



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

## **COURSE STRUCTURE AND SYLLABUS**

**For**

**B. TECH ELECTRONICS AND COMMUNICATION ENGINEERING**

*(Applicable for batches admitted from 2019-2020)*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**

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**I Year – I SEMESTER**

Sl. No	Course Code	Subjects	L	T	P	Credits
1	HS1101	English	3	0	0	3
2	BS1101	Mathematics - I	3	0	0	3
3	BS1106	Applied Chemistry	3	0	0	3
4	ES1101	Programming for Problem Solving Using C	3	0	0	3
5	ES1103	Engineering Drawing	1	0	3	2.5
6	HS1102	English Lab	0	0	3	1.5
7	BS1107	Applied Chemistry Lab	0	0	3	1.5
8	ES1102	Programming for Problem Solving Using C Lab	0	0	3	1.5
9	MC1101	Environmental Science	3	0	0	0
<b>Total Credits</b>			<b>16</b>	<b>0</b>	<b>12</b>	<b>19</b>

**I Year – IISEMESTER**

Sl. No	Course Code	Subjects	L	T	P	Credits
1	BS1202	Mathematics – II	3	0	0	3
2	BS1203	Mathematics – III	3	0	0	3
3	BS1204	Applied Physics	3	0	0	3
4	ES1209	Network Analysis	3	0	0	3
5	ES1211	Basic Electrical Engineering	3	0	0	3
6	ES1215	Electronic workshop	0	0	2	1
7	ES1208	Basic Electrical Engineering Lab	0	0	3	1.5
8	BS1205	Applied Physics Lab	0	0	3	1.5
9	HS1203	Communication Skills Lab	0	0	2	1
10	PR1201	Engineering Exploration Project	0	0	2	1
			<b>15</b>	<b>0</b>	<b>12</b>	<b>21</b>



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### II Year – I Semester

S. No.	Course	Category	L	T	P	Credits
1	Electronic Devices and Circuits	PC	3	0	0	3
2	Switching Theory and Logic Design	PC	3	0	0	3
3	Signals and Systems	PC	3	0	0	3
4	Random Variables and Stochastic Processes	PC	3	0	0	3
5	Object Oriented Programming through Java	ES	3	0	0	3
6	Managerial Economics & Financial Analysis	HS	3	0	0	3
7	Electronic Devices and Circuits - Lab	LC	0	0	3	1.5
8	Switching Theory and Logic Design - Lab	LC	0	0	3	1.5
9	Constitution of India	MC	3	0	0	0
			Sub-Total			<b>21</b>

### II Year – II Semester

S. No.	Course	Category	L	T	P	Credits
1	Electronic Circuit Analysis	PC	3	0	0	3
2	Linear Control Systems	PC	3	0	0	3
3	Electromagnetic Waves and Transmission Lines	PC	3	0	0	3
4	Analog Communications	PC	3	0	0	3
5	Computer Architecture and Organization	ES	3	0	0	3
6	Management and Organizational Behavior	HS	3	0	0	3
7	Electronic Circuit Analysis - Lab	LC	0	0	3	1.5
8	Analog Communications - Lab	LC	0	0	3	1.5
			Sub-Total			<b>21</b>



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### III Year – I Semester

S. No.	Course	Category	L	T	P	Credits
1	Linear Integrated Circuits and Applications	PC	3	0	0	3
2	Microprocessor and Microcontrollers	PC	3	0	0	3
3	Digital Communications	PC	3	0	0	3
4	Electronic Measurements & Instrumentation	PC	3	0	0	3
5	Professional Elective (PE 1)	PE	3	0	0	3
6	Linear Integrated Circuits and Applications - Lab	LC	0	0	3	1.5
7	Digital Communications Lab	LC	0	0	3	1.5
8	Microprocessor and Microcontrollers - Lab	LC	0	0	3	1.5
9	Mini Project with Hardware Development	PR	0	0	3	1.5
10	Essence of Indian Traditional Knowledge	MC	3	0	0	0
			Sub-Total			<b>21</b>

### III Year – IISemester

S. No.	Course	Category	L	T	P	Credits
1	Wired and Wireless Transmission Devices	PC	3	0	0	3
2	VLSI Design	PC	3	0	0	3
3	Digital Signal Processing	PC	3	0	0	3
4	Professional Elective (PE2)	PE	3	0	0	3
5	Open Elective (OE1)	OE	3	0	0	3
6	Internet of Things	PC	3	0	0	3
7	VLSI Lab	LC	0	0	3	1.5
8	Digital Signal Processing Lab	LC	0	0	3	1.5
9	Intellectual Property Rights (IPR) & Patents	MC	3	0	0	0
			Sub-Total			<b>21</b>



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### IV Year – I Semester

S. No.	Course	Category	L	T	P	Credits
1	Microwave and Optical Communication Engineering	PC	3	0	0	3
2	Data Communications & Computer networks	PC	3	0	0	3
3	Digital Image and Video Processing	PC	3	0	0	3
4	Professional Elective (PE3)	PE	3	0	0	3
5	Professional Elective (PE4)	PE	3	0	0	3
6	Internet of Things Lab	LC	0	0	3	1.5
7	Microwave and Optical Communication Engineering LAB	LC	0	0	3	1.5
8	Project - Part I	PR	0	0	6	3
			Sub-Total			<b>21</b>

### IV Year – II Semester

S. No.	Course	Category	L	T	P	Credits
1	Professional Elective (PE5)	PE	3	0	0	3
2	Open Elective (OE2)	OE	3	0	0	3
3	Project - Part II	PR	0	0	18	9
			Sub-Total			<b>15</b>
			<b>Total</b>			<b>160</b>





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**OPEN ELECTIVES FOR ECE:**

**Open Elective 1:**

1. DataMining
2. PowerElectronics
3. MEMS and itsapplications
4. Artificial NeuralNetworks

**Open Elective 2:**

1. 3D Printing
2. Block chainTechnology
3. Cyber Security &Cryptography

**OPEN ELECTIVES OFFERED BY ECE:**

- OE 1 Principles of communication  
OE 2 Embedded Systems



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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>ENGLISH</b>				

### 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 nativespeakers
- 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 wordforms





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

**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.



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**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

**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)





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**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)

**Reference books:**

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



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MATHEMATICS-I</b> (Common to all Branch's for I Year B.Tech)					

**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: (10hrs)**

Sequences and Series: Convergence 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.





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		<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.

**Learning 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.
- **Express** the increase in demand as wide variety of advanced materials are introduced; which have excellent engineering properties.
- **Explain** the crystal structures, and the preparation of semiconductors. Magnetic properties are also studied.
- **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.

**UNIT I POLYMER TECHNOLOGY**

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

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

**Elastomers:-** Natural rubber-drawbacks-vulcanization-preparation, properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes).

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

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

- **Outline** the properties of polymers and various additives added and different methods of forming plastic materials.
- **Explain** the preparation, properties and applications of some plastic materials.
- **Interpret** the mechanism of conduction in conducting polymers.
- **Discuss** natural and synthetic rubbers and their applications.

**UNIT II: ELECTROCHEMICAL CELLS AND CORROSION**

Single electrode potential-Electrochemical series and uses of series-standard hydrogen electrode, calomel electrode-concentration cell-construction of glass electrode-Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li ion battery, zinc air cells-Fuel cells: H<sub>2</sub>-O<sub>2</sub>, CH<sub>3</sub>OH-O<sub>2</sub>, phosphoric acid, molten carbonate.

**Corrosion:-** Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, waterline corrosion-passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control (proper designing, cathodic





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protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, specialpaints).

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

- *Explain* the theory of construction of battery and fuelcells.
- *Categorize* the reasons for corrosion and study some methods of corrosioncontrol.

**UNIT III: MATERIAL CHEMISTRY**

**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 BET, SEM and TEM methods-applications of graphene-carbon nanotubes and fullerenes: Types, preparation and applications

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

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

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

- *Understand* the importance of materials like nanomaterials and fullerenes and theiruses.
- *Understand* liquid crystals andsuperconductors.
- *Understand* the preparation ofsemiconductors.

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

**Computational chemistry:** Introduction, Ab Initio 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

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

- *Obtain* the knowledge of computationalchemistry
- *Understand* importance molecularmachines

**UNIT V: SPECTROSCOPIC TECHNIQUES & NON CONVENTIONAL ENERGY SOURCES**

**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 IR of some organic compounds, 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.





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

- understand the principles of different analytical instruments.
- explain the different applications of analytical instruments.
- design sources of energy by different natural sources.

**Standard Books:**

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publishing Co.

**Reference Books:**

1. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 edition.



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

**COURSE OBJECTIVES: COURSE OBJECTIVES:**

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

- 1) To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
- 2) To gain knowledge of the operators, selection, control statements and repetition in C
- 3) To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
- 4) To assimilate about pointers, dynamic memory allocation and know the significance of Preprocessor.
- 5) 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, Mc GrawHill
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

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



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		<b>1</b>	<b>0</b>	<b>3</b>	<b>2.5</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.



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**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 viceversa.

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.

**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 P.I. Varghese, McGraw Hill 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 LAB</b>				

**UNIT I:**

Vowels, Consonants, Pronunciation, Phonetic Transcription

**UNIT II:**

Past tense markers, word stress-di-syllabic words, Poly-Syllabic words

**UNIT III:**

Rhythm & Intonation

**UNIT IV:**

Contrastive Stress (Homographs)

**UNIT V:**

Word Stress: Weak and Strong forms  
 Stress in compound words

**References books:**

1. Infotech English, Maruthi Publications. (with CompactDisc)
2. Exercises in Spoken English Part 1,2,3,4, OUP andCIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge UniversityPress.
4. English Phonetics and Phonology-Peter Roach, Cambridge UniversityPress.
5. English Pronunciation in use- Mark Hewings, Cambridge UniversityPress.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge UniversityPress.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<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  $\text{NaOH}$ .
3. Determination of Mn (II) 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 copper (II) using standard hypso solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of iron (III) by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of the concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of  $\text{Mg}^{+2}$  present in an antacid.
12. Determination of  $\text{CaCO}_3$  present in an eggshell.
13. Estimation of Vitamin C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. 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 debugprograms.
- 3) To design & develop of C programs using arrays, strings pointers &functions.
- 4) To review the file operations, preprocessorcommands.

**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 fourcharacters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5inches.
3. Write a C program to display multiplevariables.

**Exercise 2:**

1. Write a C program to calculate the distance between the twopoints.
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 "Wrongvalues".

**Exercise 3:**

1. Write a C program to convert a string to a longinteger.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometricalshape.
3. Write a C program to calculate the factorial of a givennumber.

**Exercise 4:**

1. Write a program in C to display the n terms of even natural number and theirsum.
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 ornot.

**Exercise 5:**

1. Write a program in C to print all unique elements in anarray.
2. Write a program in C to separate odd and even integers in separatearrays.
3. Write a program in C to sort elements of array in ascendingorder.

**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 givenmatrix.

**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 reverseorder.





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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 textfile.
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>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>ENVIRONMENTAL SCIENCE</b>					

**Learning Objectives:**

The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

**UNIT-I:**

**Multidisciplinary nature of Environmental Studies:** Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects; Role of information technology in environment and human health.

**Ecosystems:** Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

**UNIT-II:**

**Natural Resources:** Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.



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### UNIT-III:

**Biodiversity and its conservation:** Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

### UNIT – IV

**Environmental Pollution:** Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his wellbeing.

**Solid Waste Management:** Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

### UNIT – V

**Social Issues and the Environment:** Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act - Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Publicawareness.

### UNIT – VI

**Environmental Management:** Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

### Text Books:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2<sup>nd</sup> Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

### Reference:



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1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, NewDelhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, NewDelhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New AgeInternational Publishers,2014



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MATHEMATICS - II</b> (Common to all Branch for I Year B. Tech)					

**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 approximating the 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 different algorithms for approximating the solutions of ordinary differential equations to its analytical computations(L3)

**Unit I: Solving systems of linear equations, Eigen values and Eigenvectors: (10 hrs)**

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous equations linear equations – Gauss Elimination for solving system of equations – Eigen values and Eigen vectors and their properties.

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

Cayley-Hamilton theorem (without proof) – Finding 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 (Ref. Book – 1).

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



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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.

**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.

**UNIT V: Numerical integration and solution of ordinary differential equations: (10 hrs)**

Trapezoidal rule – Simpson's  $1/3^{\text{rd}}$  and  $3/8^{\text{th}}$  rule – Solution of ordinary differential equations 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, 43<sup>rd</sup> Edition, Khanna Publishers.
2. **B. V. Ramana**, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

**Reference Books:**

1. **David Poole**, Linear Algebra- A modern introduction, 4<sup>th</sup> Edition, Cengage.
2. **Steven C. Chapra**, Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.
3. **M. K. Jain, S. R. K. Iyengar and R. K. Jain**, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
4. **Lawrence Turyn**, Advanced Engineering Mathematics, CRC Press.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MATHEMATICS - III</b> (Common to all Branch for I Year B. Tech)					

**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 a range of non-periodic waveforms (L3)
- identify solution methods for partial differential equations that model physical processes (L3)

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

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: (10 hrs)**

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.



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

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.

**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 (Lagrange) 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 coefficients – 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, S C Bhunia**, Engineering Mathematics, Oxford University Press.





