - Weighted Resistor Type. R-2R Ladder Type, inverted R-2R Type. Different types of ADCs - Parallel Comparator Type. Counter Type. Successive Approximation Register Type and Dual Slope Type DAC and ADC Specifications.

**Unit IV:**

Use of TTL-74XX Series & CMOS 40XX Series ICs, TTL ICs - Code Converters, Decoders, Demultiplexers, Encoders, Priority Encoders, multiplexers & their applications. Priority Generators, Arithmetic Circuit ICs-Parallel Binary Adder/Subtractor Using 2's Complement System, Magnitude Comparator Circuits.

**Unit V:**

Commonly Available 74XX & CMOS 40XX Series ICs - RS, JK, JK Master-Slave. D and T Type Flip-Flops & their Conversions, Synchronous and asynchronous counters. Decade counters. Shift Registers & applications.

**TEXT BOOKS:**

1. Linear Integrated Circuits -D. Roy Chowdhury, New Age International (p)Ltd, 3<sup>rd</sup> Ed., 2008.
2. Digital Fundamentals - Floyd and Jain, Pearson Education, 8th Edition, 2005.

**REFERENCE BOOKS:**

1. Modern Digital Electronics - RP Jain - 4/e - TMH, 2010.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI, 1987.

**Course Outcomes:**

1. Analyse the Differential Amplifier with Discrete components
2. Describe the Op-Amp and internal Circuitry: 555 Timer, PLL
3. Discuss the Applications of Operational amplifier: 555 Timer, PLL
4. Design the digital application using digital ICs
5. Use the Op-Amp in A to D & D to A Converters



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<b>PRINCIPLES OF COMMUNICATIONS</b>					
<b>(OE)</b>					

**UNIT-1**

**Amplitude modulation:** Introduction, Amplitude Modulation: Time & Frequency – Domain description, switching modulator, Envelop detector.

**Double side band-suppressed carrier modulation:** Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing.

**Single side-band and vestigial sideband methods of modulation:** SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television

**UNIT-II**

**Angle modulation:** Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing,

**UNIT III**

Signal Sampling and Analog Pulse Communication: Ideal Sampling, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation. Digital Communication Techniques: Quantization, Digital Transmission of Data, Parallel and Serial Transmission, Data Conversion, Pulse Code Modulation, Delta Modulation.

**UNIT-IV**

**Noise in analog modulation:** Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasise in FM.

**UNIT-V**

Transmission of Binary Data in Communication Systems: Digital Codes, Principles of Digital Transmission, Transmission Efficiency, Modem Concepts and Methods – FSK, BPSK, Error Detection and Correction

**Text Books:**

1. Principles of Communication Systems – H Taub& D. Schilling, GautamSahe, TMH, 2007, 3<sup>rd</sup>Edition.
2. Communication Systems – B.P. Lathi, BS Publication,2006.

**References:**

1. Principles of Communication Systems - Simon Haykin, John Wiley,2ndEdition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
3. Communication Systems– R.P. Singh, SP Sapre, Second Edition TMH,2007.



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**Course Outcomes:**

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

1. Analyze the performance of analog modulation schemes in time and frequency domains.
2. Analyze the performance of angle modulated signals.
3. Characterize analog signals in time domain as random processes and noise
4. Characterize the influence of channel on analog modulated signals
5. Determine the performance of analog communication systems in terms of SNR
6. Analyze pulse amplitude modulation, pulse position modulation, pulse code modulation and TDM systems.





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<b>BASIC ELECTRONICS</b>					
<b>(OE)</b>					

**Unit I:** Semiconductor Basics: Atomic Structure, Semiconductors, Conductors, and Insulators, Covalent Bonds, Conduction in Semiconductors, N-Type and P-Type Semiconductors, Diode, Biasing a Diode, Voltage-Current Characteristic of a Diode, Diode Models.

Diode Applications: Half- Wave Rectifiers, Full-Wave Rectifiers, Power Supply Filters and Regulators.

**Unit II:** Special-Purpose Diodes: Zener Diodes, Zener Diode Applications, Varactor Diodes, Optical Diodes

**Unit III:** Bipolar junction Transistors: Transistor Structure, Basic Transistor Operation, Transistor Characteristics and Parameters, Transistor as an Amplifier and Switch

**Unit IV:** Field-Effect Transistors (FETs): JFET, Characteristics and Parameters, JFET Biasing, MOSFET Characteristics and Parameters

**Unit V:** Thyristors and Other Devices: Basic 4-Layer Device, The Silicon-Controlled Rectifier, SCR Applications, Unijunction Transistor, IGBT, Phototransistor, Light-Activated SCR, Optical Couplers

**Text Books:**

1. Electronic Devices conventional current version By Floyd, Seventh Edition, Pearson publications

**References:**

1. Electronics devices & circuit theory- Robert L.Boylestad and Loui Nashelsky, Pearson/Prentice hall, tenth edition, 2009
2. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, SecondEdition,2007

**Course Outcomes:**

At the end of this course the student will be able to

1. Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
2. Know the construction, working principle of rectifiers with and without filters with relevant expressions and necessary comparisons.
3. Understand the construction, principle of operation of transistors,



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<b>DATA COMMUNICATIONS</b>					
<b>(OE)</b>					

**UNIT I:**

**Introduction to Data Communications:** Components, Data Representation, Data Flow, Networks-Distributed Processing, Network Criteria, Physical Structures, Network Models, Categories of Networks Interconnection of Networks, The Internet - A Brief History, The Internet Today, Protocol and Standards - Protocols, Standards, Standards Organizations, Internet Standards. Network Models, Layered Tasks, OSI model, Layers in OSI model, TCP/IP Protocol Suite, Addressing Introduction, Wireless Links and Network Characteristics, WiFi: 802.11 Wireless LANs -The 802.11 Architecture,

**UNIT II:**

**Data Link Layer:** Links, Access Networks, and LANs- Introduction to the Link Layer, The Services Provided by the Link Layer, Types of errors, Redundancy, Detection vs Correction, Forward error correction Versus Retransmission Error-Detection and Correction Techniques, Parity Checks, Check summing Methods, Cyclic Redundancy Check (CRC) , Framing, Flow Control and Error Control protocols , Noisy less Channels and Noisy Channels, HDLC, Multiple Access Protocols, Random Access ,ALOHA, Controlled access, Channelization Protocols. 802.11 MAC Protocol, IEEE 802.11 Frame.

**UNIT III:**

**The Network Layer:** Introduction, Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks-Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks, Inside a Router-Input Processing, Switching, Output Processing, Queuing, The Routing Control Plane, The Internet Protocol(IP):Forwarding and Addressing in the Internet-Datagram format, Ipv4 Addressing, Internet Control Message Protocol(ICMP), IPv6

**UNIT IV:**

**Transport Layer:** Introduction and Transport Layer Services : Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing, Connectionless Transport: UDP -UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer-Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N(GBN), Selective Repeat(SR), Connection Oriented Transport: TCP - The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control - The Cause and the Costs of Congestion, Approaches to Congestion Control

**UNIT V:**

**Application Layer:** Principles of Networking Applications – Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the File Transfer: FTP,- FTP Commands and Replies, Electronic Mail in the Internet- STMP, Comparison with HTTP, DNS-The Internet’s Directory Service – Service Provided by DNS, Overview of How DNS Works, DNS Records and messages.

**TEXT BOOKS:**

1. Computer Networking A Top-Down Approach – Kurose James F, Keith W, 6thEdition , Pearson,2017.
2. Data Communications and Networking Behrouz A.Forouzan4th Edition McGraw Hill Education,2017.



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**REFERENCES:**

1. Data communication and Networks - Bhusan Trivedi, Oxford university press, 2016
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education, 2003.
3. Understanding Communications and Networks, 3<sup>rd</sup> Edition, W.A.Shay, Cengage Learning, 2003.

**Course Outcomes:**

Upon completing this course, the student will be able to

1. Know the Categories and functions of various Data communication Networks
2. Design and analyze various error detection techniques.
3. Demonstrate the mechanism of routing the data in network layer
4. Know the significance of various Flow control and Congestion control Mechanisms



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<b>DIGITAL LOGIC DESIGN</b>					
<b>(OE)</b>					

**UNIT – I****REVIEW OF NUMBER SYSTEMS & CODES:**

Representation of numbers of different radix, conversion from one radix to another radix, r-1's compliments and r's compliments of signed members, Gray code, 4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc. Error detection & correction codes: parity checking, even parity, odd parity, Hamming code.

**BOOLEAN THEOREMS AND LOGIC OPERATIONS:**

Boolean theorems, principle of complementation & duality, De-morgan theorems, Logic operations ; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX- NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations, Realization of three level logic circuits. Study the pin diagram and obtain truth table for the following relevant ICs 7400,7402,7404,7408,7432,7486.

**UNIT – II****MINIMIZATION TECHNIQUES:**

Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables) and tabular method (Quine-mccluskey method) with only four variables and single function.

**COMBINATIONAL LOGIC CIRCUITS DESIGN:**

Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-ahead adder circuit, Design code converts using Karnaugh method and draw the complete circuit diagrams.

**UNIT – III****COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI &LSI :**

Design of encoder, decoder, multiplexer and de-multiplexers, Implementation of higher order circuits using lower order circuits . Realization of Boolean functions using decoders and multiplexers, Design of Priority encoder, 4-bit digital comparator and seven segment decoder. . Study the relevant ICs pin diagrams and their functions 7442,7447,7485,74154.

**INTRODUCTION OF PLD's :**

PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

**UNIT – IV****SEQUENTIAL CIRCUITS I:**

Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another flip-flop, Design of 5ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift, register, Study the following relevant ICs and their relevant functions 7474,7475,7476,7490,7493,74121.

**UNIT – V****SEQUENTIAL CIRCUITS II :**

Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa, Realization of sequence generator, Design of Clocked Sequential Circuit to detect the given sequence (with overlapping or without overlapping)



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**TEXT BOOKS:**

1. Switching and finite automata theory Zvi.KOHAVI, Niraj.K. Jha 3<sup>rd</sup>Edition,Cambridge UniversityPress,2009
2. Digital Design by M.Morris Mano, Michael D Ciletti,4<sup>th</sup> edition PHIpublication,2008
3. Switching theory and logic design by Hill and Peterson, Mc-Graw Hill TMH edition, 2012.

**REFERENCES:**

1. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers, 2006
2. Digital electronics by R.S. Sedha. S. Chand & company limited, 2010
3. Switching Theory and Logic Design by A. Anand Kumar, PHI Learning Pvt Ltd, 2016.
4. Digital logic applications and design by John M. Yarbough, Cengage Learning, 2006.
5. TTL74-Series data book.

**Course Outcomes:**

1. Classify different number systems and apply to generate various codes.
2. Use the concept of Boolean algebra in minimization of switching functions
3. Design different types of combination logic circuits.
4. Apply knowledge of flip-flops in designing of Registers and counters
5. The operation and design methodology for synchronous sequential circuits and algorithmic state machines
6. Produce innovative designs by modifying the traditional design techniques



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<b>REMOTE SENSING AND GIS</b>					
<b>(OE)</b>					

**UNIT – I**

Introduction to Photogrammetry: Principles & types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducial points, parallax measurement using fiducial line.

**UNIT – II**

Remote Sensing: Basic concept of remote sensing, Data and Information, Remote sensing data Collection, Remote sensing advantages & Limitations, Remote Sensing process. Electro-magnetic Spectrum, Energy interactions with atmosphere and with earth surface features (soil, water, vegetation), Indian Satellites and Sensors characteristics, Resolution, Map and Image and False color composite, introduction to digital data, elements of visual interpretation techniques.