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

**Course Objectives:**

Physics curriculum which is re-oriented to the needs of Circuital branches of graduate engineering courses offered by Jawaharlal Nehru Technological University Kakinada that serves as a transit to understand the branch specific advanced topics. The course is designed to:

- Impart Knowledge of Physical Optics phenomena like Interference and Diffraction required to design instruments with higher resolution.
- Understand the physics of Semiconductors and their working mechanism for their utility insensors.
- To impart the knowledge of materials with characteristic utility inappliances.

**UNIT-I**

**(10hrs)**

**WAVE OPTICS:** Principle of Superposition - Interference of light - Conditions for sustained Interference - Interference in thin films (reflected geometry) - Newton's Rings (reflected geometry).

Diffraction - Fraunhofer Diffraction - Diffraction due to Single slit (quantitative), Double slit, N-slits and circular aperture (qualitative) – Intensity distribution curves - Diffraction Grating – Grating spectrum – missing order – resolving power – Rayleigh's criterion – Resolving powers of Microscope, Telescope and grating(qualitative).

**Unit Outcomes:**

*The students will be able to*

- **explain** the need of coherent sources and the conditions for sustained interference.
- **analyze** the differences between interference and diffraction with applications.
- **illustrate** the resolving power of various optical instruments.

**UNIT-II**

**(9hrs)**

**QUANTUM MECHANICS:** Introduction – Matter waves – de Broglie's hypothesis – Davisson-Germer experiment – G. P. Thomson experiment – Heisenberg's Uncertainty Principle – interpretation of wave function – Schrödinger Time Independent and Time Dependent wave equations – Particle in a potential box.



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**Unit Outcomes:**

*The students will be able to*

- **explain** the fundamental concepts of quantum mechanics.
- **analyze** the physical significance of wavefunction.
- **apply** Schrödinger's wave equation for energy values of a free particle.

**UNIT-III**

**(10hrs)**

**FREE ELECTRON THEORY & BAND THEORY OF SOLIDS :** Introduction – Classical free electron theory (merits and demerits only) - Quantum Free electron theory – electrical conductivity based on quantum free electron theory – Fermi Dirac distribution function – Temperature dependence of Fermi-Dirac distribution function - expression for Fermi energy - Density of states .

Bloch's theorem (qualitative) – Kronig-Penney model(qualitative) – energy bands in crystalline solids – E Vs K diagram – classification of crystalline solids – effective mass of electron –  $m^*$  Vs K diagram - concept of hole.

**Unit Outcomes:**

*The students will be able to*

- **explain** the various electron theories.
- **calculate** the Fermi energy.
- **analyze** the physical significance of wave function.
- **interpret** the effects of temperature on Fermi Dirac distribution function.
- **summarise** various types of solids based on band theory.

**UNIT-IV**

**(9hrs)**

**SEMICONDUCTOR PHYSICS:** Introduction – Intrinsic semi conductors - density of charge carriers - Electrical conductivity – Fermi level – extrinsic semiconductors - p-type & n-type - Density of charge carriers - Dependence of Fermi energy on carrier concentration and temperature – Hall effect- Hall coefficient - Applications of Hall effect - Drift and Diffusion currents – Einstein's equation.

**Learning Outcomes:**

*The students will be able to*

- **classify** the energy bands of semiconductors.
- **outline** the properties of n-type and p-type semiconductors.
- **identify** the type of semiconductor using Hall effect.



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**UNIT-V**

**(10 hrs)**

**MAGNETISM & DIELECTRICS:** Introduction – Magnetic dipole moment – Magnetization – Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Bohr magneton – Classification of magnetic materials: Dia, para & Ferro – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – applications of Ferromagnetic material.

Introduction - Dielectric polarization – Dielectric Polarizability, Susceptibility and Dielectric constant-types of polarizations: Electronic and Ionic (Quantitative), Orientational polarizations (qualitative) – Lorentz Internal field – Claussius-Mossoti equation - Frequency dependence of polarization – Applications of dielectrics.

**Unit Outcomes:**

*The students will be able to*

- **explain** the concept of polarization in dielectric materials.
- **summarize** various types of polarization of dielectrics.
- **interpret** Lorentz field and Claussius- Mosotti relation in dielectrics.
- **classify** the magnetic materials based on susceptibility and their temperature dependence.
- **explain** the applications of dielectric and magnetic materials.
- **Apply** the concept of magnetism to magnetic devices.

**TEXT BOOKS:**

1. “A Text book of Engineering Physics” by M.N. Avadhanulu, P.G.Kshirsagar - S.Chand Publications, 2017.
2. “Engineering Physics” by D.K.Bhattacharya and Poonam Tandon, Oxford press (2015).
3. “Engineering Physics” by R.K Gaur. and S.L Gupta., - Dhanpat Rai publishers, 2012.

**REFERENCE BOOKS:**

1. “Engineering Physics” by M. R. Srinivasan, New Age international publishers (2009).
2. “Optics” by Ajoy Ghatak, 6<sup>th</sup> Edition McGraw Hill Education, 2017.
3. “Solid State Physics” by A. J. Dekker, Mc Millan Publishers (2011).



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**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>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



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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)

### 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>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



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**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.

**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 DCmotors.
- Ability to analyze the performance and speed – torque characteristics of a 3-phase induction motor and understand starting methods of 3-phase inductionmotor.
- Able to explain the operation of SynchronousMachines
- Capability to understand the operation of various specialmachines.

**TEXT BOOKS:**

1. Principles of Electrical Machines by V.K. Mehta & Rohit Mehta, S.Chandpublications
2. Theory & performance of Electrical Machines by J.B.Guptha, 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
		0	0	2	1
<b>ELECTRONIC WORKSHOP</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 Multimeters.

**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.





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

**III. Soldering practice**

Tools kit including soldering iron

Tools Kit:

- Insulated nose plier
- Insulated cutting plier
- Screw driver kit
- Electrical tester
- Soldering iron, Lead, Flux

**IV. PCB layout and Design.**

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>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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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>APPLIED PHYSIC LAB</b> (Any 10 of the following listed 15 experiments)					

**LIST OF EXPERIMENTS:**

1. Determination of wavelength of a source-Diffraction Grating-Normalincidence.
2. Newton’s rings – Radius of Curvature of Plano - ConvexLens.
3. Determination of thickness of a spacer using wedge film and parallel interferencefringes.
4. Magnetic field along the axis of a current carrying coil – Stewart and Gee’sapparatus.
5. Energy Band gap of a Semiconductor p - njunction.
6. Characteristics of Thermistor – TemperatureCoefficients
7. Determination of dielectric constant by charging and dischargingmethod
8. Determination of resistivity of semiconductor by Four probemethod.
9. StudythevariationofBversusHbymagnetizingthemagneticmaterial( B-Hcurve). 10
- Measurement of magnetic susceptibility by Gouy’smethod.
11. Dispersive power of diffractiongrating.
12. Resolving Power oftelescope
13. Resolving power ofgrating
14. Determination of Hall voltage and Hall coefficients of a given semiconductor using Hall effect.
15. Variation of dielectric constant withtemperature.



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I Year - II Semester		L	T	P	C
		0	0	2	1
<b>COMMUNICATION SKILLS LAB</b>					

**UNIT I:**

Oral Activity: JAM, Hypothetical Situations, Self/Peer Profile  
 Common Errors in Pronunciation, Neutralising Accent

**UNIT II:**

Oral Activity: Telephonic Etiquette, Role Plays  
 Poster Presentations

**UNIT III:**

Oral Activity: Oral Presentation skills, Public speaking  
 Data Interpretation

**UNIT IV:**

Oral Activity: Group Discussions: Do's and Don'ts- Types, Modalities

**UNIT V:**

Oral Activity: Interview Skills: Preparatory Techniques, Frequently asked questions, Mock Interviews.  
 Pronunciation: Connected speech (Pausing, Tempo, Tone, Fluency etc..)

**References:**

1. Infotech English, Maruthi Publications. (with Compact Disc)
2. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge University Press.
4. English Phonetics and Phonology- Peter Roach, Cambridge University Press.
5. English Pronunciation in use- Mark Hewings, Cambridge University Press.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.
8. Technical Communication- Meenakshi Raman, Sangeeta Sharma, Oxford University Press.
9. Technical Communication- Gajendra Singh Chauhan, Smita Kashiramka, Cengage Publications.



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		<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>
<b>ENGINEERING EXPLORATION PROJECT</b>					

**COURSE OBJECTIVES:**

- Build mindsets & foundations essential for designers
- Learn about the Human-Centered Design methodology and understand their real-world applications
- Use Design Thinking for problem solving methodology for investigating illdefined problems.
- Undergo several design challenges and work towards the final design challenge

Apply Design Thinking on the following Streams to

- Project Stream 1: Electronics, Robotics, IOT and Sensors
- Project Stream 2: Computer Science and IT Applications
- Project Stream 3: Mechanical and Electrical tools
- Project Stream 4: Eco-friendly solutions for waste management, infrastructure, safety, alternative energy sources, Agriculture, Environmental science and other fields of engineering.

**HOW TO PURSUE THE PROJECT WORK?**

- The first part will be learning-based-asking students to embrace the methodology by exploring all the phases of design thinking through the wallet/ bag challenge and podcasts.
- The second part will be more discussion-based and will focus on building some necessary skills as designers and learning about complementary material for human-centered design.
- The class will then divide into teams and they will be working with one another for about 2 – 3 weeks. These teams and design challenges will be the basis for the final project and final presentation to be presented.
- The teams start with **Design Challenge** and go through all the phases more in depth from coming up with the right question to empathizing to ideating to prototyping and to testing.
- Outside of class, students will also be gathering the requirements, identifying the challenges, usability, importance etc
- At the end, Students are required to submit the final reports, and will be evaluated by the faculty.



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**TASKS TO BE DONE:**

Task 1: Everyone is a Designer

- Understand class objectives & harness the designermindset

Task 2: The Wallet/Bag Challenge andPodcast

- Gain a quick introduction to the design thinkingmethodology
- Go through all stages of the methodology through a simple designchallenge
- Podcast: Observe, Listen and Engage with the surrounding environment and identify a designchallenge.

Task 3: Teams & Problems

- Start Design Challenge and learn about teams & problems throughthis
- Foster team collaboration, findinspiration from the environment and learn how to identifyproblems

Task 4: Empathizing

- Continue Design Challenge and learnempathy
- Learn techniques on how to empathize withusers
- Go to the field and interview people in theirenvironments
- Submit ActivityCard

Task 5: Ideating

- Continue Design Challenge and learn how to brainstorm effectively
- Encourage exploration and foster spaces forbrainstorming
- Submit ActivityCard

Task 6:Prototyping

- Continue Design Challenge and learn how to create effectiveprototypes
- Build tangible models and use them as communicationtools
- Start giving constructive feedback to classmates andteammates
- Submit Activity Card

Task 7:Testing

- Finish Design Challenge and iterate prototypes and ideas through userfeedback
- Evolve ideas and prototypes through user feedback and constructivecriticism
- Get peer feedback on individual and groupperformance
- Submit ActivityCard

Task8:

- Final Report Submission andPresentation

**Note:** The colleges may arrange for Guest Speakers from Various Design Fields: Graphic Design, Industrial Design, Architecture, Product Design, Organizational Design, etc to enrich the students with Design ThinkingConcept.



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**REFERENCES:**

1. Tom Kelly, *The Art of Innovation: Lessons in Creativity From IDEO, America's Leading Design Firm* (Profile Books, 2002)
2. Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* (HarperBusiness, 2009)
3. Jeanne Liedtka, Randy Salzman, and Daisy Azer, *Design Thinking for the Greater Good: Innovation in the Social Sector* (Columbia Business School Publishing, 2017)

**OTHER USEFUL DESIGN THINKING FRAMEWORKS AND METHODOLOGIES:**

- Human-Centered Design Toolkit (IDEO); <https://www.ideo.com/post/design-kit>
- Design Thinking Boot Camp Bootleg (Stanford D-School); <https://dschool.stanford.edu/resources/the-bootcamp-bootleg>
- Collective Action Toolkit (frogdesign); [https://www.frogdesign.com/wpcontent/uploads/2016/03/CAT\\_2.0\\_English.pdf](https://www.frogdesign.com/wpcontent/uploads/2016/03/CAT_2.0_English.pdf)
- Design Thinking for Educators (IDEO); <https://designthinkingforeducators.com/>



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		<b>3</b>	<b>0</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 semiconductor 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 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, 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/Prentice hall, tenth edition, 2009

**References:**

1. Integrated Electronics- J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition, 2009
2. Electronic Devices and Integrated Circuits – B.P. Singh, Rekha, Pearson publications,
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 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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II Year - I Semester	L	T	P	C
	3	0	0	3

**SWITCHING THEORY and LOGIC DESIGN**

**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.



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**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 withoutoverlapping).

**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.MorrisMano,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.



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**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 databook.

**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>0</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.



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**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.

**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 waveformsynthesis.

**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,2nd Edn,1997
3. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2ndEdition,2007

**REFERENCE BOOKS:**

1. Principles of Linear Systems and Signals – BP Lathi, Oxford University Press,2015
2. Signals and Systems – T K Rawat , Oxford University press,2011

**Course Outcomes:**At the end of this course the student will 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>II 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>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 ONE 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 Nondeterministic Processes, Distribution and Density Functions, Concept of Stationarity and Statistical Independence. First-Order Stationary Processes, Second-order and Wide-Sense Stationarity,  $N^{\text{th}}$ -order and Strict-Sense





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Stationarity, Time Averages and Ergodicity, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process.

**UNIT V**

**RANDOM PROCESSES - SPECTRAL CHARACTERISTICS:** The Power Density Spectrum: Properties, Relationship between Power Density Spectrum and Autocorrelation 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, Autocorrelation 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, Band pass, Band-Limited and Narrowband Processes, Properties.

**TEXT BOOKS:**

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.

**REFERANCE 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, McGrawHill, 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 these 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>0</b>	<b>0</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



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**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.

**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.
- 4) Java Programming, D. S. Malik, Cengage Learning.



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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>0</b>	<b>0</b>	<b>3</b>
<b>MANAGERIAL ECONOMICS &amp; FINANCIAL ANALYSIS</b>					

**Course Objectives:**

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

**Unit-I**

**Introduction to Managerial Economics and demand Analysis:**

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

**Unit – II:**

**Theories of Production and Cost Analyses:**

Theories of Production function- Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit analysis-Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

**Unit – III:**

**Introduction to Markets, Theories of the Firm & Pricing Policies:**

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson’s models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles : Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms.



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**Unit – IV:**

**Introduction to Accounting & Financing Analysis:**

Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)

**Unit – V:**

**Capital and Capital Budgeting:** Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

**TEXT BOOKS:**

1. A R Aryasri, Managerial Economics and Financial Analysis, The McGraw – Hill companies.

**REFERENCES:**

1. Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & CompanyLtd,
2. JL Pappas and EF Brigham, Managerial Economics, Holt, R & W; New editionedition
3. N.P Srinivasn and M. SakthivelMurugan, Accounting for Management, S. Chand & CompanyLtd,
4. MaheswariS.N,AnIntroduction to Accountancy, Vikas Publishing House PvtLtd
5. I.M Pandey, Financial Management , Vikas Publishing House PvtLtd
6. V. Maheswari, Managerial Economics, S. Chand & CompanyLtd.

**Course Outcomes:**

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for aproduct.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination ofinputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different BusinessUnits.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools forAnalysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decisionmaking.



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<b>II 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>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.

**Electronic Workshop Practice:**

1. Identification, Specifications, Testing of R, L, C Components (ColourCodes), Potentiometers, Coils, Gang Condensers, Relays, BreadBoards.
2. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
3. Soldering Practice- Simple circuits using active and passive components.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Multimeter, Function Generator, Regulated Power Supply and CRO.

**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  
 Part A: V-I Characteristics  
 Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with filter)  
 Part A: Half-wave Rectifier  
 Part B: Full-wave Rectifier
4. BJT Characteristics (CE Configuration)  
 Part A: Input Characteristics  
 Part B: Output Characteristics
5. FET Characteristics (CS Configuration)  
 Part A: Drain Characteristics  
 Part B: Transfer Characteristics
6. SCR Characteristics
7. UJT Characteristics
8. Transistor Biasing
9. CRO Operation and its Measurements
10. BJT-CE Amplifier
11. Emitter Follower-CC Amplifier
12. FET-CS Amplifier

**Equipment required:**

1. Regulated Power supplies



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2. Analog/Digital Storage Oscilloscopes
3. Analog/Digital Function Generators
4. Digital Multi-meters
5. Decade Resistance 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>II 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>SWITCHING THEORY and LOGIC DESIGN LAB</b>					

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

1. Verification of truth tables of Logicgates  
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 TrainerKit
3. Verification of functional table of 3 to 8 line Decoder /De-multiplexer
4. 4 variable logic function verification using 8 to 1multiplexer.
5. Design full adder circuit and verify its functionaltable.
6. Verification of functional tables of  
(i) J K Edge triggered Flip –Flop  
(ii) J K 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 waveforms.
11. Design MOD – 8 synchronous counter using T Flip-Flop and verify the result and Sketch the output waveforms.
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.

**ADD on 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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II Year-I Semester		L	T	P	C
		3	0	0	0
<b>CONSTITUTION OF INDIA</b>					

**Course Objectives:**

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

**UNIT-I**

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

**Learning outcomes:**

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

**UNIT-II**

Union Government and its Administration Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

**Learning outcomes:-**After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court





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**UNIT-III**

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions

**Learning outcomes:-**After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat
- Differentiate between structure and functions of state secretariat

**UNIT-IV**

A. Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation Panchayati Raj: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

**Learning outcomes:-**After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Analyze the role of Mayor and elected representatives of Municipalities
- Evaluate Zilla Panchayat block level organization

**UNIT-V**

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

**Learning outcomes:-**After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

**References:**

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. Subash Kashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics



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5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

**resources:**

1. [nptel.ac.in/courses/109104074/8](http://nptel.ac.in/courses/109104074/8)
2. [nptel.ac.in/courses/109104045/](http://nptel.ac.in/courses/109104045/)
3. [nptel.ac.in/courses/101104065/](http://nptel.ac.in/courses/101104065/)
4. [www.hss.iitb.ac.in/en/lecture-details](http://www.hss.iitb.ac.in/en/lecture-details)
5. [www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution](http://www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution)

**Course Outcomes:**

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
  1. Know the sources, features and principles of Indian Constitution.
  2. Learn about Union Government, State government and its administration.
  3. Get acquainted with Local administration and Pachayati Raj.
  4. Be aware of basic concepts and developments of Human Rights.
  5. Gain knowledge on roles and functioning of Election Commission



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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

<b>II 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>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.



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**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.

**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 Heatsinks.

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

**Text Books:**

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. Neaman, McGrawHill, 2010.
2. Microelectronic 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>0</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 flow graph - 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.



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**UNIT IV**

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

**UNIT V**

**CLASSICAL CONTROL DESIGN TECHNIQUES**

Compensation techniques – Lag, Lead, Lead-Lag Controllers design in frequency 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 its Properties – Concepts of Controllability and Observability.

**TEXT BOOKS:**

1. Automatic Control Systems 8th edition– by B. C. Kuo–John Wiley and Sons's, 2003.
2. Control Systems Engineering – by I. J. Nagrath and M. Gopal, New Age International (P) Limited, Publishers, 2nd 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, RBA publications, 3rd edition, 2017.
2. Control Systems by A. Anandkumar, PHI, 2<sup>nd</sup> 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>ELECTROMAGNETIC WAVES and TRANSMISSION LINES</b>					

**Course objectives:**

The main objectives of this course are to understand

- Fundamentals of steady electric and magnetic fields using various laws
- Apply the concept of static and time varying Maxwell equations and power flow using Poynting theorem
- Wave characteristics in different media for normal and oblique incidence
- Implement various concepts of transmission lines and impedance measurements

**SYLLABUS:**

Prerequisites: Understanding of Cartesian co-ordinates, spherical & cylindrical systems

**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 Magnetostatic 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,





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UniformPlane Waves – Definition, All Relations Between E & H, Sinusoidal Variations, Wave Propagation in Lossydielectrics, lossless dielectrics, free space, wave propagation in good conductors, skin depth, Polarization & Types, Illustrative Problems.

Reflection and Refraction of Plane Waves – Normal and ObliqueIncidences, for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total InternalReflection, Surface Impedance. Poynting Vector and Poynting Theorem. Illustrative Problems.

**TEXT BOOKS:**

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.

**REFERENCE BOOKS:**

1. Electromagnetic Field Theory and Transmission Lines –GSN Raju, Pearson Education2006
2. Engineering Electromagnetic – William H. Hayt Jr. and John A. Buck, TMH, 7th ed.,2006.
3. Electromagnetic Field Theory and Transmission Lines: G SasiBhushana Rao, WileyIndia 2013.
4. Networks,LinesandFieldsJohn D. Ryder,Second Edition, PearsonEducation,2015.

**Course Outcomes:**

At the end of this course the student can able to

- Determine E and H using various laws and applications of electric & magneticfields
- Apply the Maxwell equations to analyze the time varying behavior of EMwaves
- Gain the knowledge in uniform plane wave concept and characteristics of uniformplane wave invariousmedia
- Calculate Brewster angle, critical angle and total internalreflection
- Derive andCalculate the expressions for input impedance of transmission lines,reflection coefficient, VSWR etc. using smithchart





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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 communications 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 AM SSB 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, Narrow band FM, Wide band 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.



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**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 hetro dyne 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.

**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

**TEXT BOOKS:**

1. Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe, 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 Kennedy and 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 demodulationschemes and their spectralcharacteristics
- Analyze noise characteristics of various analog modulationmethods
- Analyze various functional blocks of radio transmitters andreceivers
- Design simple analog systems for various modulationtechniques.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>COMPUTER ARCHITECTURE and ORGANIZATION</b>					

**Course objectives:**

- To understand the architecture of a modern computer with its various processing units. Also the Performance measurement of the computer system.
- To understand the memory management system of computer.
- To Understand the various instructions, addressing modes
- To Understand the concept of I/O organization

**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



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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, 5th Edition, McGrawHill, 2011.
2. Computer Architecture and Organization, John P. Hayes, 3<sup>rd</sup> Edition, McGrawHill, 2002.

**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:**

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



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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



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Motivation: Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation,

**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 HRM and Marketing of new product developments.
- The learner is able to think in 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  $f_T$  of a 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. Bootstrapped 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 Oscilloscopes
3. Analog/Digital Function Generators
4. Digital Multimeters
5. Decade Resistance 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 toolbox)
- A. Amplitude Modulation - Modulation & Demodulation
  - B. AM - DSB SC - 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. PLL IC-565 as FM demodulator
  - L. Radio receiver characteristics
  - M. Radio Receiver/TV Receiver Demo kits 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 – 20 M Hz.
3. Function Generators - 0 – 1 MHz
4. Components and Breadboards
5. Multimeters and other meters
6. 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>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>LINEAR INTEGRATED CIRCUITS and APPLICATIONS</b>					

**Course objectives::**

- To understand the basic operation & performance parameters of differential amplifiers.
- To understand & learn the measuring techniques of performance parameters of Op-Amp
- To learn the linear and non-linear applications of operational amplifiers.
- To understand the analysis & design of different types of active filters using op-amps
- To learn the internal structure, operation and applications of different analog ICs
- To Acquire skills required for designing and testing integrated circuits

**UNIT I**

**Introduction:** Internal Block Diagram of various stages of Op-Amp and Roll of each Stage. Differential Amplifier using BJTs and With  $R_E$  DC and AC Analysis, Basic Current Mirror Circuit, Improved Version of current mirror circuit, current repeated circuit, Wilson current source.

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.etc, Measurements of Op-Amp Parameters. Three-Terminal Voltage Regulators 78xx & 79xx Series, current Booster, adjustable voltage, Dual Power Supply with 78xx & 79xx.

**UNIT II**

**LINEAR and NON-LINEAR APPLICATIONS OF OP-AMPS:** Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear function generation, Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti log Amplifiers, Precision rectifiers.

**UNIT III**

**ACTIVE FILTERS, ANALOG MULTIPLIERS AND MODULATORS:** Design & Analysis of Butterworth active filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and all pass filters.

Four Quadrant Multiplier, IC 1496, Sample & Hold circuits.

**UNIT IV**

**TIMERS & PHASE LOCKED LOOPS:** Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger; PLL - 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).



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**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, and IC 1408 DAC, Different types of ADCs – parallel Comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC. DAC and ADC Specifications, Specifications AD 574 (12 bit ADC).

**TEXT BOOKS:**

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p)Ltd, 2<sup>nd</sup>Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad,PHI,1987.
3. Linear Integrated Circuits by Salivahan-3<sup>rd</sup>-Edition, McGrawHill,2018

**REFERENCES:**

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma ;SK Kataria& Sons; 2<sup>nd</sup>Edition,2010
2. Operational Amplifiers & Linear Integrated Circuits–R.F.Coughlin& FredrickDriscoll, PHI, 6<sup>th</sup> Edition,2000.
3. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition,2011.
4. LinearIntegratedCircuits,byGaneshBabuT.RandSuseelaB.Scitech, 5<sup>th</sup>-Editon, 2014.

**Course Outcomes:**

- Design circuits using operational amplifiers for various applications.
- Analyze and design amplifiers and active filters using Op-amp.
- Diagnose and trouble-shoot linear electronic circuits.
- Understand the gain-bandwidth concept and frequency response of the amplifier configurations.
- Understand thoroughly the operational amplifiers with linear integrated circuits.



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

**Course objectives::**

The main objectives of this course are

- To acquire knowledge on microprocessors and microcontrollers.
- To select processors based on requirements.
- To acquire the knowledge on interfacing various peripherals, configure and develop programs to interface peripherals/sensors.
- To develop programs efficiently on ARM Cortex processors and debug.

**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 Converters, Stepper motor interface, keyboard, LCD

Interfacing, Traffic light control.

**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.



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Programmers Model – Modes of operation and execution, Instruction set summary, System address map, write buffer, bit-banding, processor core register summary, exceptions.

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. Microprocessors and Interfacing – Programming and Hardware by Douglas V Hall, SSSP Rao, Tata McGraw Hill Education Private Limited, 3<sup>rd</sup> Edition, 1994.
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.