**UNIT – III**

Geographic Information Systems: Introduction to GIS; Components of a GIS; Geospatial Data: Spatial Data-Attribute data – Joining Spatial and Attribute data; GIS Operations: Spatial Data Input- Attribute data Management –Data display- Data Exploration- Data Analysis. COORDINATE SYSTEMS: Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters

**UNIT – IV**

Vector Data Model: Representation of simple features- Topology and its importance; coverage and its data structure, Shape file; Data models for composite features Object Based Vector Data Model; Classes and their Relationship; The geobase data model; Geometric representation of Spatial Feature and data structure, Topology rules

**UNIT – V**

Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data Conversion, Integration of Raster and Vector data. Data Input: Metadata, Conversion of Existing data, creating new data; Remote Sensing data, Field data, Text data, Digitizing, Scanning, on screen digitizing, importance of source map, Data Editing

**TEXT BOOKS:**

1. Remote Sensing and GIS Lillesand and Kiefer, John Willey 2008.
2. Remote Sensing and GIS B. Bhatta by Oxford Publishers 2015.
3. Introduction to Geographic Information System – Kang-Tsung Chang, McGraw-Hill 2015



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**REFERENCES:**

1. Concepts & Techniques of GIS by C. P. Lo Albert, K.W. Yongng, Prentice Hall (India) Publications.
2. Principals of Geo physical Information Systems – Peter A Burragh and Rachael A. Mc Donnell, Oxford Publishers 2004.
3. Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications

**Course Outcomes:** At the end of the course, the student will be able to:

1. Retrieve the information content of remotely sensed data
2. Analyze the energy interactions in the atmosphere and earth surface features
3. Interpret the images for preparation of thematic maps
4. Apply problem specific remote sensing data for engineering applications
5. Analyze spatial and attribute data for solving spatial problems
6. Create GIS and cartographic outputs for presentation



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<b>BIO MEDICAL INSTRUMENTATION</b>					
<b>(OE)</b>					

**UNIT-I**

**Sources of Bioelectric potentials and Electrodes:** Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials. Electrodes: Electrode theory, Bio Potential Electrodes, Biochemical Transducers, introduction to bio-medical signals

**UNIT-II**

**The Cardiovascular System:** The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds, Cardio Vascular Measurements, Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmography, Measurement of Heart Sounds, Event detection, PQRS & T-Waves in ECG, the first & second Heart beats, ECG rhythm analysis, the di-crotic notch in the carotid pulse detection of events and waves, analysis of exercise ECG, analysis of event related potentials, correlation analysis of EEG channels, correlation of muscular contraction.

**UNIT- III**

**Patient Care & Monitory and Measurements in Respiratory System:** The elements of Intensive Care Monitory, Diagnosis, Calibration and reparability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators, the physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment, analysis of respiration.

**UNIT-IV**

Bio telemetry and Instrumentation for the clinical laboratory Introduction to bio telemetry, Physiological parameters adaptable to bio telemetry, the components of bio telemetry system, implantable units, applications of telemetry in patient care – The blood, tests on blood cells, chemical test, automation of chemical tests.

**UNIT-V****X-ray and radioisotope instrumentation and electrical safety of medical equipment:**

Generation of Ionizing radiation, instrumentation for diagnostic X-rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy - Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention, Modern Imaging Systems: Tomography, Magnetic resonance Imaging System, Ultrasonic Imaging System, Medical Thermography

**TEXT BOOK:**

1. Biomedical Instrumentation and Measurements – C. Cromwell, F.J. Weibell, E.A.Pfeiffer – Pearson education.
2. Biomedical signal analysis – Rangaraj, M. Rangayya – Wiley Inter science – John willey & Sons Inc.





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**Reference:**

1. Hand Book of Bio-Medical Instrumentation – R.S. Khandpur, (TMH)
2. Introduction to Bio-Medical Engineering – Domach, (Pearson)
3. Introduction to Bio-Medical Equipment Technology – Cart, (Pearson)

**Course outcomes:**

1. Apply principles and concepts of electronics to analyze input and output signals in medical electronics
2. Apply principles and concepts of electronics to design filters for de-noising of medical measurements
3. Recognize different types of transducers, ongoing progress in improving their design, and their application in medical measurements
4. Apply principles and concepts of engineering to quantify and model measurements of biopotentials
5. Apply principles and concepts of sensing and engineering to (i) design diagnostic devices for detection of markers in biofluids, and (ii) be able to evaluate quality of diagnostic devices
6. Apply engineering tools to evaluate parameters needed for point-of-care health screening and mobile-health, and design of appropriate point-of-care diagnostic devices



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<b>Data Acquisition Systems</b>					

**UNIT-1**

**INTRODUCTION:** Objective of a DAS, single channel DAS, Multi-channel DAS, Components used in DAS– Converter Characteristics-Resolution-Non-linearity, settling time, Monotonicity.

**UNIT-2**

**ANALOG TO DIGITAL CONVERTERS (ADCS):** Classification of A/D Converters, Parallel feed back – Successive approximation – Ramp comparison – Dual slope integration – Voltage to frequency – Voltage to Time – Logarithmic types of ADCS.

**NON-LINEAR DATA CONVERTERS (NDC):** Basic NDC configurations – Some common NDACS and NADCS – Programmable non-linear ADCS – NADC using optimal sized ROM – High speed hybrid NADC – PLS based NADC – Switched capacitor NDCS.

**ADC APPLICATIONS:** Data Acquisition systems – Digital signal processing systems – PCM voice communication systems – Test and measurement instruments – Electronic weighing machines.

**UNIT-3**

**DIGITAL TO ANALOG CONVERTERS (DACs): Principles and design of – Parallel R– 2R, Weighted resistor, inverted ladder, D/A decoding – Codes other than ordinary binary.**

**DATA CONVERTER APPLICATIONS:** DAC applications – Digitally programmable V/I sources – Arbitrary waveform generators – Digitally programmable gain amplifiers – Analog multipliers/ dividers – Analog delay lines.

**UNIT-4**

**Monolithic data converters:** typical study of monolithic DACs and ADCs. Interfacing of DACs and ADCs to a  $\mu$ P

**UNIT-5**

**Error budget of DACs and ADCs:** Error sources, error reduction and noise reduction Techniques in DAS, Error budget analysis of DAS, case study of a DAC and an ADC

**TEXT BOOKS:**

1. Electronic data converters fundamentals and applications – Dinesh K. Anvekar, B.S. Sonde – Tata McGraw Hill

**REFERENCES:**

1. Electronic Analog/ Digital conversions – Hermann Schmid – Tata McGraw Hill.
2. E.R. Hanateck, User's Handbook of D/A and A/D converters – Wiley
3. Electronic instrumentation by HS Kalsi- TMH 2 ndEdition, 2004.
4. Data converters by G.B. Clayton



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**Course Outcomes:**

1. Be able to identify a data acquisition system.
2. Be able to prescribe a sensor type to measure a specific environmental change.
3. Be able to determine what type of amplifier is needed for a specific sensor output.
4. Be familiar with different forms of signal conditioning.
5. Be familiar with different methods of Analog-to-Digital conversion.
6. Be able to identify the type of interface used to get a digital signal into a microprocessor.



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<b>ADAPTIVE CONTROL SYSTEMS</b>					

**Unit-1:**

Introduction: Definitions, History of adaptive Control, Essential aspects of adaptive control, Classification of adaptive control system: Feedback adaptive controllers, Feed forward adaptive controllers, Why adaptive control?

**Unit-2:**

Model Reference Adaptive System: Different configuration of model reference adaptive Systems, classification of MRAS, Mathematical description, and Equivalent representation as a nonlinear time-varying system, direct and indirect MRAS.

**Unit-3:**

Analysis and Design of Model Reference Adaptive Systems: Model reference control with local parametric optimization (Gradient method), MIT rule, MRAS for a first order system, MRAS based on Lyapunov stability theory, Design of a first order MRAS based on stability theory, Hyperstability approach, Monopoli's augmented error approach.

**Unit-4:**

Self Tuning Regulators: Introduction: The basic idea; process models, disturbance models, General linear difference equation models, model simplification, Different approaches to self-tuning, Recursive Parameter Estimation Methods: The RLS method, extended Least squares, Recursive instrumental variable method; U-D factorization, Covariance resulting, variable data forgetting, Estimation accuracy, Direct and Indirect Self-tuning regulators, Clarke and Gawthrop's Self tuning Controller, Pole Placement approach to self tuning control; Connection between MRAS and STR.

**Unit 5:**

Gain Scheduling: Introduction, The Principal, Design of Gain Scheduling Regulators, Nonlinear transformations, Applications of gain scheduling Alternatives to Adaptive Control: Why not Adaptive Control? Robust High gain feedback control, Variable Structure schemes, Practical aspects, application and Perspectives on adaptive control.

**References Books:**

1. B Landau, Adaptive Control - The Model Reference Approach, New York; Marcel Dekker, 1979.
2. K. J. Astrom and B. Wittenmark, Adaptive Control, Addison Wesley Publication Company, 1989.
3. B. Roffel, P. J. Vermeer, P. A. Chin, Simulation and Implementation of self Tuning Controllers, Prentice-Hall, Englewood cliffs, NJ, 1989.
4. R. Isermann, K. Lashmann and D. Marko, Adaptive Control Systems, Printice-Hall International (UK) Ltd. 1992.
5. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems



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**Course Outcomes:**

- CO1: Design identifiers and adaptive controllers for linear systems
- CO2: Design Adaptive feedback linearizing control systems for nonlinear systems
- CO3: Apply the concept of different types of optimal control for solving problems
- CO 4 Apply the concept of calculus of variation and principal of optimality for solving problems
- CO 5 Apply the concept of Linear Quadratic method for solving problems
- CO 6 Apply the concept of adaptive control technique for solving problems



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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

<b>POOL-1 (HONOR)</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>
<b>BIO-MEDICAL INSTRUMENTATION</b>					

**UNIT-I**

**Sources of Bioelectric potentials and Electrodes:** Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials. Electrodes: Electrode theory, Bio Potential Electrodes, Biochemical Transducers, introduction to bio-medical signals

**UNIT-II**

**The Cardiovascular System:** The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds, Cardio Vascular Measurements, Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmography, Measurement of Heart Sounds, Event detection, PQRS & T-Waves in ECG, the first & second Heart beats, ECG rhythm analysis, the di-crotic notch in the carotid pulse detection of events and waves, analysis of exercise ECG, analysis of event related Potentials, correlation analysis of EEG channels, correlation of muscular contraction.

**UNIT- III**

**Patient Care & Monitory and Measurements in Respiratory System:** The elements of Intensive Care Monitory, Diagnosis, Calibration and reparability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators, the physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment, analysis of respiration.

**UNIT-IV**

Bio telemetry and Instrumentation for the clinical laboratory Introduction to bio telemetry, Physiological parameters adaptable to bio telemetry, the components of bio telemetry system, implantable units, applications of telemetry in patient care – The blood, tests on blood cells, chemical test, automation of chemical tests.

**UNIT-V**

**X-ray and radioisotope instrumentation and electrical safety of medical equipment:** Generation of Ionizing radiation, instrumentation for diagnostic X-rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy - Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention, Modern Imaging Systems: Tomography, Magnetic resonance Imaging System, Ultrasonic Imaging System, Medical Thermography

**TEXT BOOK:**

1. Biomedical Instrumentation and Measurements – C. Cromwell, F.J. Weibell, E.A.Pfeiffer – Pearson education.
2. Biomedical signal analysis – Rangaraj, M. Rangayya – Wiley Inter science – John Willey & Sons Inc.



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**Reference:**

1. Hand Book of Bio-Medical Instrumentation – R.S. Khandpur, (TMH)
2. Introduction to Bio-Medical Engineering – Domach, (Pearson)
3. Introduction to Bio-Medical Equipment Technology – Cart, (Pearson)

**Course outcomes:**

1. Apply principles and concepts of electronics to analyze input and output signals in medical electronics
2. Apply principles and concepts of electronics to design filters for de-noising of medical measurements
3. Recognize different types of transducers, ongoing progress in improving their design, and their application in medical measurements
4. Apply principles and concepts of engineering to quantify and model measurements of bio potentials
5. Apply principles and concepts of sensing and engineering to (i) design diagnostic devices for detection of markers in bio fluids, and (ii) be able to evaluate quality of diagnostic devices
6. Apply engineering tools to evaluate parameters needed for point-of-care health screening and mobile-health, and design of appropriate point-of-care diagnostic devices



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<b>DIGITAL CONTROL SYSTEMS</b>					

**UNIT –I:**

**Sampling and Reconstruction:** Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal.

**The Z – Transforms:** Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z –Transforms, the inverse Z – transforms, Modified Z- Transforms.

**Z-Plane Analysis of Discrete-Time Control System:** Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips and Complementary Strips.

**UNIT –II:**

**State Space Analysis:** State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and its Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations

**UNIT –III:**

**Controllability and Observability:** Concepts of Controllability and Observability, Tests for controllability and Observability, Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.

**Stability Analysis:** Stability Analysis of closed loop systems in the Z-Plane, Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion, Stability analysis using Liapunov theorems.

**UNIT –IV:**

**Design of Discrete Time Control System by Conventional Methods:** Design of digital control based on the frequency response method – Bilinear Transformation and Design procedure in the W-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.

**UNIT –V:**

**State Feedback Controllers and Observers:** Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman’s formula, State Observers – Full order and Reduced order observers. Introduction to Kalman filters, State estimation through Kalman filters, introduction to adaptive controls.

**TEXT BOOKS:**

1. K. Ogata - “Discrete-Time Control systems” - Pearson Education/PHI, 2nd Edition.
2. M.Gopal - “Digital Control and State Variable Methods”- TMH

**REFERENCE BOOKS:**

1. Kuo - “Digital Control Systems”- Oxford University Press, 2nd Edition, 2003.
2. M. Gopal - “Digital Control Engineering”.





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**Course outcomes:**

1. Design a pure, two-pole system that satisfies specified performance specifications like percent overshoot, peak time, settling time, and DC gain.
2. Calculate the z-plane location of a pair of dominant poles given time-domain performance information like percent overshoot, settling time, and peak time.
3. Create discrete equivalents from given continuous-time systems,
4. Able to Construct a discrete-time difference equation containing input variables and output variables at particular time instances from a system's discrete-time transfer function.
5. Numerically compute the value of any system variable (e.g., state variable or output variable) at any discrete, time instant given initial conditions and input waveforms.



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<b>PROCESS CONTROL INSTRUMENTATION</b>					

**UNIT-1**

P & ID symbols. Process characteristics: Process load, Process lag, self-regulation. Control system parameters: control lag, dead time, cycling. Discontinuous controller modes: two position, multi position, floating control modes. Continuous controller modes: Mathematical representation and description of P, I, D controller modes. Composite control modes: Mathematical representation and description of PI, PD, PID control modes. Response of control modes to linear, step and square wave error signals.

**UNIT-2**

Electronic Controller mode implementation: Designing of P, PI, PD, PID using OP amplifiers.

**UNIT-3**

Pneumatic controller mode implementation: Implementation of P, PI, PD, PID using flapper – nozzle system.

**UNIT-4**

Final control: Actuators – Electrical & Pneumatic. Control Valves – Quick opening, linear and equal percentage control valves, valve sizing. I to P, P to I converters

**UNIT-5**

Programmable controllers & Digital Controllers:

Programmable controllers: Ladder Diagram, Programmable controller program from the ladder diagram of simple applications. Digital Controllers: Data logging, supervisory control, computer based controller.

**Text Book:**

1. Process control Instrumentation Technology by Curtis Johnson, 4 th Edition – PHI, Dec, 2000.

**Reference Books:**

1. Principles of Process control by D. Patranabis- TMH 2 nd Edition, 1996
2. P. Harriott, process control, Tata MoGraw – Hill publishing Co., Ltd., New Delhi, 1984.

**Course Outcomes:**

- Understand the popular process automation technologies.
- Design and development of different PLC programming for simple process applications.
- Understand the different security design approaches, Engineering and operator interface issues for designing Distributed control system.
- Know the latest communication technologies like HART and Field bus protocol. Mapping of Course Outcome with Programme Outcomes:



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<b>TRANSDUCERS AND SENSORS</b>					

**Unit – 1**

**Introduction:** functional elements of an instrument, generalized performance characteristics of instruments – static characteristics, dynamic characteristics.

Zero order, first order, second order instruments – step response, ramp response and impulse response. Response of general form of instruments to periodic input and to transient input  
 Experimental determination of measurement system parameters, loading effects under dynamic conditions

**Unit – 2**

**Transducers for motion and dimensional measurements:** Relative displacement, translation and rotational resistive potentiometers, resistance strain gauges, LVDT, synchros, capacitance pickups, Piezo-electric transducers, electro-optical devices, nozzle – flapper transducers, digital displacement transducers, ultrasonic transducers.

Magnetic and photoelectric pulse counting methods, relative acceleration measurements, seismic acceleration pickups, calibration of vibration pickups. Gyroscopic sensors

**Unit – 3**

**TRANSDUCERS FOR FORCE MEASUREMENT:** Bonded strain gauge transducers, Photo-electric transducers, variable reluctance pickup, torque measurement dynamometers.

**TRANSDUCERS FOR FLOW MEASUREMENT:** Hot wire and hot-film anemometers, Electro-magnetic flow meters, laser Doppler velocimeter

**TRANSDUCERS FOR PRESSURE MEASUREMENT:** Manometers, elastic transducers, liquid systems, gas systems, very high pressure transducers. Thermal conductivity gauges, ionization gauges, microphone.

**Unit – 4**

**TRANSDUCERS FOR TEMPERATURE MEASUREMENT:** Thermal expansion methods, Thermometers (liquid in glass), pressure thermometers, Thermocouples, Materials configuration and techniques. Resistance thermometers, Thermistors, junction semiconductors, Sensors, Radiation methods, Optical pyrometers, Dynamic response of temperature sensors heat flux Sensors, Transducers for liquid level measurement, humidity, silicon and quartz sensors, fiber optic sensors.

**Unit – 5**

**Smart sensors:** Introduction, primary sensors, converters, compensation. Recent trends in sensor technology – film sensors, semi conductor IC technology, MEMS, Nano-sensors.

**Text Book:**

1. Doebelin, E.O., “Measurement systems – Application and Design”, McGraw Hill.
2. D. Patranabis, “Sensors and Transducers”, PHI, 2nd Edition.

**Reference:**

1. Instrumentation Measurement & Analysis, by B.C. Nakra, K.K. Choudry, (TMH)
2. Transducers and Instrumentation, by D.V.S. Murthy (PHI)



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**Course Outcomes:**

At the end of the course, a student will be able to:

1. Use concepts in common methods for converting a physical parameter into an electrical quantity
2. Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
4. Predict correctly the expected performance of various sensors
5. Locate different type of sensors used in real life applications and paraphrase their importance
6. Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers
7. develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.



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<b>MEMS</b>					

**UNIT I:** Overview of MEMS and Microsystems: MEMS and Microsystems, Typical MEMS and Micro-system products, Evolution of Micro-fabrication, Micro-system and Microelectronics, The Multidisciplinary nature of micro-system design and manufacture, Micro-system and Miniaturization. Application of Microsystems in the automotive industry, Application of Microsystems in other industries: Health care industry, Aerospace industry, Industrial products, Consumer products, Telecommunications. Markets for Microsystems

**UNIT II:** Working Principles of Microsystems: Introduction, Micro-sensors: Acoustic Wave Sensors, Biomedical sensors and Biosensors, Chemical sensors, Pressure sensors, Thermal sensors. Micro actuation: Actuation using thermal forces, shaped memory alloys, Piezoelectric crystals, Electrostatic forces. MEMS with Micro actuators: Micro-grippers, Micro-motors, Micro-valves, Micro-pumps, Micro accelerators, Micro-fluidics.

**UNIT III:** Scaling Laws in Miniaturization: Introduction to scaling, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

Materials for MEMS and Microsystems: Introduction, Substrates and wafers, Active substrate materials, Silicon as a substrate material. Silicon compounds, Silicon piezo resistors, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers, Packing materials.

**UNIT IV:** Micro system Fabrication Process: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition, Deposition by Epitaxy, Etching. Overview of Micro manufacturing and Applications: Bulk Micro manufacturing- any one example of application, Surface Micromachining- any one example of application. LIGA Process- any one example of application

**UNIT V:** Applications of MEMS-Switching: Introduction, Switch parameters, Basics of switching, Mechanical switches, Electronic switches for RF and microwave applications, Mechanical RF switches, PIN diode RF switches.

**Text Books:**

1. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, Tata McGraw Hill, (2002).
2. Gabriel M. Rebeiz, “RF MEMS Theory, Design and Technology”, Wiley India Pvt Ltd.

**Reference Books:**

1. Stephen D. Senturia, “Microsystem Design”, Springer International Edition, (2010).
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press,(2002).
3. Chang Liu, “Foundations of MEMS”, Second Edition, Pearson Publication.



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**Course Outcomes:**

1. Understand the basic overview of MEMS and Microsystems with broad category of MEMS& Micro system applications.
2. Understanding the working principles of Microsystems
3. Understand the Scaling Laws in Miniaturization and Materials for MEMS and Microsystems
4. Understand the Micro system Fabrication Process and Analyze the different Micro manufacturing process and Applications.
5. Study and Analyze the different types of RF switches, Various Switching Mechanism and their applications.



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<b>Intelligent and Smart Instrumentation</b>					

**UNIT I:**

**Introduction:** Definition of intelligent instrumentation, types of instruments, Static Characteristics: Accuracy and Precision, Error, Correction, and Uncertainty, Repeatability, Reproducibility, and Hysteresis, Sensitivity, Offset, and Dead Band, Resolution and Linearity, Statistical Characteristics, Error Modeling, Dynamic Characteristics, Dynamic Error and Dynamic Sensitivity, Input-Output Impedances, Historical Perspective, Current status, software based instruments.

**UNIT II:**

**Intelligent Sensors:** Classification, Smart sensors, Cogent Sensors, Soft or Virtual sensors, Self-Adaptive Sensors, Self-Validating Sensors, VLSI Sensors, Temperature Compensating Intelligent Sensors, Pressure Sensor, Indirect Sensing

**UNIT III:****Linearization, Calibration, and Compensation:**

Analog Linearization of Positive and Negative Coefficient Resistive Sensors, Higher-Order Linearization, Nonlinear ADC- and Amplifier-Based Linearization, Interpolation, Piecewise Linearization, Microcontroller-Based Linearization, Artificial Neural Network-Based Linearization, Nonlinear Adaptive Filter-Based Linearization, Sensor Calibration, Conventional Calibration Circuits, Offset Compensation, Error and Drift Compensation, Lead Wire Compensation

**UNIT IV:****Sensors with Artificial Intelligence:**

Artificial Intelligence, Sensors with Artificial Intelligence, Multidimensional Intelligent Sensors, AI for Prognostic Instrumentation, ANN-Based Intelligent Sensors, Fuzzy Logic-Based Intelligent Sensors

**UNIT V:****Intelligent Sensor Standards and Protocols:**

IEEE 1451 Standard, STIM, TEDS, NCAP, Network Technologies, LonTalk, CEBUS, J1850 Bus, 1 Signal Logic and Format, MI Bus, Plug-n-Play Smart Sensor Protocol

**Text Books:**

1. Manabendra Bhuyan, —Intelligent Instrumentation: Principles and Applications|| CRC Press, 2011.
2. G. C. Barney, —Intelligent Instrumentation||, Prentice Hall, 1995.
3. J.B DIXIT, A. yadav Laxmi Publications, Ltd., 01-Sep-2011

**Course Outcomes:**

1. To develop the design methodologies for measurement and instrumentation of real world problems.
2. To be study the concepts of intelligent sensor devices, their performance characteristics and signal and system dynamics.
3. To address the issues in dealing signal conditioning operations such as calibration, linearization and compensation
4. To use artificial intelligence in sensor signal processing to solve real world problems
5. To deal with interfacing protocols in wireless networking platform.