**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. Cortex -M3 Technical Reference Manual.

**Course Outcomes:**

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

- Understand the architecture of microprocessor/ microcontroller and their operation.
- Demonstrate programming skills in assembly language for processors and controllers.
- Analyze various interfacing techniques and apply them for the design of processor/controller based systems.



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<b>DIGITAL COMMUNICATIONS</b>				

**Course Objectives:**

The student will be able to

- Understand pulse digital modulation systems such as PCM, DPCM and DM.
- Understand various digital modulation techniques and able to analyze various systems for their performance in terms of probability of error.
- Study the concepts of information theory and need for source coding.
- Study Block codes, cyclic codes and convolution codes.

**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 drawbacks, 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.



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**TEXT BOOKS:**

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. Communication Systems Analog & Digital – Singh & Sapre, TMH,2004.
3. Modern Digital and Analog Communication Systems –B.P.Lathi,Zhi Ding,Hari Mohan Gupta,Oxford University Press,4<sup>th</sup> Edition,2017

**Course Outcomes:**

After going through this course the student will be able to

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



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<b>ELECTRONIC MEASUREMENTS &amp; INSTRUMENTATION</b>					

**Course Objectives:**

- Learn and understand functioning of various measuring system and metrics for performance analysis.
- Acquire knowledge of principle of operation, working of different electronic instruments viz. signal generators, signal analyzers, recorders and measuring equipment.
- To Compare various measuring bridges and their balancing conditions.
- Learn and understand the use of various measuring techniques for measurement of different physical parameters using different classes of transducers.

**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.



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**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.

**TEXTBOOKS :**

1. Electronic instrumentation, second edition - H.S. Kalsi, Tata McGrawHill,2004.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrickand W.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

- Select the instrument to be used based on therequirements.
- Understand and analyze different signal generators andanalyzers.
- Understand the design of oscilloscopes for differentapplications.
- Design different transducers for measurement of differentparameters.





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<b>INFORMATION THEORY &amp; CODING</b> (Professional Elective 1)					

**Course objectives:**

The main objectives of this course are given below

- Understand the concept of Entropy and sourcecoding
- Understand the concept of channel and its capacity
- Encoding and Decoding of Digital DataStreams
- Be Aware of Compression and DecompressionTechniques
- Learn the Concepts of MultimediaCommunication

**UNIT I****INFORMATION THEORY AND SOURCE CODING**

Uncertainty, information, entropy and its properties, entropy of binary memory less source and its extension to discrete memory less source, source coding theorem, data compression, prefix coding, Huffman coding, Lempel-Ziv coding, Source with memory and itsentropy.

**UNIT II****DISCRETE CHANNELS**

Binary Symmetric Channel, mutual information & its properties, Channel capacity, channel coding theorem and its application to BSC, Shannon’s theorem on channel capacity, capacity of a channel of infinite bandwidth, bandwidth - S/N trade off, practical communication systems in light of Shannon’s theorem, Fading channel, channels withmemory.

**UNIT III****GROUPS, FIELDS AND LINEAR BLOCK CODES**

Galois field and its construction in  $GF(2^m)$  and its basic properties, vector spaces and matrices in  $GF(2)$ , Linear block codes, systematic codes and its encoding circuit, syndrome and error detection, minimum distance, error detecting and correcting capabilities of block code, decoding circuit, probability of undetected error for linear block code in BSC, Hamming code and their applications.

**UNIT IV****CYCLIC CODES AND BCH CODES**

Basic properties of Cyclic codes, Generator and parity check matrix of cyclic codes, encoding and decoding circuits, syndrome computation and error detection, cyclic Hamming codes, encoding and decoding of BCH codes, error location andcorrection.

**UNIT V****CONVOLUTIONALCODES**

Introduction to convolution code, its construction and Viterbi algorithm for maximum likelihood decoding. Automatic repeat request strategies and their throughput efficiency considerations.



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**Text Books:**

1. Sklar, Digital Communication, Pearson Education Asia, 2<sup>nd</sup> Edition, 2001.
2. Shu Lin and Costello, Error Control Coding: Fundamentals and Applications, 2<sup>nd</sup> Edition, Pearson, 2004.

**Reference Books:**

1. Haykin Simon, Digital Communication, Wiley Publications, 2013.
2. Information theory and coding, Muralidhar Kulkarni, KS Ashiva prakash, 2015.
3. JS Chithode, Information theory and coding, Technical publishers, 1<sup>st</sup> Edition, 2014.

**Course Outcomes:**

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

- Design an Application with Error-Control coding
- Use Compression and Decompression Techniques
- Perform source coding and channel coding



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<b>DIGITAL SYSTEM DESIGN USING HDL</b> <b>(Professional Elective 1)</b>					

**Course objectives:**

The student will be able to

- Learn and understand the architectures of Field-programmable GateArrays
- Translate a software application into hardware logic for FPGA architectures
- Design synthesizable systems based on industry-standard coding methods
- Build test benches and create data models to verify bit-true accurate designs.

**UNIT-I**

**INTRODUCTION:** Hardware Description Languages, FPGA Boards and Software Tools.

**Field-Programmable Gate Arrays:** Transistor as a Switch, Logic Gates from Switches, FPGA Building Blocks, Layout of the Xilinx Artix-7 XC7A35T FPGA, Input/output Blocks, Configurable Logic Blocks, Interconnect Resources, Block RAM, DSP Slices, Clock Management, The XADC Block, High-Speed Serial I/O Transceivers, Peripheral Component Interconnect Express Interface, FPGA-Based Digital System Design Philosophy, How to Think While Using FPGAs, Advantages and Disadvantages of FPGAs, Usage Areas of FPGAs

**Introduction to Verilog:** Verilog Fundamentals, Module Representation, Timing and Delays in Modelling, Hierarchical Module Representation, Test bench Formation in Verilog, Structure of a Verilog Test bench File, Displaying Test Results.

**UNIT-II**

**VERILOG DATA TYPES AND OPERATORS:** Data Types in Verilog, Net and Variable Data Types, Data Values, Naming a Net or Variable, Defining Constants and Parameters, Defining Vectors, Operators in Verilog, Arithmetic Operators, Concatenation and Replication Operators, Application on Data Types and Operators, FPGA Building Blocks Used in Data Types and Operators, Implementation Details of Vector Operations, Implementation Details of Arithmetic Operations.

**UNIT-III**

**COMBINATIONAL CIRCUITS:** Combinational Circuit Analysis, Logic Function Formation between Input and Output, Boolean Algebra, Gate-Level Minimization, Combinational Circuit Implementation, Truth Table-Based Implementation, Combinational Circuit Design.

**COMBINATIONAL CIRCUIT BLOCKS:** Adders in Verilog, Comparators in Verilog, Decoders in Verilog, Encoders in Verilog, Multiplexers in Verilog, Parity Generators and Checkers in Verilog, Applications on Combinational Circuits, Implementing the Home Alarm System, Implementing the Digital Safe System, Implementing the Car Park Occupied Slot Counting System, FPGA Building Blocks Used in Combinational Circuits.

**DATA STORAGE ELEMENTS:** Latches in Verilog, Flip-Flops in Verilog, Register, Memory, Read-Only Memory, ROM in Verilog, ROM Formation Using IP Blocks, Random Access



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Memory, Application on Data Storage Elements, FPGA Building Blocks Used in Data Storage Elements.

#### **UNIT-IV**

**SEQUENTIAL CIRCUITS:** Sequential Circuit Analysis, State Table, State Diagram, State Representation in Verilog, Timing in Sequential Circuits, Synchronous Operation, Asynchronous Operation, Shift Register as a Sequential Circuit, Shift Registers in Verilog, Multiplication and Division Using Shift Registers, Counter as a Sequential Circuit, Synchronous Counter, Asynchronous Counter, Counters in Verilog, Frequency Division Using Counters, Sequential Circuit Design, Applications on Sequential Circuits.

#### **UNIT-V**

**DIGITAL INTERFACING:** Universal Asynchronous Receiver/Transmitter(UART) in Verilog, UART Applications, Serial Peripheral Interface (SPI) in Verilog, , SPI Application, Inter-Integrated Circuit (I<sup>2</sup>C) in Verilog, , I2C Application, Video Graphics Array (VGA) in Verilog, VGA Application, Universal Serial Bus (USB) Receiving Module in Verilog, USB Keyboard Application, Ethernet, FPGA Building Blocks Used in Digital Interfacing.

**ADVANCED APPLICATIONS:** Vending Machine, Digital Clock, Moving Wave via LEDs, Translator, Air Freshener Dispenser, Obstacle-Avoiding Tank, Intelligent Washing Machine, Non-Touch Paper Towel Dispenser, Car Parking Sensor System. Digital Table Tennis Game.

#### **TEXT BOOKS:**

1. CemUnsalan, BoraTar“DigitalSystemDesignwithFPGAImplementationUsing Verilog and VHDL” McGraw-Hill Education,2017
2. Design through Verilog HDL – T.R. Padmanabhan and B. Bala Tripura Sundari, WSE, IEEE Press,2004.

#### **REFERENCES:**

1. Advanced Digital Design with Verilog HDL – Michael D. Ciletti, PHI,2005.
2. Fundamentals of Logic Design with Verilog – Stephen. Brown andZvonkoVranesic, TMH,2005.
3. A Verilog Primer – J. Bhasker, BSP,2003.

#### **Course Outcomes:**

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

- Understand the architecture of FPGAs, tools used in modelling of digitaldesign
- Analyze and design basic digital circuits with combinatorial and sequential logic circuits using VerilogHDL.
- Model complex digital systems at several levels ofabstractions.
- Design real time applications such as vending machine and washing machinesetc.



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<b>DATASTRUCTURES and ALGORITHMS</b> (Professional Elective 1)					

**Course objectives:**

- Explain the systematic methods of efficiently organizing and accessing data in data structures and algorithms.
- Identify the properties and structural patterns in data structures.
- Apply abstract data types to the design of data structures.
- Analyze algorithms using a mathematical notation and experimental studies.
- Perform comparative analysis of the typical data structures and algorithms.
- Design and analyze recursive algorithms in data structures

**UNIT – I:**

**Data Structures Basics:** Structure and Problem Solving, Data structures, Datastructure Operations, Algorithm: complexity, Time- space trade-off.

**Linked List:** Introduction, Linked lists, Representation of linked lists in Memory, traversing a linked list, Searching a linked list, Memory allocation and Garbage collection, insertion into linked list, Deletion from a linked list, Types of linked list.

**UNIT – II:**

**Stack and Queue:** Introduction, Array Representation of Stack, Linked List Representation of stack, Application of stack, Queue, Array Representation of Queue, Linked List Representation of Queue.

**Trees:** Definitions and Concepts, Operations on Binary Trees, Representation of binary tree, Conversion of General Trees to Binary Trees, Sequential and Other Representations of Trees, Tree Traversal.

**UNIT – III:**

**Graphs:** Matrix Representation of Graphs, List Structures, Other Representations of Graphs, Breadth First Search, Depth First Search, Spanning Trees. Directed Graphs Types of Directed Graphs; Binary Relation as a Digraph; Euler's Digraphs; Matrix Representation of Digraphs.

**Applications of Graphs:** Topological Sorting, Shortest-Path Algorithms – Weighted Shortest Paths – Dijkstra's Algorithm, Minimum spanning tree- Prim's Algorithm, Introduction to NP-Completeness.

**UNIT – IV:**

**Searching and Sorting Techniques:** Sorting Techniques – Bubblesort, Merge sort, Selection sort, Heap sort, Insertion Sort, Searching Techniques – Sequential Searching, Binary Searching, Search Trees.

**Elementary Algorithms:** Notation for Expressing Algorithms; Role and Notation for Comments; Example of an Algorithm; Problems and Instances; Characteristics of an Algorithm;



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Building Blocks of Algorithms; Procedure and Recursion – Procedure, Recursion; Outline of Algorithms; Specification Methods for Algorithms.

**UNIT – V:**

**Mathematical Functions and Notations:** Functions and Notations; Modular Arithmetic / Mod Function; Mathematical Expectation in Average Case Analysis; Efficiency of an Algorithm; Well Known Asymptotic Functions and Notations; Analysis of Algorithms – Simple Examples; Well Known Sorting Algorithms – Insertion sort, Bubble sort, Selection sort, Shell sort, Heap sort.

**Divide and Conquer:** Divide and Conquer Strategy; Binary Search; Max. And Min.; Merge sort; Quick sort. Greedy Method: Greedy Method Strategy; Optimistic Storage on Tapes; Knapsack Problem; Job Sequencing with Deadlines; Optimal Merge Pattern; Single Source ShortlistPaths.

**Dynamic Programming:** Dynamic Programming Strategy; Multistage Graphs; All Pair Shortest Paths; Travelling Salesman Problems. Backtracking Strategy, 8-Queens Problem, Sum of Subsets, Knapsack Problem.

**TEXTBOOKS:**

1. Data structures and Algorithm Analysis in C++, M. A. Weiss, 3<sup>rd</sup> Edition, Addison-Wesley, 2005.
2. Data structures in C++, Malik D.S, 2<sup>nd</sup> Edition, Cengage Learning, 2009.
3. Data structures, Richard F. Gilberg and Behrouz A. Forouzan, 2<sup>nd</sup> Edition, Cengage Learning, 2007.

**REFERENCE BOOKS:**

1. Data Structures and Algorithms: Concepts – Techniques and Applications, G. A. V. Pai, 1<sup>st</sup> Edition, McGraw Hill Education, 2017.
2. Classic Data Structures, Debasis Samanta, 2<sup>nd</sup> Edition, PHI, 2009.
3. Data structures, Seymour Lipschutz, 1<sup>st</sup> Edition, McGraw Hill Education, 2014.

**Course Outcomes:**

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

- Demonstrate analytical comprehension of concepts such as abstract datatypes
- Analyze various generic programming techniques,
- Compare various sorting algorithms and perform their efficiency analysis.
- Demonstrate the ability to analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions.
- Demonstrate the ability of using generic principles for data representation & manipulation with a view for efficiency, maintainability, and code-reuse.



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<b>SOFT COMPUTING TECHNIQUES AND PYTHON PROGRAMMING</b> (Professional Elective 1)					

**Course Objectives:**

The objectives of this course include

- Teach an example of scripting and interpretative language and compare it with classical compiled programming languages
- Introduce the student to Python programming fundamentals
- Expose students to application development and prototyping using Python
- Learn to apply fundamental problem solving technique
- Introduce the student to soft computing and genetic algorithms with relevant applications

**UNIT-I:**

**Introduction:** History of Python, Need of Python Programming, how a program works, Variables, Operators in python, type conversions, expressions, if, if-elif-else, for, while, break, continue, pass.

**UNIT – II:**

**Types, Data structures and functions:** Types - Integers, Strings, Booleans; Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions. Defining Functions, Calling Functions, Passing Arguments, types of arguments, Anonymous Functions, Scope of the Variables in a Function - Global and Local Variables, introduction to modules, creating modules, name spacing.

**UNIT –III: Design with classes and GUI** - Classes, 'self-variable', Methods, Constructor Method, Inheritance, Overriding Methods, Data hiding, polymorphism, working with instances. GUI Programming, using the tkinter module, display text with label widgets, widgets with frames, button widgets and info dialog boxes, getting input with entry widget, check buttons, radio buttons, Turtle Graphics.

**UNIT – IV: Introduction to soft computing and fuzzy systems:** Evolutionary computing, soft computing vs hard computing, soft computing methods, recent trends in soft computing, characteristics of soft computing, applications of soft computing, fuzzy sets, fuzzy relations, fuzzy logic, fuzzy rule-based systems

**UNIT – V: Genetic Algorithms:** Basic concepts, basic operators for genetic algorithms, crossover and mutation properties, genetic algorithm cycle, fitness function. Rough sets, rule induction and discernibility matrix, integration of soft computing techniques.





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**TEXT BOOKS :**

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage learning.
2. Think Python First Edition, by Allen B. Downey, O’rielly publishing,2001.
3. Python Programming, vamsi kurama, Pearson,2017.
4. Soft Computing – Advances and applications – Jan 2015 by B.K. Tripathy and J.Anuradha CengageLearning

**REFERENCE BOOKS:**

1. Introduction to Computation and programming using python. John v. guttag, the MIT press, 2<sup>nd</sup> Edition,2016.
2. James Payne, beginning python using python 2.6 and python 3, Wrox publishing,2010.

**Course Outcomes:**

- Understand and comprehend the basics of pythonprogramming.
- Demonstrate the principles of structured programming and be able to describe,design, implement, and test structured programs using currently acceptedmethodology.
- Explain the use of the built-in data structures list, sets, tuples anddictionary.
- Make use of functions and itsapplications.
- Identify real-world applications using oops, files and exceptionhandling provided by python.
- Formulate and implement a program to solve a real-world problem using GUI and Turtle graphics.
- Understand soft computing applications





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SIMULATION &amp; MATHEMATICAL MODELING</b> (Professional Elective 1)					

**OBJECTIVE:**

To introduce various system modelling and simulation techniques and highlight their applications in different areas. It includes modelling, design, simulation, planning, verification and validation.

**UNIT – I:****Introduction to Simulation**

When simulation is the appropriate tool and when it is not appropriate; Advantages and disadvantages of Simulation; Areas of application; Systems and system environment; Components of a system; Discrete and continuous systems; Model of a system; Types of Models; Discrete-Event System Simulation; Steps in a Simulation Study. The basics of Spreadsheet simulation, Simulation example: Simulation of queuing systems in a spreadsheet. General Principles, Simulation software: Concepts in Discrete-Event Simulation: The Event-Scheduling / Time-Advance Algorithm, World Views, Manual simulation Using Event Scheduling; List processing.

**UNIT –II:****Mathematical Models**

Statistical Models in simulation – Concepts, Discrete Distribution, Continuous Distribution, Poisson Process, Empirical Distributions, Queuing Models – Characteristics, Notation, Queuing Systems, Markovian Models, Generation of Pseudo Random numbers, Properties of random numbers, Techniques for generating random numbers, Testing random number generators, Generating Random-Variates, Inverse Transform technique, Acceptance- Rejection technique, Composition & Convolution Method

**UNIT – III:****Analysis of Simulation Data**

Input modelling: Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models.

Estimation of Absolute Performance: Types of simulations with respect to output analysis; Stochastic nature of output data; Absolute measures of performance and their estimation; Output analysis for terminating simulations; Output analysis for steady-state simulations.

**UNIT – IV:****Verification, Calibration, and Validation**

Optimization: Model building, verification and validation; Verification of simulation models; Calibration and validation of models, Optimization via Simulation

**Simulation of computer systems and case studies**



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Simulation tools, Model input, high level computer system simulation, comparison of systems via simulation, simulation programming techniques, development of simulation models.

**UNIT – V:**

**Case Studies**

City traffic simulation, Indoor air quality simulation of a building, machine health simulation (DC motor health)

**TEXTBOOKS:**

1. Discrete Event System Simulation, Jerry Banks and John S. Carson II, 5<sup>th</sup> Edition, Pearson, 2010.
2. Simulation Modelling and Analysis, Averill M. Law, 4<sup>th</sup> Edition, McGraw Hill, 2007.
3. Introduction to probability models, Sheldon M. Ross, 7<sup>th</sup> Edition, Academic Press, 2000.

**REFERENCE BOOKS:**

1. Simulation, Sheldon M. Ross, 5<sup>th</sup> Edition, Elsevier, 2012.
2. System Modelling and Simulation – An Introduction, Frank L. Severance, Wiley, 2001.
3. System Simulation, Geoffrey and Gordon, 2<sup>nd</sup> Edition, PHI, 2002.
4. Handbook of simulation: Principles, Methodology, Advances, Applications and Practice, Jerry Banks, 1<sup>st</sup> Edition, Wiley, 1998.

**Course Outcomes:**

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

- Solve real world problems which cannot be solved strictly by mathematical approaches.
- Understand the principles within mathematic modelling of material science.
- Demonstrate the ability describe the mathematical components in mechanical and thermal analyses.
- be able to describe the conditions in numerical code for solving stress loading problems.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>LINEAR INTEGRATED CIRCUITS and APPLICATIONS LAB</b>					

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

1. Study of OP AMPs – IC 741, IC 555, IC 565, IC 566, IC 1496 – functioning, parameters and Specifications.
2. OP AMP Applications – Adder, Subtractor, Comparator Circuits.
3. A. Integrator and Differentiator Circuits.
4. B. Waveform Generator using single OP-AMP with variable duty cycle
5. Active Filter Applications – LPF, HPF (first order)
6. Active Filter Applications – BPF, Band Reject (Wideband) and Notch Filters.
7. Oscillator Circuits – Phase Shift and Wien Bridge Oscillators using single OP-AMP
8. Function Generator using OPAMPs.
9. IC 555 Timer – Monostable Operation Circuit, Astable Operation Circuit
10. Design Schmitt Trigger Circuits – using Single OP-AMP with Reference voltage.
11. PLL Operation and Estimation of Capture and Lock range.
12. IC 566 – VCO Applications.
13. Design of Dual Power Supply using 78XX and 79XX (use full wave Bridge Rectifier with shunt capacitance filters).

**Equipment required for Laboratories:**

1. Dual TRPS
2. CRO
3. Function Generators 1MHz
4. Multi Meters (Digital, FET input Voltmeters)
5. Analog IC Trainer Kits
7. Bread Boards
8. Components: - IC741, IC555, IC565, IC1496, IC723, 7805, 7809, 7912, 8038 and other

**Essential components:**

1. 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 divisionmultiplexing.
2. Pulse codemodulation.
3. Differential pulse codemodulation.
4. Deltamodulation.
5. Frequency shiftkeying.
6. Phase shiftkeying.
7. Differential phase shiftkeying.
8. Companding
9. Source Encoder andDecoder
10. Linear Block Code-Encoder andDecoder
11. Binary Cyclic Code - Encoder andDecoder
12. Convolution Code - Encoder andDecoder
13. BCH Codes

**Equipment required for Laboratories:**

1. RPS - 0 – 30 V
2. CRO - 0 – 20 MHz.
3. Function Generators - 0 – 1 MHz
4. RF Generators - 0 – 1000 M Hz./0 – 100 MHz.
5. Rated Voltmeters andAmmeters
6. Lab Experimental kits for DigitalCommunication
7. Components
8. Breadboards and Multimeters
9. Spectrum Analyzer



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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 numbers.
4. Interfacing ADC to 8086
5. Interfacing DAC to 8086.
6. Interfacing stepper motor to 8086.

**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 in 8051.
4. Interfacing Traffic Light Controller to 8051.
5. UART operation in 8051
6. Interfacing LCD to 8051.

**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
6. DAC module
7. Stepper motor module



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8. Keyboardmodule
9. LED, 7-SegmentUnits
10. DigitalMultimeters
11. ROM/RAM Interfacemodule
12. Bread Boardetc.
13. ARM CORTEX M3
14. KEIL MDKARM



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	<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>MINI PROJECT WITH HARDWARE DEVELOPMENT</b>				

Mini Project is introduced during V semester. The student may execute the mini project during summer vacation for a period of 6 weeks i.e. between IV and V Semesters. The student shall submit a diary and a technical report for evaluation. This shall be evaluated in the V semester for 50 marks by a committee consisting of external examiner, Head of the Department along with supervisor and two senior faculty members of the Department. Mini Project work may involve carrying out a detailed feasibility study, literature survey along with the implementation results and preparing a work plan for major project. A student shall acquire 1.5 credits assigned, when he/she secures 40% or more marks for the total of 50 marks. In case, if a student fails, he/she shall reappear as and when the VII semester supplementary examinations are conducted.





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE</b>					

**Course Objectives:**

To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system

- The course aim of the importing basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledgesystem
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act2003
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge andprotection
- To know the student traditional knowledge in differentsector

**Course Outcomes:**

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

- Understand the concept of Traditional knowledge and itsimportance
- Know the need and importance of protecting traditionalknowledge
- Know the various enactments related to the protection of traditionalknowledge
- Understand the concepts of Intellectual property to protect the traditionalknowledge

**UNIT I**

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

Learning Outcomes:

At the end of the unit, the student will able to:

- Understand the traditionalknowledge.
- Contrast and compare characteristics importance kinds of traditionalknowledge.
- Analyze physical and social contexts of traditionalknowledge.
- Evaluate social change on traditionalknowledge.

**UNIT II**

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Learning Outcomes:

At the end of the unit, the student will able to:

- Know the need of protecting traditionalknowledge.
- Apply significance of tkprotection.



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- Analyze the value of tk in globaleconomy.
- Evaluate role ofgovernment

**UNIT III**

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

Learning Outcomes:

At the end of the unit the student will able to:

- Understand legal framework ofTK.
- Contrast and compare the ST and other traditional forestdwellers
- Analyze plant variantprotections
- Evaluate farmers rightact

**UNIT IV**

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Learning Outcomes:

At the end of the unit, the student will ableto:

- Understand TK andIPR
- Apply systems of TKprotection.
- Analyze legal concepts for the protection ofTK.
- Evaluate strategies to increase the protection ofTK.

**UNIT V**

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Learning Outcomes:

At the end of the unit, the student will able to:

- Know TK in differentsectors.
- Apply TK inengineering.
- Analyze TK in varioussectors.
- Evaluate food security and protection of TK in thecountry.



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**Reference Books:**

- 1) Traditional Knowledge System in India, by Amit Jha, 2009.
- 2) Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, PratibhaPrakashan 2012.
- 3) Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
- 4) "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

**e-Resources:**

- 1) <https://www.youtube.com/watch?v=LZP1StpYEPM>
- 2) <http://nptel.ac.in/courses/121106003/>



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**WIRED and WIRELESS TRANSMISSION DEVICES**

**Course objectives:**

The student will be able to

- understand the applications of the electromagnetic waves in freespace.
- introduce the working principles of various types of antennas
- discuss the major applications of antennas with an emphasis on how antennas are employed to meet electronic system requirements.
- understand the concepts of radio wave propagation in the atmosphere.

**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; Power Transmission and Power Losses in Rectangular Guide, Impossibility of TEM mode. Related Problems, Excitation techniques-waveguides

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

**UNIT II**

**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, Radiation Intensity, Directivity, Gain Antenna Apertures, Aperture Efficiency, Effective Height, illustrated Problems.