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<b>VLSI TECHNOLOGY AND DESIGN</b>					

**UNIT 1: MOS Transistors**

Introduction, The Structure of MOS Transistors, The Fluid Model, The MOS Capacitor, The MOS Transistor, Modes of Operation of MOS Transistors, Electrical Characteristics of MOS Transistors, Threshold Voltage, Transistor Transconductance  $g_m$ , Figure of Merit, Body Effect, Channel-Length Modulation, MOS Transistors as a Switch, Transmission Gate

**UNIT 2: MOS Fabrication Technology**

Introduction, Basic Fabrication Processes, Wafer Fabrication, Oxidation, Mask Generation, Photolithography, Diffusion, Deposition. N-MOS Fabrication Steps, CMOS Fabrication Steps, n-Well Process, p-Well Process, Twin-Tub Process, Latch-Up Problem and Its Prevention, Use of Guard Rings, Use of Trenches, Short-Channel Effects-Channel Length Modulation Effect. Drain-Induced Barrier Lowering, Channel Punch Through, Hot carrier effect, Velocity Saturation Effect

**UNIT 3: Layout Design Rules**

Scaling Theory, Scalable CMOS Design Rules, CMOS Process Enhancements, Transistors, Interconnects, Circuit Elements, Efficient layout Design techniques

**UNIT 4: Combinational Logic Networks**

Layouts for logic networks. Delay through networks. Power optimization. Switch logic networks. Combinational logic testing

**UNIT 5: Sequential Systems**

Memory cells and Arrays, clocking disciplines, sequential circuit Design, Performance Analysis, Power optimization, Design validation and testing.

**Text Books:**

1. Principals of CMOS VLSI Design-N.H.EWeste, K. Eshraghian, 2nd Edition, Addison Wesley.
2. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Ed., 2011.
3. Low-Power VLSI Circuits and Systems, Ajit Pal, SPRINGER PUBLISHERS
4. Modern VLSI Design – Wayne Wolf, 3rd Ed., 1997, Pearson Education.

**Reference Books:**

1. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.
2. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2nd Ed., PHI.

**Course outcomes**

At the end of the course the student able to

1. Understand the basics of MOS transistors and also the characteristics of MOS transistors.
2. Learn about the MOS fabrication process and short channel effects.
3. Learn about the basic rules in layout designing.
4. Analyse various combinational logic networks and sequential systems.





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<b>CMOS ANALOG IC DESIGN</b>					

**UNIT -I**

Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers –Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage

**UNIT -II:**

Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors– Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.

**UNIT -III:**

Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs.

**UNIT -IV:**

Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.

**UNIT -V:**

Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators.

**Text Books:**

1. B.Razavi, “Design of Analog CMOS Integrated Circuits”, 2nd Edition, McGraw Hill Edition 2016.
2. Paul. R.Gray & Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5th Edition, 2009.

**Reference Books:**

1. T. C. Carusone, D. A. Johns & K. Martin, “Analog Integrated Circuit Design”, 2nd Edition, Wiley, 2012.
2. P.E.Allen & D.R. Holberg, “CMOS Analog Circuit Design”, 3rd Edition, Oxford University Press, 2011.
3. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3rd Edition, Wiley, 2010.
4. Recent literature in Analog IC Design.



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**Course Outcomes:**

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

1. Design MOSFET based analog integrated circuits.
2. Analyze analog circuits at least to the first order.
3. Appreciate the trade-offs involved in analog integrated circuit design.
4. Understand and appreciate the importance of noise and distortion in analog circuits.



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<b>CMOS DIGITAL IC DESIGN</b>					

**UNIT-I: MOS Design**

Pseudo NMOS Logic – Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

**UNIT-II: Combinational MOS Logic Circuits:**

MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OAI gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

**UNIT-III: Sequential MOS Logic Circuits**

Behaviour of bistable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.

**UNIT-IV: Dynamic Logic Circuits**

Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits.

**UNIT-V: Semiconductor Memories**

Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NAND flash.

**Text Books:**

1. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.
2. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3<sup>rd</sup> Ed., 2011.

**Reference Books:**

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011
2. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan Borivoje Nikolic, 2<sup>nd</sup> Ed., PHI.

**Course Outcomes:**

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

1. Demonstrate advanced knowledge in Static and dynamic characteristics of CMOS, Alternative CMOS Logics, Estimation of Delay and Power, Adders Design.
2. Classify different semiconductor memories.
3. Analyze, design and implement combinational and sequential MOS logic circuits.
4. Analyze complex engineering problems critically in the domain of digital IC design for conducting research.
5. Solve engineering problems for feasible and optimal solutions in the core area of digital ICs.



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<b>DESIGN OF TESTABILITY</b>					

**UNIT-I: Introduction to Testing**

Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modeling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault.

**UNIT-II: Logic and Fault Simulation**

Simulation for Design Verification and Test Evaluation, Modeling Circuits for Simulation, Algorithms for True-value Simulation, Algorithms for Fault Simulation

**UNIT -III: Testability Measures**

SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

**UNIT-IV: Built-In Self-Test**

The Economic Case for BIST, Random Logic BIST: Definitions, BIST Process, Pattern Generation, Response Compaction, Built-In Logic Block Observers, Test-Per-Clock, Test-Per- Scan BIST Systems, Circular Self Test Path System, Memory BIST, Delay Fault BIST.

**UNIT-V: Boundary Scan Standard**

Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BSDL Description Components, Pin Descriptions.

**TEXT BOOKS:**

1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits - M.L. Bushnell, V. D. Agrawal, Kluwer Academic Publishers.

**REFERENCE BOOKS:**

1. Digital Systems and Testable Design - M. Abramovici, M.A.Breuer and A.D Friedman, Jaico Publishing House.
2. Digital Circuits Testing and Testability - P.K. Lala, Academic Press.

**Course Outcome:**

Students are able to

1. apply the concepts in testing which can help them design a better yield in IC design.
2. tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
3. analyse the various test generation methods for static & dynamic CMOS circuits.
4. identify the design for testability methods for combinational & sequential CMOS circuits.
5. recognize the BIST techniques for improving testability.



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<b>POOL-2 (HONOR)</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>
<b>SYSTEM ON CHIP</b>					

**Unit 1:**

**ASIC:** Overview of ASIC types, design strategies, CISC, RISC and NISC approaches for SOC architectural issues and its impact on SoC design methodologies, Application Specific Instruction Processor (ASIP) concepts.

**Unit 2:**

**NISC:** NISC Control Words methodology, NISC Applications and Advantages, Architecture Description Languages (ADL) for design and verification of Application Specific Instruction set Processors (ASIP), No-Instruction-Set-computer (NISC)- design flow, modeling NISC architectures and systems, use of Generic Netlist Representation - A formal language for specification, compilation and synthesis of embedded processors.

**Unit 3:**

**Simulation:** Different simulation modes, behavioral, functional, static timing, gate level, switch level, transistor/circuit simulation, design of verification vectors, Low power FPGA, Reconfigurable systems, SoC related modeling of data path design and control logic, Minimization of interconnects impact, clock tree design issues.

**Unit 4:**

**Low power SoC design / Digital system:** Design synergy, Low power system perspective-power gating, clock gating, adaptive voltage scaling (AVS), Static voltage scaling, Dynamic clock frequency and voltage scaling (DCFS), building block optimization, building block memory, power down techniques, power consumption verification.

**Unit 5:**

**Synthesis:** Role and Concept of graph theory and its relevance to synthesizable constructs, Walks, trails paths, connectivity, components, mapping/visualization, nodal and admittance graph. Technology independent and technology dependent approaches for synthesis, optimization constraints, Synthesis report analysis Single core and Multi core systems, dark silicon issues, HDL coding techniques for minimization of power consumption, Fault tolerant designs

**Text Books:**

1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication”, Cambridge University Press, 2008.
2. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006

**Reference Books:**

1. Rochit Rajsuman, “System-on- a-chip: Design and test”, Advantest America R & D Center, 2000
2. P Mishra and N Dutt, “Processor Description Languages”, Morgan Kaufmann, 2008
3. Michael J. Flynn and Wayne Luk, “Computer System Design: System-on-Chip”.



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**Course Outcomes:** At the end of the course, students will be able to:

1. Identify and formulate a given problem in the framework of SoC based design approaches Design SoC based system for engineering applications
2. Realize impact of SoC on electronic design philosophy and Macro-electronics thereby incline towards entrepreneurship & skill development.



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<b>PROGRAMMABLE LOGIC DEVICES AND ASIC</b>					

**Unit I:**

INTRODUCTION TO ASICS, CMOS LOGIC, ASIC LIBRARY DESIGN: Types of ASICs - Design flow – CMOS transistors- CMOS Design rules –Combinational logic Cell Sequential logic cell - Transistor as Resistors - Transistor parasitic capacitance – Logical effort - Library cell design – Library architecture.

**Unit II:**

PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS: Anti fuse - Static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA – Altera FLEX - Altera MAX DC & AC inputs and outputs - Xilinx I/O blocks.

**Unit III:**

PROGRAMMABLE ASIC INTERCONNECT, PROGRAMMABLE ASIC 09 DESIGN SOFTWARE AND LOW LEVEL DESIGN: Entry: Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Logic Synthesis - Half gate ASIC -Low level design language - PLA tools EDIF- CFI design representation.

**Unit IV:**

SILICON ON CHIP DESIGN: Voice over IP SOC - Intellectual Property – SOC Design challenges- Methodology and design-FPGA to ASIC conversion – Design for integration- SOC verification-Set top box SOC.

**Unit V:**

PHYSICAL AND LOW POWER DESIGN: Over view of physical design flow- tips and guideline for physical design- modern physical design techniques- power dissipation-low power design techniques and methodologies-low power design tools- tips and guideline for low power design.

**Text book:**

1. M.J.S. Smith, —Application Specific Integrated Circuits, Pearson Education, 2008
2. Wayne Wolf, —FPGA-Based System Design, Prentice Hall PTR, 2009.
3. Farzad Nekoogar and Faranak Nekoogar, —From ASICs to SOCs: A Practical Approach, Prentice Hall PTR, 2003.

**Course Outcomes:** At the end of the course, students will be able to

1. Recognize need for programmable devices
2. Describe architecture of programmable devices.
3. Explain programmable methodologies.
4. Recall IC fabrication techniques vis-à-vis CMOS switch
5. Relate design and implementation flow for PLDs
6. low power design techniques and methodologies



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<b>SCRIPTING LANGUAGE</b>				

**UNIT-I:**

**Introduction to Scripts and Scripting:** Basics of Linux, Origin of Scripting languages, scripting today, Characteristics and uses of scripting languages.

**PERL:** Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, Control structures, Built-in functions, Collections of Data, working with arrays, Lists and hashes,

Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments

**UNIT-II:**

**Advanced PERL:** Finer points of Looping, Subroutines, Using Pack and Unpack, working with files, Type globs, Eval, References, Data structures, Packages, Libraries and modules, Objects, Objects and modules in action, tied variables, interfacing to the operating systems, Security issues

**UNIT-III:**

**TCL:** The TCL phenomena, Philosophy, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures, Working with Strings, Patterns, Files and Pipes, Example code.

**UNIT-IV:**

**Advanced TCL:** The eval, source, exec and up-level commands, Libraries and packages, Namespaces, trapping errors, Event-driven programs, Making applications 'Internet-aware', 'Nuts-and-bolts' internet programming, Security issues, TCL and TK integration.

**UNIT-V:**

**PYTHON:** Introduction to PYTHON language, PYTHON-syntax, statements, functions, Built-in functions and Methods, Modules in PYTHON, Exception Handling.

**Text Books:**

1. The World of Scripting Languages- David Barron, Wiley Student Edition, 2010.
2. PYTHON Web Programming, Steve Holden and David Beazley, New Riders Publications

**References:**

1. TCL/TK: A Developer's Guide- CliffFlynt, 2003, Morgan Kaufmann Series.
2. Core PYTHON Programming, Chun, Pearson Education, 2006.
3. Learning Perl, Randal L. Schwartz, O' Reilly publications 6th edition 2011.
4. Linux: The Complete Reference", Richard Peterson McGraw Hill Publications, 6th Edition, 2008.

**Course Outcomes:**

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

1. Gain fluency in programming with scripting languages
2. Create and run scripts using PERL/TCL/PYTHON in CAD Tools
3. Demonstrate the use of PERL/PYTHON/ TCL in developing system and web applications





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<b>LOW POWER VLSI DESIGN</b>					

**UNIT-I: Sources of Power Dissipation**

Introduction, Short-Circuit Power Dissipation, Switching Power Dissipation, Dynamic Power for a Complex Gate, Reduced Voltage Swing, Switching Activity, Leakage Power Dissipation, p–n Junction Reverse-Biased Current, Band-to-Band Tunneling Current, Subthreshold Leakage Current, Short-Channel Effects

**UNIT 2: Supply Voltage Scaling for Low Power**

Device Feature Size Scaling, Constant-Field Scaling, Constant-Voltage Scaling, Architectural-Level Approaches: Parallelism for Low Power, Pipelining for Low Power, Combining Parallelism with Pipelining, Voltage Scaling Using High-Level Transformations: Multilevel Voltage Scaling Challenges in MVS Voltage Scaling Interfaces, Static Timing Analysis Dynamic Voltage and Frequency Scaling

**UNIT-3: Switched Capacitance Minimization**

Probabilistic Power Analysis: Random logic signals, probability and frequency, probabilistic power analysis techniques, signal entropy, Bus Encoding: Gray Coding, One-Hot Coding, Bus-Inversion, T0 Coding, Clock Gating, Gated-Clock FSMs FSM State Encoding, FSM Partitioning, Precomputation, Glitching Power Minimization

**UNIT 4: Leakage Power Minimization**

Fabrication of Multiple Threshold Voltages, Multiple Channel Doping, Multiple Oxide CMOS, Multiple Channel Length, Multiple Body Bias, VTCMOS Approach, MTCMOS Approach, Power Gating, Clock Gating Versus Power Gating, Power-Gating Issues, Isolation Strategy, State Retention Strategy, Power-Gating Controller, Power Management, Combining DVFS and Power Management

**UNIT 5: Low power clock distribution & Simulation Power Analysis**

Low power clock distribution: Power dissipation in clock distribution, single driver versus distributed buffers, Zero skew versus tolerable skew, chip and package co design for clock network.

Simulation Power Analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, architecture level analysis, data correlation analysis of DSP systems, Monte Carlo Simulation

**Text Books:**

1. Low-Power VLSI Circuits and Systems, Ajit Pal, SPRINGER PUBLISHERS
2. Practical Low Power Digital Vlsi Design , Gary Yeap Motorola, Springer Science Business Media, LLC.

**Reference Books:**

1. Low Power CMOS Design – Anantha Chandrakasan, IEEE Press/Wiley International, 1998. 2
2. Massoud Pedram, Jan M. Rabaey , “Low power design methodologies “, Kluwer Academic Publishers.



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3. Low Power CMOS VLSI Circuit Design – A. Bellamour, M. I. Elamasri, Kluwer Academic Press, 1995.

**Course Outcomes:**

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

1. Identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.
2. Characterize and model power consumption & understand the basic analysis methods.
3. Understand leakage sources and reduction techniques.



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<b>WIRELESS SENSOR NETWORKS</b>					

**Unit I**

Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

**Unit II**

Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tiny OS, MANTIS, Contiki, and RetOS.

**Unit III**

Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

**Unit IV**

Overview of sensor network protocols (details of atleast 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

**Unit V**

Data dissemination and processing; differences compared with other database management systems, data storage; query processing. Specialized features: Energy preservation and efficiency; security challenges; fault- tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

**TEXT BOOKS:**

1. H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, India, 2012.
2. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, “Wireless Sensor Networks”, Springer Verlag, 1<sup>st</sup> Indian reprint, 2010.

**REFERENCES:**

1. F. Zhao and L. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Morgan Kaufmann, 1st Indian reprint, 2013.
2. YingshuLi, MyT. Thai, Weili Wu, “Wireless sensor Network and Applications”, Springer series on signals and communication technology, 2008.

**Course Outcomes:**

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

1. Design wireless sensor network system for different applications under consideration.
2. Understand the hardware details of different types of sensors and select right type of sensor for various applications.
3. Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
4. Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
5. Handle special issues related to sensors like energy conservation and security challenges



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<b>SOFTWARE DEFINED RADIO</b>					

**UNIT -I:**

**Introduction:** The Need for Software Radios, What is Software Radio, Characteristics and benefits of software radio- Design Principles of Software Radio, RF Implementation issues- The Purpose of RF Front – End, Dynamic Range- The Principal Challenge of Receiver Design – RF Receiver Front- End Topologies- Enhanced Flexibility of the RF Chain with Software Radios- Importance of the Components to Overall Performance- Transmitter Architectures and Their Issues- Noise and Distortion in the RF Chain, ADC and DAC Distortion.

**UNIT -II:**

**Multi Rate Signal Processing:** Introduction- Sample Rate Conversion Principles- Polyphase Filters Digital Filter Banks- Timing Recovery in Digital Receivers Using Multirate Digital Filters.  
**Digital Generation of Signals:** Introduction- Comparison of Direct Digital Synthesis with Analog Signal Synthesis- Approaches to Direct Digital Synthesis- Analysis of Spurious Signals- Spurious Components due to Periodic jitter- Band Pass Signal Generation- Performance of Direct Digital Synthesis Systems- Hybrid DDS-PLL Systems- Applications of direct Digital Synthesis- Generation of Random Sequences- ROM Compression Techniques.

**UNIT -III:**

**Analog to Digital and Digital to Analog Conversion:** Parameters of ideal data converters- Parameters of Practical data converters- Analog to Digital and Digital to Analog Conversion- Techniques to improve data converter performance- Common ADC and DAC architectures.

**UNIT -IV:**

**Digital Hardware Choices:** Introduction- Key Hardware Elements- DSP Processors- Field Programmable Gate Arrays- Trade-Offs in Using DSPs, FPGAs, and ASICs- Power Management Issues Using a Combination of DSPs, FPGAs, and ASICs.

**UNIT -V:**

**Object – Oriented Representation of Radios and Network Resources:** Networks- Object Oriented Programming- Object Brokers- Mobile Application Environments- Joint Tactical Radio System. Case Studies in Software Radio Design: Introduction and Historical Perspective, SPEAK easy- JTRS, Wireless Information Transfer System, SDR-3000 Digital Transceiver Subsystem, Spectrum Ware, CHARIOT

**TEXT BOOKS:**

1. Software Radio: A Modern Approach to Radio Engineering - Jeffrey H. Reed, 2002, PEA Publication.
2. Software Defined Radio: Enabling Technologies- Walter Tuttle Bee, 2002, Wiley Publications.

**REFERENCE BOOKS:**

1. Software Defined Radio for 3G - Paul Burns, 2002, Artech House.
2. Software Defined Radio: Architectures, Systems and Functions - Markus Dillinger, KambizMadani, Nancy Alonistioti, 2003, Wiley.
3. Software Radio Architecture: Object Oriented Approaches to wireless System Engineering – Joseph Mitola, III, 2000, John Wiley & Sons.
4. R.F Microelectronics – B. Razavi, 1998, PHI. 5. DSP – A Computer Based Approach – S. K. Mithra, 1998, McGraw-Hill



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**COURSE OUTCOMES:**

On successful completion of this course the students will be able to

1. Demonstrate advanced knowledge in the evolving paradigm of Software defined radio and technologies for its implementation.
2. Analyze complex problems critically in the domains of Radio frequency implementation issues, Multirate signal processing in SDR, as well as a Smart antenna techniques for better spectrum exploitation for conducting research.
3. Apply appropriate techniques for the development of scientific and technological knowledge in designing software defined radios and their usage for cognitive radio.



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<b>DATA COMMUNICATION &amp; COMPUTER NETWORKS</b>					

**UNIT I**

**Introduction to Data Communications:** Components, Data Representation, Data Flow, Networks- Distributed Processing, Network Criteria, Physical Structures, Network Models, Categories of Networks Interconnection of Networks, The Internet - A Brief History, The Internet Today, Protocol and Standards - Protocols, Standards, Standards Organizations, Internet Standards. Network Models, Layered Tasks, OSI model, Layers in OSI model, TCP/IP Protocol Suite, Addressing Introduction, Wireless Links and Network Characteristics, WiFi: 802.11 Wireless LANs -The 802.11 Architecture

**UNIT II**

**Data Link Layer:** Links, Access Networks, and LANs- Introduction to the Link Layer, The Services Provided by the Link Layer, Types of errors, Redundancy, Detection vs Correction, Forward error correction Versus Retransmission Error-Detection and Correction Techniques, Parity Checks, Check summing Methods, Cyclic Redundancy Check (CRC) , Framing, Flow Control, and Error Control protocols , Noisy less Channels and Noisy Channels, HDLC, Multiple Access Protocols, Random Access ,ALOHA, Controlled access, Channelization Protocols. 802.11 MAC Protocol, IEEE 802.11 Frame

**Unit-III**

**The Network Layer:** Introduction, Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks-Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks, Inside a Router-Input Processing, Switching, Output Processing, Queuing, The Routing Control Plane, The Internet Protocol(IP):Forwarding and Addressing in the Internet- Datagram format, Ipv4 Addressing, Internet Control Message Protocol(ICMP), IPv6

**Unit-IV**

**Transport Layer:** Introduction and Transport Layer Services : Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing, Connectionless Transport: UDP -UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer-Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go- Back-N(GBN), Selective Repeat(SR), Connection Oriented Transport: TCP - The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control - The Cause and the Costs of Congestion, Approaches to Congestion Control-The Cause and the Costs of Congestion, Approaches to Congestion Control

**Unit-V**

**Application Layer:** Principles of Networking Applications – Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the File Transfer: FTP,- FTP Commands and Replies, Electronic Mail in the Internet- STMP, Comparison with HTTP, DNS-The Internet's Directory Service – Service Provided by DNS, Overview of How DNS Works, DNS Records and messages.



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**TEXTBOOKS:**

1. Computer Networking A Top-Down Approach – Kurose James F, Keith W, 6th Edition, Pearson.
2. Data Communications and Networking Behrouz A. Forouzan 4th Edition McGraw-Hill Education

**REFERENCES:**

1. Data communication and Networks - Bhusan Trivedi, Oxford university press, 2016
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education
3. Understanding Communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.