**UNIT III**

**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, Beam widths, Directivity, Effective Area and Effective Height, Antenna Theorems – Applicability and Proofs for equivalence of directional characteristics, Loop Antennas: Small Loops - Field Components, Concept of short magnetic dipole,  $D$  and  $R_f$  relations for small loops.

**ANTENNA ARRAYS:** Principle of Pattern Multiplication,  $N$  element Uniform Linear Arrays – Broadside, End-fire Arrays, Binomial Arrays, Arrays with Parasitic Elements. Yagi-Uda Arrays, Folded Dipoles and their characteristics.



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**UNIT IV**

**NON-RESONANT RADIATORS:** Introduction, Traveling wave radiators, Long wire antennas, Rectangular Patch Antennas –Geometry and Parameters, Impact of different parameters on characteristics. Helical Antennas, Geometry, basic properties

**VHF, UHF AND MICROWAVE ANTENNAS:** Reflector Antennas: Corner Reflectors. Parabolic Reflectors – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking, Cassegrain Feeds.

Horn Antennas – Types, Optimum Horns, Lens Antennas – Geometry, Features, Dielectric Lenses and Zoning, Applications.

**UNIT V**

**WAVE PROPAGATION:** Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations, Space Wave Propagation–Mechanism, LOS and Radio Horizon, Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth’s Radius, Effect of Earth’s Curvature, Field Strength Calculations.

**ANTENNA MEASUREMENTS** – Patterns, Set Up, Distance Criterion, Directivity, VSWR, Impedance and Gain Measurements (Comparison, Absolute and 3-Antenna Methods)

**TEXT BOOKS**

1. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2<sup>nd</sup> Edition,2000.
2. Antennas and wave propagation- Sisir K Das, Annapurna Das, TMH,2013.

**REFERENCES**

1. Antennas – John D. Kraus, McGraw-Hill, 2<sup>nd</sup> Edition,1988.
2. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont, The Services Text Book of Radio, vol. 5, Standard Publishers Distributors,Delhi,2009.
3. Antennas and wave propagation by Prof G S N Raju, Pearsion Publications, First impression,2016

**Course Outcomes:**

After going through this course the student will be able to

- Identify basic antennaparameters.
- Design and analyze wire antennas, loop antennas, reflector antennas, lens antennas, horn antennas and micro stripantennas
- Quantify the fields radiated by various types ofantennas
- Design and analyze antennaarrays
- Analyze antenna measurements to assess antenna’sperformance
- Identify the characteristics of radio wavepropagation



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

**OBJECTIVES:**

**The main objectives of this course are:**

- To learn the MOS Process Technology
- To understand the operation of MOS devices
- Understand and learn the characteristics of CMOS circuit construction.
- Describe the general steps required for processing of CMOS integrated circuits.
- To impart in-depth knowledge about analog and digital CMOS circuits.

**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,



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Gate Design in the Ultra Deep-Submicron Era, Latch Versus Register, Latch based design, timing decimation, positive feedback, instability, Metastability, 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, FinFET, TFET.

**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 Nanoelectronics: Nanoscale CMOS, Post-CMOS and Allied Nanotechnologies Vinod Kumar Khanna, Springer India, 1<sup>st</sup> edition, 2016.
3. FinFETs and other multi-gate transistors, Colinge JP, Editor New York, Springer, 2008.

**OUTCOMES:**

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

- Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
- Apply the design Rules and draw layout of a given logic circuit.
- Design MOSFET based logic circuit.
- Design basic building blocks in Analog IC design.
- Analyze the behaviour of amplifier circuits with various loads.
- Design various CMOS logic circuits for design of Combinational logic circuits.
- Design amplifier circuits using MOS transistors.
- Design MOSFET based logic circuits using various logic styles like static and dynamic CMOS.
- Analyze the behaviour of static and dynamic logic circuits.





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<b>DIGITAL SIGNAL PROCESSING</b>					

**Course Objectives:**

The student will be able to

- Analyze the discrete-time signals and systems in time and frequency domains.
- Know the importance of FFT algorithm for computation of Discrete Fourier Transform
- Understand the various implementations of digital filter structures
- Learn the FIR and IIR Filter design procedures
- Learn the concepts of DSP Processors

**UNIT I INTRODUCTION:** Introduction to Digital Signal Processing: Discrete-time signals & sequences, Classification of discrete-time systems, stability and causality of LTI systems, Response of LTI systems to arbitrary inputs. Solution of linear constant coefficient difference equations. Discrete-time Fourier Transform (DTFT), 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, Circular convolution and linear convolution using DFT.

**UNIT III DESIGN OF IIR DIGITAL FILTERS & REALIZATIONS:** Analog filter approximations – Butterworth 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 technique and Frequency Sampling technique, Comparison of IIR & FIR filters. Basic structures of FIR systems.

**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, Multiported memory, VLIW architecture, Pipelining, Special addressing modes, On-Chip Peripherals.

**Architecture of ARM processors:** Technical details of ARM Processors, Introduction to





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Cortex-M3 and cortex M4 processors - Processor type, processor architecture, instruction set, block diagram, memory systems.

**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,2010.
3. Digital Signal Processors, Architecture, Programming and Applications, B.Venkataramani, M. Bhaskar, TMH,2002.
4. Digital Signal Processing Using the ARM Cortex M4, Donald S.Reay,2015.

**REFERENCE BOOKS:**

- 1 Digital Signal Processing: MH Hayes, Schaum's Outlines, TMH,2007.
- 2 Fundamentals of Digital Signal Processing using MATLAB – Robert J. Schilling,Sandra L. Harris, Thomson, 2007.
- 3 Digital Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, PHI Ed.,2006
- 4 Digital Signal Processing, Tarun Kumar Rawat by OXFORD Publishers

**Course Outcomes:**

After going through this course the student will be able to

- Formulate engineering problems in terms of DSP operations
- Analyze digital signals and systems
- Analyze discrete time signals in frequency domain
- Design digital filters and implement with different structures
- Understand the key architectural



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>CELLULAR &amp; MOBILE COMMUNICATION</b> (Professional Elective 2)					

**Course Objectives:**

The student will be introduced to:

- Understand the basic cellular concepts like frequency reuse, cell splitting, cell sectoring etc and various cellular systems.
- Understand the different types of interferences influencing cellular and mobile communication.
- Understand the frequency management, channel assignment and various propagation effects in cellular environment.
- Understand the different types of antennas used at cell site and mobile.
- Understand the concepts of handoff and types of handoffs.
- Understand the architectures of GSM and 3G cellular systems.

**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-cochannel 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.





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL IC DESIGN</b> (Professional Elective-2)					

**Course objectives:**

The main objectives of this course are:

- The student will be able to understand the MOS Design.
- In this course, students can study Combinational MOS Logic Circuits and Sequential MOS Logic Circuits.
- Another main object of this course is to motivate the graduate students to design and to develop the Digital Integrated Circuits for different Applications.
- The concepts of Semiconductor Memories, Flash Memory, RAM Array organization

**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.

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

**UNIT-IV**

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

**UNIT-V**

**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.



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**TEXTBOOKS:**

1. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, AnanthaChandrakasan, Borivoje Nikolic, 2<sup>nd</sup>Ed., PHI, 2016.
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, 2006.

**Course Outcomes:**

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

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



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<b>BUSINESS INTELLIGENCE &amp; ANALYTICS</b> (Professional Elective 2)					

**OBJECTIVE:**

To make students to extract insights from large volumes of data in various forms, by employing statistical mathematics techniques for drawing conclusions about that information

**UNIT – I**

**Essentials of Data analysis** - Data Collection, Data Cleansing, Data Exploration, Statistical Analysis, Reporting, Decision

**Statistical Methods:** Arithmetic mean, The Arithmetic mean of grouped Data, The Median, The mode; The variance and standard deviation, Interpretation of SD, Chebyshev's Lemma or Rule (for sample), Skewness and Kurtosis, Skewness and its measurement, Kurtosis and its measurements.

**Probability Distribution & Statistical Inference:** Elements of Probability, Random Variable, Probability distribution/density functions (Normal, Binomial, Poisson), Point Estimate, Interval Estimate, Testing of hypothesis

**UNIT – II**

**Visualization:** Comparison, Distribution, Relationship, Composition, Visual Charts – Bar chart, Column chart, variable width column chart, Line chart, Column histogram, Line histogram, Scatter chart, stacked column chart, stacked 100% column chart, waterfall chart, pie chart, stacked area chart, 3D area chart, stacked 100% area chart, Bubble chart, Geometric Forms, Pictorial Diagrams, ParetoDiagrams

**Applications:** Graphical representation of data from Battery health monitoring, Indoor Air Quality, CO2 emissions by country/region (Practice using MS-Excel & R/Python)

**UNIT – III**

Time series Analysis: Characteristics Movements in a time series; Time series models; Measurement of Trend; Secular Trend; Seasonal Movements; Cyclical Movements; Irregular Movements; Long Cycles,

Applications: Analyze the trends of population growth, global temperatures, solar radiation, wind patterns. (Practice using MS-Excel & R/Python).

**UNIT – IV**

Business Intelligence and Analytics: What is Business Intelligence and Analytics? The need for BI and analytics, how to determine requirements, Using the BI tools for extracting insights for data driven decisions

Microsoft Power BI - Part I: Understanding key concepts in business intelligence, data analysis, and data visualization. Getting Started with Power BI and Analytics - Creating account, Power BI Desktop, Working with Data - Connect, Import, Shape and Transform data, Creating Visualization, Author Reports and Schedule automated refresh of reports, Publishing Data to BI



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online, Using Quick Insights, Use natural language queries, Create real-time dashboards, Create custom visualizations which can be re-usable in reports and dashboards, Sharing dashboard effectively based on needs.

**UNIT – V**

Microsoft Power BI - Part II: Exploring live connections to data with Power BI, connecting directly to data bases, Introduction to Power BI Development API, Leveraging custom visuals in Power BI, Introduction to DAX

**TEXTBOOKS:**

1. Statistics Concepts and applications, Nabendu pal & Sahadeb sarkar, PHI Learning Pvt. Ltd.,2008.
2. Effective Data Visualization: The Right Chart for the Right Data 1st Edition, Dr. Stephanie D. H. Evergreen, SAGE Publications
3. Introducing Microsoft Power BI, Alberto Ferrari and Marco Russo,2016.

**REFERENCE BOOKS**

1. Applied Microsoft Power BI: Bring your data to life! Teo Lachev,2015
2. Microsoft Power BI guided learning.

**Course Outcomes:**

The student will be able to

- Understand the essentials of data analytics and the corresponding terminologies
- Determine the relevance of data to business
- Be familiar with the steps involved in the analytics process
- Understand and use statistical and graphical analysis to bring insights out from the data
- Understand and use BI tools to present data in the form of Dashboards and reports



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<b>PATTERN RECOGNITION</b> (Professional Elective 2)					

**Course Objectives**

- To equip students with basic mathematical and statistical techniques commonly used in Pattern recognition.
- To introduce students to a variety of pattern recognition algorithms.
- Enable students to apply machine learning concepts in real life problems.

**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, Ad boost, 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 , Pearson publishing, 2018.





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**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

- Study the parametric and linear models for classification
- Design neural network and SVM for classification
- Develop machine independent and unsupervised learning techniques.



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<b>ROBOTICS and AUTOMATION</b> (Professional Elective 2)					

**OBJECTIVE:**

To impart knowledge about basic mathematics related to industrial robots for their control, design and application in robotics & automation Industries.

**UNIT – I****Introduction to Robotics**

Types and components of a robot, classification of robots

Study components of an industrial robot (PUMA, KUKA, FANUC, MTAB, UR, etc.) and its DH parameters.

**UNIT – II****Robot Kinematics and Dynamics:**

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Singularity, and Statics.

Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.

**Sensors**

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean / Similarity / Affine / Projective transformations, Vision applications in robotics

**UNIT – III****Robot Actuation Systems**

Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

**Robot Control:**

Robot control, Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, issues in nonlinear control, force feedback, hybrid control, Motion Planning, Obstacle avoidance, configuration space, road map methods, graph search algorithms, potential field methods

**UNIT – IV****Control Hardware and Interfacing:**

Embedded systems: Microcontroller Architecture and integration with sensors, actuators, components, Programming Applications for Industrial robot - programming in – VAL II

**Case Study:** Bin Picking in Industrial Warehouse.



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**UNIT – V**

**AI in Robotics:**

Applications in unmanned systems, defence, medical, industries, Robotics and Automation for Industry 4.0 Robot safety and social robotics

**TEXTBOOKS:**

1. Introduction to Robotics – Mechanics and Control, John J. Craig, 3<sup>rd</sup> Edition, Pearson Prentice Hall,2004.
2. Industrial Robots, Groover M. P. and Ashish Dutta, McGrawHill,2012
3. Robots Dynamics & Control, Spong M. W. and Vidyasagar M., John Wiley & Sons (ASIA) PteLtd.

**REFERENCE BOOKS**

1. Introduction to Robotics: Analysis, Control, Applications, Saeed B. Niku, 3<sup>rd</sup> Edition, Wiley,2019
2. Robotics Engineering, R. Klafter,PHI.
3. Robotics, Subir K. Saha, McGrawHill.

**Course Outcomes:**

The student will be able to:

- Perform kinematic and dynamic analyses withsimulation.
- Design control laws for a simplerobot.
- Integrate mechanical and electrical hardware for a real prototype of roboticdevice.
- Select a robotic system for given industrialapplication.



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<b>Data Mining</b> <b>Open Elective (OE1)</b>					

**Course objectives:**

The main objectives of this course are:

- Students will be enabled to understand and implement classical models and algorithms in data warehousing and datamining.
- They will learn how to analyze the data, identify the problems, and choose the relevant models and algorithms to apply.
- They will further be able to assess the strengths and weaknesses of various methods and algorithms and to analyze their behavior.

**UNIT-I:**

**INTRODUCTION:** Need of Data Warehouse, Need and Usage of Data Mining Technologies, Types of Data and Patterns to be mined, In Real Time Applications. Brief Introduction of Pattern Recognition: Pattern, Feature, Database Query Vs Mining, Curse of Dimensionality, Need for Efficiency. Major Issues in Data Mining. Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity

**UNIT-II:**

**DATA PRE-PROCESSING:** Data Preprocessing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization

**UNIT-III:**

**CLASSIFICATION:** Basic Concepts, General Approach to solving a classification problem, Decision Tree Induction: Working of Decision Tree, building a decision tree, methods for expressing an attribute test conditions, measures for selecting the best split, Algorithm for decision tree induction. Bayes' Theorem, Naïve Bayesian Classification, Bayesian Belief Networks

**UNIT-IV:**

**ASSOCIATION ANALYSIS: BASIC CONCEPTS AND ALGORITHMS:** Problem Defecation, Frequent Item Set generation, Rule generation, compact representation of frequent item sets, FP-Growth Algorithm. (**Tan & Vipin**)



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**UNIT-V:**

**CLUSTER ANALYSIS: BASIC CONCEPTS AND ALGORITHMS: OVERVIEW:** Basics and Importance of Cluster Analysis, Clustering techniques, Different Types of Clusters; K-means: The Basic K-means Algorithm, K-means Additional Issues, Bisecting K-means, Strengths and Weaknesses; Agglomerative Hierarchical Clustering: Basic Agglomerative Hierarchical Clustering Algorithm DBSCAN: Traditional Density Center-Based Approach, DBSCAN Algorithm, Strengths and Weaknesses. **(Tan&Vipin)**

**TEXT BOOKS:**

1. Introduction to Data Mining: Pang-Ning Tan & Michael Steinbach, Vipin Kumar, Pearson.
2. Data Mining concepts and Techniques, 3/e, Jiawei Han, Michel Kamber, Elsevier.

**REFERENCE BOOKS:**

1. Data Mining Techniques and Applications: An Introduction, Hongbo Du, Cengage Learning.
  2. Data Mining: Vikram Pudi and P. Radha Krishna, Oxford.
  3. Data Mining and Analysis - Fundamental Concepts and Algorithms; Mohammed J. Zaki, Wagner Meira, Jr, Oxford
  4. Data Warehousing Data Mining & OLAP, Alex Berson, Stephen Smith, TMH.
  5. [http://onlinecourses.nptel.ac.in/noc18\\_cs14/preview](http://onlinecourses.nptel.ac.in/noc18_cs14/preview)  
(NPTEL course by Prof. Pabitra Mitra)
  6. [http://onlinecourses.nptel.ac.in/noc17\\_mg24/preview](http://onlinecourses.nptel.ac.in/noc17_mg24/preview)  
(NPTEL course by Dr. Nandan Sudarshanam & Dr. Balaraman Ravindran)
- [http://www.saedsayad.com/data\\_mining\\_map.htm](http://www.saedsayad.com/data_mining_map.htm)

**Course Outcomes:**

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

- Understand Data Mining Principles
- Identify appropriate data mining algorithms to solve real world problems
- Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining



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<b>POWER ELECTRONICS</b> <b>Open Elective (OE1)</b>					

**Course objectives:**

**The main objectives of this course are:**

- To study the characteristics of various power semiconductor devices and gate drive circuits.
- To understand the operation of single phase full-wave converters and analyze harmonics in the input current.
- To study the operation of three phase full-wave converters.
- To understand the operation of different types of DC-DC converters.
- To understand the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.

**UNIT-I:**

**Power Semiconductor Devices:** Operation of SCR, power MOSFET and power IGBT and their characteristics–Gate drive circuits for SCR, IGBT and MOSFET–protection circuits for power IGBT and power MOSFETs.

**UNIT-II:**

**AC-DC Single-Phase Converters:** 1-phase fully-controlled bridge rectifiers feeding R load, RL, RLE loads (continuous and discontinuous current conduction mode of operation)– 1-phase semi-controlled bridge rectifiers feeding R, RL and RLE loads (continuous and discontinuous current conduction mode of operation)– Harmonic Analysis.

**UNIT-III:**

**AC-DC Three-Phase Converters:** 3-phase Full converter feeding R, RL and RLE loads (continuous current conduction mode only)– 3-phase semi-converter feeding R, RL and RLE loads (continuous current conduction mode only)–Harmonic analysis -Dual converter.

**UNIT-IV:**

**DC-DC Converters:** Analysis of Buck, boost, buck-boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) – Output voltage equations using volt-sec balance in CCM & DCM- output voltage ripple & inductor current ripple for CCM only – Principle operation of forward and fly back converters in CCM.



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**UNIT – V:**

**DC–AC Converters and AC-AC converters:** 1- phase half-bridge and full bridge inverters with R and RL loads – Unipolar and bipolar switching-Quasi-square wave pulse width modulation-3-phase square wave inverters –  $120^\circ$  conduction and  $180^\circ$  conduction modes of operation – Sinusoidal pulse width modulation –single-phase Current Source Inverter (CSI)-single-phase AC-AC voltage regulator with R and RLload.

**TEXT BOOKS:**

1. Power Electronics: converters, applications & design -by Nedmohan, Tore M.Undeland, Robbins by Wiley India Pvt.Ltd.
2. Power Electronics- by Daniel W.Hart, Mc Graw Hillpublications
3. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hallof India

**REFERENCE BOOKS:**

1. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India,2009
2. Elements of Power Electronics–Philip T.Krein. Oxfordpublishers.
3. Power Electronics – by P.S.Bhimbra, KhannaPublishers.

**Course Outcomes:**

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

- Explain the characteristics of various power semiconductor devicesand understand the gate drivercircuits.
- Explain the operation of single-phase full wave converters and performharmonic analysis.
- Explain the operation of three phase full–wave converters and performharmonic analysis.
- Analyze the operation of different types of DC-DCconverters.
- Explain the operation of inverters and application of PWM techniques for voltagecontrol and harmonicmitigation.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MEMS and its applications</b> <b>Open Elective (OE1)</b>					

**Course objectives:**

- To introduce the basic concepts of micro systems and advantages of miniaturization.
- To study the various materials and their properties used for micromachining techniques.
- To analyze the fundamentals of micromachining and micro fabrication techniques.
- To impart knowledge of the basic concept of electromechanical effects, thermal effects, Micro fluidics and Integrated fluidic systems.
- To study the fundamentals of pressure sensors and accelerometer sensors through design and modeling.

**UNIT I:** Overview of MEMS and Microsystems: MEMS and Microsystems, Typical MEMS and Microsystem products, Evolution of Microfabrication, Microsystem and Microelectronics, The Multidisciplinary nature of microsystem design and manufacture, Microsystem 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, Microsensors: Acoustic Wave Sensors, Biomedical sensors and Biosensors, Chemical sensors, Pressure sensors, Thermal sensors. Micro actuation: Actuation using thermal forces, shape memory alloys, Piezoelectric crystals, Electrostatic forces. MEMS with Micro actuators: Microgrippers, Micromotors, Microvalves, Micropumps, Micro accelerators, Microfluidics.

**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, Packaging materials.





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**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.

**E-resources:**

1. <https://nptel.ac.in/courses/117105082/4>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-777j-design-and-fabrication-of-microelectromechanical-devices-spring-2007/lecture-notes/>
3. <https://www.edx.org/course/micro-nanofabrication-mems-epflx-memsx-0>

**Course Outcomes:**

- Understand the basic overview of MEMS and Microsystems with broad category of MEMS & Micro system applications.
- Understanding the working principles of Microsystems
- Understand the Scaling Laws in Miniaturization and Materials for MEMS and Microsystems
- Understand the Micro system Fabrication Process and Analyze the different Micro manufacturing process and Applications.
- Study and Analyze the different types of RF switches, Various Switching Mechanism and their applications..



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Artificial Neural Networks</b> <b>Open Elective (OE1)</b>					

**Course objectives:**

The main objectives of this course are:

- To provide an introduction to the field of artificial neural networks and machine learning.
- To teach students how to solve practical problems via implementation of these techniques via simulation.
- To promote further independent learning on the topics of artificial neural networks and machine learning.

**UNIT-I:**

**INTRODUCTION:** History of Neural Networks, Structure and Functions of Biological and Artificial Neuron, Neural Network Architectures, Characteristics of ANN, Basic Learning Laws and Methods.

**UNIT-II:**

**SUPERVISED LEARNING:** Single Layer Neural Network and architecture, McCulloch-Pitts Neuron Model, Learning Rules, Perceptron Model, Perceptron Convergence Theorem, Delta learning rule, ADALINE, Multi-Layer Neural Network and architecture, MADALINE, Back Propagation learning, Back Propagation Algorithm.

**UNIT-III:**

**UNSUPERVISED LEARNING-1:** Outstar Learning, Kohonen Self Organization Networks, Hamming Network And MAXNET, Learning Vector Quantization, Mexican hat.

**UNIT-IV:**

**UNSUPERVISED LEARNING-2:** Counter Propagation Network -Full Counter Propagation network, Forward Only Counter Propagation Network, Adaptive Resonance Theory (ART) - Architecture, Algorithms.

**UNIT V:**

**ASSOCIATIVE MEMORY NETWORKS:** Introduction, Auto Associative Memory, Hetero Associative Memory, Bidirectional Associative Memory (BAM) -Theory and Architecture, BAM Training Algorithm, Hopfield Network: Introduction, Architecture of Hopfield Network.



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**TEXT BOOKS:**

1. B. Yegnanarayana” Artificial neural networks” PHI, New Delhi.
2. S.N. Sivanandam, S.N. Deepa, “Introduction to Neural Networks using MATLAB6.0“, TATA MCGraw- Hillpublications.
3. J.M. Zurada,” Introduction to Artificial neural systems” –Jaicopublishing.

**REFERENCE BOOKS:**

1. S.Rajasekaran and G.A.Vijayalakshmpai “Neural Networks.Fuzzy Logicand genetic Algorithms”.
2. James A Freeman and Davis Skapura” Neural Networks Algorithm, applications and programming Techniques”, Pearson Education,2002.
3. Simon Hakins “Neural Networks “ PearsonEducation.

**Course Outcomes:**

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

- Survey of attractive applications of Artificial NeuralNetworks.
- practically approach for using Artificial Neural Networks in various technical, organizational and economicapplications



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	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>INTERNET OF THINGS</b>				

**Course Objectives:**

- To learn and understand elements of IoT system.
- Acquire knowledge about various protocols of IoT.
- To learn and understand design principles and capabilities of IoT.

**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.

**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.



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**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.

**Course Outcomes:**

The student will be able to:

- Understand internet of Things and its hardware and software components.
- Interface I/O devices, sensors & communication modules.
- Remotely monitor data and control devices.
- Design real time IoT based applications



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>VLSI 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 behavioural, 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

- a. Universal Gates
- b. An Inverter
2. Full Adder
3. Full Subtractor





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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 TI DSP 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>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Intellectual Property Rights (IPR) &amp; Patents</b>					

**UNIT I**

Introduction to Intellectual Property Rights (IPR): Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR - Layout Designs and Integrated Circuits – Use and Misuse of Intellectual PropertyRights.

**UNIT II**

Copyrights and Neighboring Rights: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip ProtectionAct.

**UNIT III**

Patents: Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Compulsory Licensing — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer relatedInnovations

**UNIT IV**

Trademarks: Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities

Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing Off Action.



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**UNIT V**

Trade Secrets & Cyber Law and Cyber Crime: Introduction to Trade Secrets – General Principles  
- Laws Relating to Trade Secrets–

Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements – Breach of Contract –Law of Unfair Competition – Trade Secret Litigation – Applying State Law.

Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions –

E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers.

**References:**

- 1) Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, NewDelhi.
- 2) Deborah E.Bouchoux: Intellectual Property, Cengage Learning, NewDelhi.
- 3) PrabhuddhaGanguli: Intellectual Property Rights, Tata Mc-Graw –Hill, NewDelhi
- 4) Richard Stim: Intellectual Property, Cengage Learning, NewDelhi.
- 5) Kompal Bansal &Parishit Bansal Fundamentals of IPR for Engineers, B. S. Publications (Press).
- 6) Cyber Law - Texts & Cases, South-Western’s Special TopicsCollections.
- 7) R.Radha Krishnan, S.Balasubramanian: Intellectual Property Rights, Excel Books. New Delhi.
- 8) M.Ashok Kumar and MohdIqbal Ali: Intellectual Property Rights, SerialsPub.