**Course Outcomes:**

Upon completing this course, the student will be able to

1. Know the Categories and functions of various Data communication Networks
2. Design and analyze various error detection techniques.
3. Demonstrate the mechanism of routing the data in network layer
4. Know the significance of various Flow control and Congestion control Mechanisms
5. Know the Functioning of various Application layer Protocols.



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<b>COGNITIVE RADIO</b>					

**Unit I: Introduction to Cognitive Radios:** Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

**Unit II: Sensing:** Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

**Unit III: Optimization Techniques of Dynamic Spectrum Allocation:** Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

**Unit IV: Dynamic Spectrum Access and Management:** Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

**Unit V: Spectrum Trading:** Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential). Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross-layer design for cognitive radio networks

**TEXT BOOKS:**

1. Ekram Hossain, Dusit Niyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive radio networks”, John Wiley & Sons Ltd., 2009.

**REFERENCE BOOKS**

1. Bruce Fette, “Cognitive radio technology”, Elsevier, 2nd edition, 2009.
2. Huseyin Arslan, “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer, 2007.
3. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, “Optimizing Wireless Communication Systems” Springer, 2009.
4. Linda Doyle, “Essentials of Cognitive Radio”, Cambridge University Press, 2009





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

1. Understand the fundamental concepts of cognitive radio networks.
2. Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3. Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
4. Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better Spectrum exploitation



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<b>5G COMMUNICATION</b>					

**UNIT I:**

Overview of 5G Broadband Wireless Communications: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.

**UNIT II:**

The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mm Wave MIMO Systems.

**UNIT III:**

Transmission and Design Techniques for 5G: Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).

**UNIT IV:**

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications

**UNIT V:**

Millimeter-wave Communications – spectrum regulations, deployment scenarios, beam forming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM)

**Textbooks:**

1. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks” , Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Daniels, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.

**References**

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk “Essentials of LTE and LTE-A”, Cambridge University Press



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**Course outcomes:** At the end of the course the student will be able to

1. Learn 5G Technology advances and their benefits
2. Learn the key RF, PHY, MAC and air interface changes required to support 5G
3. Learn Device to device communication and millimeter wave communication
4. Implementation options for 5G



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<b>POOL-3 (HONOR)</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>
<b>SATELLITE COMMUNICATION</b>					

**UNIT I**

**INTRODUCTION** Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications.

**ORBITAL MECHANICS AND LAUNCHERS** : Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.

**UNIT II**

**SATELLITE SUB SYSTEMS** : Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification.

**UNIT III**

**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 example.

**UNIT IV**

**MULTIPLE ACCESS:** Frequency division multiple access (FDMA) Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, link design using TDMA, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA), Spread spectrum transmission and reception.

**EARTH STATION TECHNOLOGY:** Introduction, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods.

**UNIT V**

**LOW EARTH ORBIT AND GEO-STATIONARY SATELLITE SYSTEMS:** Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs

**SATELLITE NAVIGATION & THE 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, GPS C/A code accuracy, Differential GPS



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**TEXT BOOKS:**

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnut, WSE, Wiley Publications, 2ndEdition, 2003.
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G. Suyderhoud, 2ndEdition, Pearson Publications, 2003.
3. Digital satellite communication by TRI T HA .....TMH

**REFERENCES:**

1. Satellite Communications : Design Principles – M. Richharia, BS Publications, 2nd Edition, 2003.
2. Satellite Communication - D.C Agarwal, Khanna Publications, 5th Ed.
3. Fundamentals of Satellite Communications – K.N. Raja Rao, PHI, 2004
4. Satellite Communications – Dennis Roddy, McGraw Hill, 2nd Edition, 1996.

**Outcomes:**

**At the end of this course the student can able to:**

1. Understand the concepts, applications and subsystems of Satellite communications.
2. Derive the expression for G/T ratio and to solve some analytical problems on satellite link design.
3. Understand the various types of multiple access techniques and architecture of earth station design.
4. Understand the concepts of GPS and its architecture.



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<b>OPTICAL COMMUNICATION</b>					

**UNIT I**

**Overview of optical fiber communication** - Historical development, The general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection, Acceptance angle, Numerical Aperture, Skew rays, Cylindrical fibers- Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index, Related problems.

**UNIT II**

Fiber materials:- Glass, Halide, Active glass, Chalcogenide glass, Plastic optical fibers. Signal distortion in optical fibers-Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay, Types of Dispersion:- Material dispersion, Wave-guide dispersion, Polarization-Mode dispersion, Intermodal dispersion, Pulse broadening in Graded index fiber, Related problems.

**UNIT III**

. Optical fiber Connectors-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints.

**UNIT IV**

Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED&ILD, Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors, Related problems.

**UNIT V**

**Source to fiber power launching** - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling, Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit, Analog receivers.

**Optical system design** - Point-to- point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links, WDM, Necessity, Principles, Measurement of Attenuation and Dispersion, Eye pattern.

**TEXT BOOKS:**

1. Optical Fiber Communications – Gerd Keiser, Mc Graw-Hill International edition, 3<sup>rd</sup> Edition, 2000.
2. Optical Fiber Communications – John M. Senior, PHI, 2nd Edition, 2002.



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**REFERENCES:**

1. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education,2005.
2. Text Book on Optical Fiber Communication and its Applications – S.C.Gupta, PHI, 2005.
3. Fiber Optic Communication Systems – Govind P. Agarwal , John Wiley, 3rd Edition, 2004.
4. Fiber Optic Communications – Joseph C. Palais, 4th Edition, Pearson Education, 2004.

**OUTCOMES:**

After going through this course the student will be able to

1. Choose necessary components required in modern optical communications systems .
2. Design and build optical fiber experiments in the laboratory, and learn how to calculate electromagnetic modes in waveguides, the amount of light lost going through an optical system, dispersion of optical fibers.
3. Use different types of photo detectors and optical test equipment to analyze optical fiber and light wave systems.
4. Choose the optical cables for better communication with minimum losses
5. Design, build, and demonstrate optical fiber experiments in the laboratory



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<b>GLOBAL NAVIGATIONAL SATELLITE SYSTEMS</b>					

**UNIT I:**

**Introduction**, GNSS overview, Global Positioning System, Russian GLONASS system, Galileo satellite system, Chinese BeiDou system, Regional system: Quasi-Zenith Satellite System (QZSS), Navigation with Indian Constellation (NavIC), Augmentations, Markets and Applications.

**Fundamentals of satellite Navigation:** Concept of Ranging using Time of arrival Measurements: Two-Dimensional Position Determination, Principle of Position Determination via Satellite-Generated Ranging Codes, Fundamentals of satellite orbits: Orbital Mechanics, Constellation Design, Positioning determination using Ranging codes: Determining Satellite-to-User Range,

**UNIT II:**

**Global positioning system:** overview: Space Segment Overview, Control Segment Overview, User Segment Overview, Space segment description: GPS Satellite Constellation Description, Space Segment Phased Development, Control segment description: OCS Current Configuration, OCS Transition, OCS Planned Upgrades, User segment: GNSS Receiver Characteristics

**UNIT III:**

**Navigation with Indian Constellation (NavIC):** overview, space segment, NavIC control segment, Geodesy and time system, Navigation services, signals, applications and NavIC user equipment.

**UNIT – IV:**

**GNSS Receiver:** Acquisition: Single Trial Detector, Tong Search Detector, M of N Search Detector, Combined Tong and M of N Search Detectors, FFT-Based Techniques, Direct Acquisition of GPS Military Signals, Vernier Doppler and Peak Code Search, carrier tracking, code tracking: Carrier Loop Discriminator, sequence of initial receiver operation.

**UNIT – V:**

**GNSS errors:** Introduction, Measurement errors: satellite clock error, ephemeris error, relative effects, atmospheric effects, receiver noise and resolution, multipath and shadowing effects, hardware bias errors, Pseudorange error budgets.

**Text Books:**

1. Elliott D. Kaplan, Christopher J. Hegarty, **Understanding GPS/GNSS** principles and applications, third edition, artech house publishers, Boston, 2017

**Reference Books:**

1. G S Rao, Global Navigational satellite system, Tata McGraw-Hill education private Ltd, New Delhi, 2010
2. ISRO-IRNSS-ICD-SPS-1.1, Bangalore, 2017
3. Bhatta, B., 2010. Global Navigation Satellite Systems: Insights Into GPS, Glonass, Galileo, Compass, and Others, BS Publications, New Delhi.





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4. Grewal, M. S., Weill, L. R., Andrews, A. P., 2006. Global Positioning Systems, Inertial Navigation, and Integration, John Wiley & Sons, New York.
5. Hofmann-Wellenhof, B., Lichtenegger, H., Wasle, E., 2008. GNSS – Global Navigation Satellite Systems, Springer, Verlag Wien.

**Course Outcomes:**

1. Understand global navigational satellite systems
2. Understand Indian regional Navigational Satellite System
3. Develop GNSS Receiver



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<b>SPEECH SIGNAL PROCESSING</b>					

**Unit I**

**Mechanics of speech:** Speech production: Mechanism of speech production, Acoustic phonetics, The Acoustic Theory of Speech Production: Uniform lossless tube, Effects of losses in the vocal tract, Digital models for speech signals: Vocal tract, Radiation, Excitation, Auditory perception: psycho acoustics. Representations of speech waveform: Sampling of speech signals, Quantization.

**Unit II**

**Time and frequency domain methods for speech processing:** Time domain parameters of Speech signal: Short-Time Energy, Average Magnitude, Average Zero crossing Rate, Silence Discrimination using ZCR and energy, Short Time Auto Correlation Function, Pitch period estimation using Auto Correlation Function.

Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Sampling rates in time and frequency, Pitch detection, Analysis by Synthesis, Analysis synthesis systems: Phase vocoder, Channel Vocoder, Median Smoothing, Spectrographic displays

**Unit III**

**Linear predictive analysis of speech:** Basic Principles of linear predictive analysis: Auto correlation method, Covariance method, Solution of LPC equations: Cholesky method, Durbin's Recursive algorithm, Application of LPC parameters: Pitch detection using LPC parameters, Formant analysis using LPC parameters, VELP. Relations Between the Various Speech Parameters, CELP.

**Unit IV**

**Application of speech processing:** Voice response systems: General considerations in the design of voice response systems, A multiple output digital voice response system, Speaker recognition systems: Speaker verification system, Speaker identification system.

**Unit V**

**Speech recognition systems:** Isolated digit recognition system, Continuous digit recognition system. Typical applications of computer voice response systems: Wiring communication equipment, Information retrieval systems

**Textbooks:**

1. L.R.Rabinerand, R.W.Schaffer, Digital Processing of Speech signals, Prentice Hall, 2004
2. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., Singapore, 2004

**References:**

1. Quatieri, Discrete-time Speech Signal Processing, PrenticeHall,2001
2. L.R. Rabiner and B. H. Juang, Fundamentals of speech recognition, Prentice Hall, 1999.



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**Course Outcomes:**

At the end of this course the student will be able to:

1. Summarize the mechanism of human speech production and articulation
2. Identify the time domain speech signal parameters
3. Differentiate time and frequency domain methods of speech processing
4. Attribute linear predictive analysis for speech signals
5. Explain the solutions for LPC equations
6. Implement the differential algorithms and models involved for speaker and speech recognition systems



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<b>VIDEO SIGNAL PROCESSING</b>					

**Unit – I**

Video formation, perception and representation – color perception and specification – video capture and display – Analog video raster – Analog color television systems, Digital video and Frequency Domain characterization of Video Signals.

**Unit – II**

Video sampling – Basics of the Lattice theory, Sampling of Video Signals, Conversion of Signals Sampled on Different Lattices, Sampling Rate Conversion of Video Signals

**Unit -III**

Video modeling-Camera model, Illumination model, Object model and Scene model, Two dimensional models, Two Dimensional motion estimation-Types, Optical Flow, Pixel Based Motion, Block matching Algorithm.

**Unit -IV**

Waveform Based Video Coding-Predictive coding, Video coding using Temporal prediction and transform coding, Content Dependent Video Coding – Two dimensional shape coding, Texture coding for Arbitrarily shaped Regions

**Unit-V**

Video Compression standards-Standardization- Video Telephony with H.261 and H.263- Multimedia content description with MPEG7

**Text Books**

1. Video Processing and Communication – 1st edition - Yao Wang, J.Ostermann, Ya Zhang, Prentice Hall, 2001.

**Reference Books:**

1. Image processing, analysis, and machine vision, 2nd Edition,-Sonka M, Hlavac V, Boyle R. Brooks Cole publishing, 1999.
2. Multidimensional, signal, image and video processing and coding, -Woods, Elsevier, Academic press, 2006.

**Course Outcomes:**

1. Understand the formation of video, its perception and representation and characterization of video in frequency domain
2. Understand the concept of Lattice theory and sampling of video signals
3. Modeling of the video signal in different methods and understand the different motion estimation algorithms
4. Coding of video in different approaches / algorithms
5. Knowledge in Video compression standards



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<b>ADAPTIVE SIGNAL PROCESSING</b>					

**Unit -I**

Introduction to Adaptive Systems: Adaptive Systems: Definitions, Characteristics, Applications, Example of an Adaptive System. The Adaptive Linear Combiner - Description, Weight Vectors, Desired Response, Performance function - Gradient & Mean Square Error.

**Unit-II**

Development of Adaptive Filter Theory & Searching the Performance surface: Introduction to Filtering - Smoothing and Prediction – Linear Optimum Filtering, Problem statement, Principle of Orthogonality - Minimum Mean Square Error, Wiener- Hopf equations, Error Performance surface Searching the performance surface – Methods & Ideas of Gradient Search methods, Gradient Searching Algorithm & its Solution, Stability & Rate of convergence , Learning Curve.

**Unit-III**

Steepest Descent Algorithms: Gradient Search by Newton's Method, Method of Steepest Descent, Comparison of Learning Curves.

**Unit-IV**

LMS Algorithm & Applications: Overview - LMS Adaptation algorithms, Stability & Performance analysis of LMS Algorithms - LMS Gradient & Stochastic algorithms - Convergence of LMS algorithm. Applications: Noise cancellation – Cancellation of Echoes in long distance telephone circuits, Adaptive Beam forming.

**Unit-V**

RLS & Kalman Filtering: Introduction to RLS Algorithm, Statement of Kalman filtering problem, The Innovation Process, Estimation of State using the Innovation Process- Expression of Kalman Gain, Filtering Examples using Kalman filtering.

**Text Books**

1. Adaptive Signal Processing - Bernard Widrow, Samuel D. Stearns, 2005, PE.
2. Adaptive Filter Theory - Simon Haykin-, 4th Ed., 2002, PE Asia.

**Reference Books**

1. Optimum signal processing: An introduction – Sophocles .J. Orfamadis, 2nd Ed., 1988, McGraw-Hill, New York
2. Adaptive signal processing-Theory and Applications - S.Thomas Alexander, 1986, Springer –Verlag.
3. Signal analysis – Candy, McGraw Hill Int. Student Edition
4. James V. Candy - Signal Processing: A Modern Approach, McGraw-Hill, International Edition, 1988



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**Course outcomes**

1. Review the Adaptive Systems and Understand the various measures to be opted for developing adaptive system
2. Study of different algorithms to develop the adaptive filter theory
3. Application of adaptive filter theory for different problems
4. Study of RLS & Kalman Filtering



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<b>BIO- MEDICAL SIGNAL PROCESSING</b>					

**Unit I**

Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters

**Unit II**

Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering

**Unit III**

Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time-frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)

**Unit IV**

Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications

**Unit V**

Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio-Signals analysis Multi resolution analysis (MRA) and wavelets, Principal component analysis(PCA), Independent component analysis(ICA). Pattern classification– supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.

**Text Books:**

1. W. J. Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall,1993.
2. Eugene N Bruce, “Biomedical Signal Processing and Signal Modeling”, John Wiley & Son’s publication,2001.

**References:**

1. Myer Kutz, “Biomedical Engineering and Design Handbook, Volume I”, McGraw Hill, 2009.
2. D C Reddy, “Biomedical Signal Processing”, McGraw Hill,2005.
3. Katarzyn J. Blinowska, Jaroslaw Zygierewicz, “Practical Biomedical Signal Analysis Using MATLAB”, 1st Edition, CRC Press,2011

**Course Outcomes:**

1. Understand different types of biomedical signal.
2. Identify and analyze different biomedical signals.
3. Find applications related to biomedical signal processing



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<b>DSP PROCESSORS AND ARCHITECTURES</b>					

**Unit – I:**

Introduction to Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Digital filters, Decimation and interpolation. Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

**Unit – II:**

Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.

**Unit-III:**

Programmable Digital Signal Processors: Commercial digital signal processing devices, Data Addressing modes of TMS320C54XX DSPs, data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX processors, program control, TMS320C54XX instructions and programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, pipeline Operation of TMS320C54XX Processors.

**Unit – IV:**

Analog Devices Family of DSP Devices: Analog Devices Family of DSP Devices ALU and MAC block diagram, Shifter Instruction, Base Architecture of ADSP 2100, ADSP2181 high performance processor. Introduction to Blackfin Processor- The Blackfin Processor, Introduction to Micro signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

**Unit – V:**

Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).

**Text Books:**

1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. A Practical Approach To Digital Signal Processing - K Padmanabhan, R. Vijayarajeswaran, Ananthi. S, New Age International, 2006/2009
3. Embedded Signal Processing with the Micro Signal Architecture Publisher: Woon-Seng Gan, Sen M. Kuo, Wiley-IEEE Press, 2007





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**Reference Books:**

1. Digital Signal Processors, Architecture, Programming and Applications–B. Venkata ramani and M. Bhaskar, 2002, TMH.
2. DSP Processor Fundamentals, Architectures & Features – Lapsley et al., S. Chand & Co
3. Digital Signal Processing Applications Using the ADSP-2100 Family, Amy Mar, PHI
4. The Scientist and Engineer's Guide to Digital Signal Processing by Steven W. Smith, California Technical Publishing
5. Embedded Media Processing, David J. Katz and Rick Gentile of Analog Devices, Newnes

**Course Outcomes:**

1. Understand the basics of Digital Signal Processing and transforms.
2. Able to distinguish between the architectural features of general purpose processors and DSP processors.
3. Understand the architectures of TMS320C54xx devices and ADSP 2100 DSP devices.
4. Able to write simple assembly language programs using instruction set of TMS320C54xx.
5. Can interface various devices to DSP Processors.



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<b>WAVELET THEORY</b>					

**Unit – I**

The Age of Wavelets –Introduction-The Origins of Wavelets-Are They Fundamentally New-Wavelets and Other Reality Transforms, Managing Heisenberg's Uncertainty Ghost. History of Wavelet from Morlet to Daubechies Via Mallat , Different Communities of Wavelets, Different Families of Wavelets within Wavelet Communities, Interesting Recent Developments, Wavelets in the Future

**Unit – II**

Introduction-Vector spaces – bases, orthonormality, projection, functions and function spaces, orthogonal functions, orthonormal functions, function spaces, orthogonal basis functions, orthonormality and the method of finding the coefficients, complex fourier series, orthogonality of complex exponential bases

**Unit – III**

Continuous Wavelet and Short time Fourier Transform-Wavelet Transform, mathematical preliminaries, continuous time frequency representation of signals, the windowed fourier transform(Short Time Fourier Transform), The uncertainty principle and time frequency tiling, properties of wavelets used in Continuous Wavelet Transform, Continuous Versus Discrete Wavelet Transform

**Unit – IV**

Discrete Wavelet Transform-Haar scaling functions and function spaces, Nested Spaces, Haar Wavelet Function, Normalization of Haarbases at different scales, Standardizing the Notations, Refinement Relation with Respect to Normalized Bases, Support of a wavelet system, Daubechies Wavelets

**Unit – V**

Biorthogonal Wavelets-Biorthogonality in vector space, Biorthogonal Wavelet Systems, Signal Representation using Biorthogonal Wavelet System, Biorthogonal Analysis, Biorthogonal Synthesis, Construction of Biorthogonal Wavelet Systems.

**Text Book:**

1. Insight into Wavelets: From theory to practice by K.P.Soman, Ramachandran, Resmi, PHI Learning PVT Ltd,2010
2. L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

**References:**

1. Wavelet Transforms - Introduction to Theory and Applications, Raghuveer M.Rao, Ajit Bopardikar, Pearson Education, Asia
2. Fundamentals of Wavelets - Theory, Algorithms and Applications, Jaideva C.Goswami, Andrew K. Chan, John Wiley & Sons.



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**Course Outcomes:**

1. Understand windowed Fourier transform and difference between windowed Fourier Transform and wavelet transform.
2. Understand wavelet basis and characterize continuous and discrete wavelet transforms
3. Understand multiresolution analysis and identify various wavelets and evaluate their Time- frequency resolution properties
4. Implement discrete wavelet transforms with multirate digital filters and understand Wavelet packets
5. Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields



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<b>MULTIRATE SYSTEMS AND FILTER BANKS</b>					

**Unit – I:** Fundamentals of Multirate Systems: Basic Multirate Operations, Interconnection of Building Blocks, The Polyphase representation, Multistage Implementations, Some Applications of Multirate Systems, Special Filters and Filter Banks

**Unit – II**

Maximally Decimated Filter Banks: Errors created in the QMF Bank, A Simple Alias Free QMF System, Power Symmetric QMF Banks, M-Channel Filter Banks, Polyphase representation, Perfect Reconstruction Systems, Alias Free Filter Banks, Tree Structured Filter Banks, Trans-Multiplexers

**Unit – III**

Para unitary Perfect Reconstruction (PR) Filter Banks: Lossless Transfer Matrices, Filter Bank Properties Induced by Para unitariness, Two channel FIR Para unitary QMF Banks, The Two channel Para unitary QMF Lattice, Transform Coding and the LOT.

**Unit – IV**

Cosine Modulated Filter Banks: The Pseudo QMF Bank, Design of Pseudo QMF Bank, Efficient Polyphase Structures, Deeper Properties of Cosine Matrices, Cosine Modulated Perfect Reconstruction Systems.

**Unit – V**

Quantization effects, Types of Quantization effects, Review of standard techniques, Noise transmission in multirate systems, Noise in filter banks, Filter bank output noise, Limit Cycles, Coefficient Quantization

**Text Book:**

1. Multirate Systems and Filter Banks, P.P.Vaidyanathan, Pearson Education, Low Priced Edition, 2006.

**Reference Books:**

1. Multirate Signal Processing for Communication Systems by F.J.Harris, Pearson Education, Low Priced Edition.
2. Digital Signal Processing, A computer Based Approach by Sanjit K Mitra, Tata McGraw Hill Publishing.

**Course Outcomes:**

1. Understand the concepts multi-rate systems
2. Describe the applications of multi-rate systems
3. Study of various filter banks
4. Analyze the efforts of quantization
5. Explain the overall multi-rate systems and filter banks



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<b>POOL-4 (HONOR)</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>
<b>MATHEMATICAL METHODS FOR SIGNAL PROCESSING</b>					

**Unit – I**

Vectors: Representation and Dot products, Matrices: Matrix Multiplication, Transposes, Inverses, Gaussian Elimination, factorization, rank of a matrix, Vector spaces: Column and row spaces, Solving  $Ax=0$  and  $Ax=b$ , Independence, basis, dimension, linear transformations, Orthogonality: Orthogonal vectors and subspaces, projection and least squares, Gram-Schmidt orthogonalization.

**Unit – II**

Determinants: Determinant formula, cofactors, inverses and volume, Eigenvalues and Eigenvectors: characteristic polynomial, Diagonalization, Hermitian and Unitary matrices, Spectral theorem, Change of basis, Positive definite matrices and singular value decomposition, Linear transformations.

**Unit – III**

Review of Probability: Basic set theory and set algebra, basic axioms of probability, Conditional Probability, Bayes theorem/Law of total probability.

**Unit – IV**

Random variables PDF/PMF/CDF Properties, random vectors marginal/joint/conditional density functions, transformation of Random Variables, characteristic/moment generating functions, Random sums of Random variables, Law of Large numbers (strong and Weak), Limit theorems convergence types, Inequalities Chebyshev/Markov/Chernoff bounds.

**Unit – V**

Random processes: classification of random processes, wide sense stationary processes, autocorrelation function and power spectral density and their properties. Examples of random process models - Gaussian/Markov Random process, Random processes through LTI systems.

**Textbooks:**

1. Introduction to linear algebra - Gilbert Strang, SIAM, 2016.
2. Introduction to probability - Bertsekas and Tsitsiklis, Athena, 2008

**References Books:**

1. Probability and Random processes for Electrical Engineers, Leon Garcia Addison Wesley, 2nd edition, 1994
2. Probability and Random Processes, Geoffrey Grimmett, David Stirzaker, 3rd Edition, Oxford University Press, 2001.
3. Probability and Stochastic Process, Roy D Yates, David J Goodman, 2nd edition Wiley, 2010



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**Course Outcomes:**

1. Understand and solve the problems associated with Vectors
2. Solve the problem associated with linear algebra
3. Understand probability theory and conditional probability
4. Summarize the concepts associated with multiple random variables and to solve the problems associated with power spectral density of the output of the system.
5. Recognize the usage of random process in signal processing and to solve the corresponding problems.



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MINOR Course		L	T	P	C
		<b>3</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>ELECTRONICS DEVICES AND BASIC CIRCUITS</b>					

**UNIT-I :Review of Semi Conductor Physics:** Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic Semiconductors

**Junction Diode Characteristics :** energy band diagram of PN junction Diode, Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in PN junction Diode, diode equation, V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance.

**UNIT-II:**

**Special Semiconductor Devices:** Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Varactor Diode, Photodiode, Tunnel Diode, UJT, PNP Diode, SCR. Construction, operation and V-I characteristics.

**Rectifiers and Filters:** Basic Rectifier setup, half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, rectifier circuits-operation, input and output waveforms, Filters, Inductor filter(Series inductor), Capacitor filter(Shunt inductor),  $\pi$ -Filter, comparison of various filter circuits in terms of ripple factors.

**UNIT- III: Transistor Characteristics:**

**BJT:** Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through/ reach through, Photo transistor, typical transistor junction voltage values.

**FET:** FET types, construction, operation, characteristics,  $\mu$ ,  $g_m$ ,  $r_d$  parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

**UNIT- IV: Transistor Biasing and Thermal Stabilization :** Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self bias, Stabilization against variations in  $V_{BE}$ ,  $I_c$ , and  $\beta$ , Stability factors,  $(S, S', S'')$ , Bias compensation, Thermal runaway, Thermal stability.

FET Biasing- methods and stabilization.

**UNIT- V: Small Signal Low Frequency Transistor Amplifier Models:**

**BJT:** Two port network, Transistor hybrid model, determination of h-parameters, conversion of h-parameters, generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers.

**FET:** Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers, comparison of FET amplifiers.

**Text Books:**

1. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition, 2007
2. Electronic Devices and Circuits by David A. Bell, Oxford University Press
3. Electronics devices & circuit theory- Robert L. Boylestad and Loui Nashelsky, Pearson/Prentice hall, tenth edition, 2009



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**References:**

1. Integrated Electronics-J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition, 2009
2. Electronic Devices and Circuits-K. Lal Kishore, BS Publications, Fourth Edition, 2016.
3. Electronic Devices and Circuits-Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, 4<sup>th</sup> Edition, 2008.
4. Electronic Devices and Integrated Circuits – B.P. Singh, Rekha , Pearson publications, 2006.

**OUTCOMES:**

At the end of this course the student will be able to

1. Apply the basic concepts of semiconductor physics.
2. Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
3. Know the construction, working principle of rectifiers with and without filters with relevant expressions and necessary comparisons.
4. Understand the construction, principle of operation of transistors, BJT and FET with their V-I characteristics in different configurations.
5. Know the need of transistor biasing, various biasing techniques for BJT and FET and stabilization concepts with necessary expressions.
6. Perform the analysis of small signal low frequency transistor amplifier circuits using BJT and FET in different configurations.





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<b>DIGITAL ELECTRONICS</b>					

**UNIT – I****REVIEW OF NUMBER SYSTEMS & CODES:**

Representation of numbers of different radix, conversion from one radix to another radix,  $r-1$ 's complements and  $r$ 's complements of signed members. Gray code, 4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc. Error detection & correction codes: parity checking, even parity, odd parity, Hamming code.

**BOOLEAN THEOREMS AND LOGIC OPERATIONS:**

Boolean theorems, principle of complementation & duality, De-morgan theorems. Logic operations ; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX-NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations, Realization of three level logic circuits. Study the pin diagram and obtain truth table for the following relevant ICs 7400,7402,7404,7408,7432,7486.

**UNIT – II****MINIMIZATION TECHNIQUES:**

Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables) and tabular method (Quine-mcCluskey method) with only four variables and single function.

**COMBINATIONAL LOGIC CIRCUITS DESIGN:**

Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-ahead adder circuit, Design code converters using Karnaugh method and draw the complete circuit diagrams.

**UNIT – III****COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI & LSI :**

Design of encoder, decoder, multiplexer and de-multiplexers, Implementation of higher order circuits using lower order circuits. Realization of Boolean functions using decoders and multiplexers. Design of Priority encoder, 4-bit digital comparator and seven segment decoder. . Study the relevant ICs pin diagrams and their functions 7442,7447,7485,74154.

**INTRODUCTION OF PLD's :**

PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

**UNIT – IV****SEQUENTIAL CIRCUITS I:**

Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another



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flip-flop. Design of 5 ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift, register.

Study the following relevant ICs and their relevant functions  
 7474,7475,7476,7490,7493,74121.

**UNIT – V**

**SEQUENTIAL CIRCUITS II :**

Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa. Realization of sequence generator, Design of Clocked Sequential Circuit to detect the given sequence (with overlapping or without overlapping).

**TEXT BOOKS:**

1. Switching and finite automata theory Zvi.KOHAVI, Niraj.K.Jha 3<sup>rd</sup> Edition, Cambridge University Press,2009
2. Digital Design by M.Morris Mano, Michael D Ciletti,4<sup>th</sup> edition PHI publication,2008
3. Switching theory and logic design by Hill and Peterson, Mc-Graw Hill TMH edition, 2012.

**REFERENCES:**

1. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers,2006
2. Digital electronics by R S Sedha.S.Chand& company limited,2010
3. Switching Theory and Logic Design by A. Anand Kumar, PHI Learning pvt ltd,2016.
4. Digital logic applications and design by John M Yarbough, Cengage learning, 2006.
5. TTL 74-Series data book.

**Course Outcomes:**

1. Classify different number systems and apply to generate various codes.
2. Use the concept of Boolean algebra in minimization of switching functions
3. Design different types of combinational logic circuits.
4. Apply knowledge of flip-flops in designing of Registers and counters
5. The operation and design methodology for synchronous sequential circuits and algorithmic state machines.
6. Produce innovative designs by modifying the traditional design techniques.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>PRINCIPLES OF COMMUNICATIONS</b>					

**UNIT-I**

**Amplitude modulation:** Introduction, Amplitude Modulation: Time & Frequency – Domain description, switching modulator, Envelop detector.

**Double side band-suppressed carrier modulation:** Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing.

**Singleside–**

**and vestigial sideband methods of modulation:** SSB Modulation, VSB Modulation, Frequency Translation, Frequency-Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television

**UNIT-II**

**Angle modulation:** Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing,

**Phase-Locked Loop:** Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems. The Super-heterodyne Receiver

**UNIT-III**

**Random variables & process:** Introduction, Probability, Conditional Probability, Random variables, Several Random Variables. Statistical Averages: Function of a random variable, Moments, Random Processes, Mean, Correlation and Covariance function: Properties of autocorrelation function, Cross-correlation functions.

**Noise:** Shot Noise, Thermal noise, White Noise, Noise Equivalent Bandwidth, Noise Figure.

**UNIT-IV**

**Noise in analog modulation:** Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasis in FM.

**UNIT-V**

**Digital representation of analog signals:** Introduction, Why Digitize Analog Sources?, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, The Quantization Process, Quantization Noise,

**Pulse Code Modulation:** Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing

**Textbooks:**

1. Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe, TMH, 2007, 3<sup>rd</sup> Edition.
2. Communication Systems – B.P. Lathi, BS Publication, 2006.



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**References:**

1. Principles of Communication Systems – Simon Haykin, John Wiley, 2<sup>nd</sup> Edition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
3. Communication Systems–R.P. Singh,SPSapre,SecondEditionTMH,2007.

**Course Outcomes:**

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

1. Analyze the performance of analog modulation schemes in time and frequency domains.
2. Analyze the performance of angle modulated signals.
3. Characterize analog signals in time domain as random processes and noise
4. Characterize the influence of channel on analog modulated signals
5. Determine the performance of analog communication systems interms of SNR
6. Analyzepulseamplitudemodulation,pulsepositionmodulation,pulseco demodulationandTDMsystems



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<b>MINOR Course</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>SIGNAL ANALYSIS</b>					

**UNIT- I: INTRODUCTION:** Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions. Related Problems.

**UNIT–II: FOURIER Analysis of Periodic Signals:**

Fourier series representation of continuous time periodic signals, properties of Fourier series, Dirichlet’s conditions, Trigonometric Fourier series and Exponential Fourier series, Relation between Trigonometric and Exponential Fourier series, Complex Fourier spectrum.

**UNIT-III: FOURIER Analysis of Aperiodic Signals:**

Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Introduction to Hilbert Transform. Related Problems.

**UNIT –IV:**

**CORRELATION:** Auto-correlation and cross-correlation of functions, properties of correlation function, Energy density spectrum, Parseval’s theorem, Power density spectrum, Relation between Convolution and correlation

**SAMPLING THEOREM :** Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling, Related problems.

**UNIT –V:**

**LAPLACE TRANSFORMS:** Introduction, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T’s, Inverse Laplace transform, Relation between L.T’s, and F.T. of a signal.

**Z–TRANSFORMS:** Concept of Z- Transform of a discrete sequence. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms. Distinction between Laplace, Fourier and Z transforms.

**TEXT BOOKS:**

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2ndEdn,1997



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**REFERENCE BOOKS:**

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2ndEdition,2007

**Course Outcomes:** At the end of this course the student will able to:

1. Differentiate the various classifications of signals and systems
2. Analyze the frequency domain representation of signals using Fourier concepts
3. Know the sampling process and various types of sampling techniques.
4. Apply Laplace and z-transforms to analyze signals and Systems (continuous & discrete).