**Course Outcomes:**

- IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seekPatents
- Student get an insight on Copyrights, Patents and Software patents which are instrumental for furtheradvancements
- advanced Technical and Scientific disciplines
- Imparting IPR protections and regulations for further advancement, so that the students can familiarize with the latestdevelopments



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**MICROWAVE and OPTICAL COMMUNICATION ENGINEERING**

**Course Objectives:**

The student will be able to

- Understand fundamental characteristics of waveguides and Micro strip lines through electromagnetic field analysis.
- Understand the basic properties of waveguide components and Ferrite materials composition
- Understand the function, design, and integration of the major microwave components oscillators, power amplifier.
- Understand a Microwave test bench setup for measurements.

**UNIT I**

**MICROWAVE TUBES (Qualitative treatment only):** Cavities, Re-entrant Cavities, Two Cavity Klystrons-Structure, Velocity Modulation and Bunching process, Reflex Klystrons-Structure, principle of working.

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

**M-TYPE TUBES**

Introduction, Cross-field effects, Magnetrons – 8-Cavity Cylindrical Travelling Wave Magnetron.

**MICROWAVE SOLID STATE DEVICES:** Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, LSA Mode of operation

**UNIT II**

**WAVEGUIDE COMPONENTS AND APPLICATIONS- I (Qualitative treatment only):**

Waveguide Attenuators – Resistive Card, Rotary Vane types, Scattering matrix parameters: Definition, Properties, Salient Features -S- parameters of two port, three port, four port networks. 2 Hole, Bethe Hole types.

**UNIT III** Over view of optical fiber communication, Total Internal Reflection, Numerical Aperture, Graded index fibers, Cut off wavelength.

**OPTICAL FIBER CONNECTORS-** Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Multimode fiber joints, single mode fiber joints.



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**UNIT I V**

**OPTICAL SOURCES and Detectors:** Qualitative treatment, Structures, Materials, Quantum efficiency, Physical principles and comparison of: Optical sources and detectors, Related problems.

Optical system design- Point to point links – Component Choice and considerations, Link power budget, Line coding in Optical links, WDM, Necessity, Principles, Eye pattern.

**UNIT –V: MEASUREMENTS:**

**a. MICROWAVE MEASUREMENTS:** Description Of Microwave Bench- Different Blocks, Microwave Power Measurement- Bolometer Method. Measurement of Attenuation by Reflection Method, VSWR, Impedance Measurement

**b. OPTICAL MEASUREMENTS:** OTDR, Attenuation, Detector Characteristics

**TEXT BOOKS :**

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition, 1994.
2. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley, 2nd Edition, 2002.
3. Optical Fiber Communications – Gerd Keiser, Mc Graw-Hill International edition, 3rd Edition, 2000.

**REFERENCES :**

1. Microwave Engineering- Annapurna Das and Sisir K. Das, Mc Graw Hill Education, 3<sup>rd</sup> Edition, 2014.
2. Microwave Engineering – G S N Raju , I K International Publishing House Pvt. Limited, 2008.
3. Fiber Optic Communication Systems – Govind P. Agarwal , John Wiley, 3rd Edition, 2004.

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

- Design different modes in waveguide structures
- Calculate S-matrix for various waveguide components and splitting the microwave energy in a desired direction
- Distinguish between Microwave tubes and Solid State Devices, calculation of efficiency devices.
- 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>DATA COMMUNICATIONS &amp; COMPUTER NETWORKS</b>					

**Course Objectives:**

- To introduce the Fundamentals of data communication networks
- To demonstrate the Functions of various protocols of Data link layer.
- To demonstrate Functioning of various Routing protocols.
- To introduce the Functions of various Transport layer protocols.
- To understand the significance of application layer protocols

**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



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**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 CongestionControl

**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 andmessages.

**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.

**REFERENCES:**

1. Data communication and Networks - Bhusan Trivedi, Oxford university press,2016
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, PearsonEducation,2003.
3. Understanding Communications and Networks,3rdEdition,W.A.Shay,CengageLearning,2003.

**Course Outcomes:**

Upon completing this course, the student will be able to

- Know the Categories and functions of various Data communication Networks
- Design and analyze various error detectiontechniques.
- Demonstrate the mechanism of routing the data in networklayer
- Know the significance of various Flow control and Congestion controlMechanisms
- Know the Functioning of various Application layerProtocols.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL IMAGE and VIDEO PROCESSING</b>					

**Course Objectives:**

- To study the image fundamentals and mathematical transforms necessary for image Processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the basics of Video processing and 2-D Motion estimation

**UNIT I:**

**Fundamentals of Image Processing and Image Transforms:**

Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Applications of Digital image processing. Introduction, Need for transform, image transforms, Fourier transform, 2 D Discrete Fourier transform and its transforms, Importance of phase, Walsh transform, Hadamard transform, Haar transform, slant transform Discrete cosine transform, KL transform, singular value decomposition, comparison of different image transforms.

**UNIT II:**

**Image Enhancement:**

Spatial domain methods: point processing techniques, Histogram processing, Fundamentals of Spatial filtering, smoothing spatial filters, sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

**Image Restoration:**

Introduction to Image restoration, Image degradation, Types of image blur, Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques, Blind de-convolution.

**UNIT III:**

**Image Segmentation:**

Introduction to image segmentation, Point, Line and Edge Detection, Region based segmentation., Classification of segmentation techniques, Region approach to image segmentation, clustering techniques, Image segmentation based on thresholding, Edge based segmentation, Edge detection and linking, Hough transform.

**Image Compression:**

Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes, Fundamentals of information theory, Run length coding, Shannon – Fano coding, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression, Image



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compression standard, Wavelet-based image compression, JPEG Standards.





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**UNIT IV:**

**Basic Steps of Video Processing:**

Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, filtering operations.

**UNIT V:**

**Motion Estimation:** Optical flow, General Methodologies, Pixel Based Motion Estimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Videocoding.

**TEXT BOOKS**

1. Digital Image Processing – Gonzaleze and Woods, 3<sup>rd</sup>Ed,Pearson,2008.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.2<sup>nd</sup>Ed.2015.

**REFERENCE BOOKS**

1. Digital Image Processing – S.Jayaraman, S.Esakkirajan, T.Veera Kumar – TMH,2009.
2. Video Processing and Communication – Yao Wang, JoemOstermann and Ya–quin Zhang.1<sup>st</sup> Ed., PH Int,2017
3. Digital Image Processing and Analysis-Human and Computer Vision Applicationwith CVIP Tools – ScotteUmbaugh, 2nd Ed, CRC Press,2011.

**Course Outcomes:**

- Defining the digital image, representation of digital image, importance of image resolution, applications in imageprocessing.
- Know the advantages of representation of digital images in transform domain, application of various imagertransforms.
- Know how an image can be enhanced by using histogram techniques, filtering techniques etc
- Understand image degradation, image restoration techniques using spatial filtersand frequencydomain
- Know the detection of point, line and edges in images, edge linking through local processing, globalprocessing.
- Understand the redundancy in images, various image compressiontechniques.
- Know the video technology from analog color TV systems to digital video systems,how video signal is sampled and filtering operations in videoprocessing.
- Know the general methodologies for 2D motion estimation, various coding used in video processing.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>COMMUNICATION STANDARDS and PROTOCOLS</b> (Professional Elective 3)					

**Objective:**

- Acquire knowledge about transferring data into cloud using various Wired/Wireless communication technologies.

**Prerequisites:**

Basic knowledge on Digital numbering system; Micro Controller Peripheral Programming, interfacing different types of sensors using I2C, SPI, UART ; wired and wireless communications.

**Unit-I:**

**Introduction to Communication and Networking :** Communications, Signal Types and its characteristics (Analog/Digital), Data Transmission Types (Serial/Parallel), Communication Techniques (Asynchronous, Synchronous), Data Transmission Modes (Simplex, Half/Full Duplex), Network Topologies (Star, Ring, Mesh, Point to Point, Tree, Bus, Daisy chain, Multi drop) and its applications, Modulation need and types.

**Unit-II:**

**OSI Layers:** Communication Layers and its applications, Communication media (Twisted Pair, Coaxial, Fiber Optics), Introduction to Errors (Error types, Detection, Correction) and Flow Control and its applications.

**Unit-III:**

**Wired Communication Protocols: Ethernet** (Types, Socket, MAC, IP, ARP, ICMP, TCP, UDP, DHCP), CAN, Mod-bus (RTU, ASCII), UART (RS485, RS232), OFC and Advantages, Disadvantages and its applications, Introduction to Dial up Modems, Leased line modems.

**Unit-IV:**

**Wireless Communication Protocols:** Zigbee, Bluetooth, Wi-Fi, GPRS, GSM , NFC , IR, Satellite Communication. Advantages, Disadvantages and its applications.

**Unit-V:**

**Network Types:** Introduction to LAN, WAN, PAN, Internet and Intranet, sensor networks (wired/wireless) and its applications.

**Network Security :** Introduction to NAT, PAT, DNS, Network Routing algorithms, Introduction to Switch, Hub, Bridges and its working, Network Security and Introduction to Firewall and its applications.



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**Text books:**

1. Introduction to data communication and networking by Wayne Tomasi, PearsonPrentice Hall,2005
2. Introduction to data communication and networking by Behrouz Forouzan ,4<sup>th</sup>Edition McGraw HillEducation,2017.
3. Basics of data communications by WilliamStallings.

**Reference books:**

1. Basics of computer networking by Thomas Robertazzi Stony BrookUniversity,2011
2. Wireless Networking Absolute Beginner's Guide by MichaelMiller:
3. Designing and Deploying 802.11n Wireless Networks by Jim Geier 2nd Edition, Kindle Edition.
4. CAN System Engineering from Theory to Practical Applications,2nd Edition,Springer,2013

**Course Outcomes:**

- Able to develop sensornetworks
- Able to communicate data via Wired/Wirelesscommunication
- Configure and test communicationtechnologies



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ANALOG IC DESIGN</b> <b>(Professional Elective 3)</b>					

**Course Objectives:**

The student will be able to

- Understand the behavior of MOS Devices and Small-Signal & Large-Signal Modeling of MOS Transistor and Analog Sub-Circuits.
- Learn and understand CMOS Amplifiers like Differential Amplifiers, Cascode Amplifiers, Output Amplifiers, and Operational Amplifiers.
- Design and Develop the Analog CMOS Circuits for different Analog operations.
- Learn and understand the concepts of Open-Loop Comparators and Different Types of Oscillators like Ring Oscillator, LC Oscillator etc.

**UNIT -I:**

**MOS Devices and Modelling:** The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modelling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model.

**UNIT -II:**

**Analog CMOS Sub-Circuits:** MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors-Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

**UNIT -III:**

**CMOS Amplifiers:** Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures.

**CMOS Operational Amplifiers:** Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

**UNIT -IV:**

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

**UNIT -V:**

**Oscillators & Phase-Locked Loops:** General Considerations, Ring Oscillators, LC Oscillators, Voltage Controlled Oscillators.

Simple PLL, Charge Pump PLLs, Non-Ideal Effects in PLLs, Delay Locked Loops, Applications.



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**TEXT BOOKS:**

1. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition, Second Edition.
2. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010.

**REFERENCES:**

1. Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, Wiley India, Fifth Edition, 2010.
2. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, 2013.

**Course Outcomes:**

After going through this course, the student will be able to

- Model and simulate different MOS Devices using small signal Model.
- Design and analyze any Analog Circuits in real time applications.
- Apply the concepts Analog Circuit Design to develop various Applications in Real Time.
- Analyze and compare different Open-Loop Comparators and Oscillators.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SMART SENSORS</b> <b>(Professional Elective 3)</b>					

**OBJECTIVE:**

To make student to acquire the knowledge on types of sensors/transducers, working principles, selection procedure, applications of sensing systems

**UNIT – I**

**Introduction to Measurement:** Measurement units, applications, elements, choosing appropriate measuring instruments. Instrument Types and Performance Characteristics: Review of instrument types, Static characteristics, dynamic characteristics

**Error during measurement process:** Sources of systematic error, reduction and quantification of systematic errors, random errors, aggregation of measurement system errors.

**Calibration:** Calibration of measuring instruments, Primary calibration, secondary calibration and field calibration. Calibration methods for different parameters (temperature, pressure, humidity, flow...etc.). Automatic Calibration mechanisms.

**UNIT – II**

**Temperature Sensors:** Thermo-resistive, Resistance Temperature Detectors, Silicon Resistive, Thermistors, Semiconductor, Optical, Acoustic, Piezoelectric

**Humidity and Moisture Sensors:** Capacitive, Electrical Conductivity, Thermal Conductivity, Optical Hygrometer, Time Domain Reflectometer.

**Pressure and Force Sensors:** Mercury Pressure, Bellows, Membranes, and Thin Plates, Piezoresistive, Capacitive, Optoelectronic, Vacuum, Strain Gauges, Tactile, Piezoelectric Force

**Applications:** Case studies in processing industries, indoor environment monitoring in offices, cold storages

**UNIT – III**

**Occupancy and Motion Detectors:** Ultrasonic, Microwave Motion, Capacitive Occupancy, Visible and Near-Infrared Light, Far-Infrared Motion, PIR Motion, Position, Displacement, and Level Sensors: Potentiometric, Gravitational, Capacitive, Inductive and Magnetic, Optical, Ultrasonic, Radar

**Velocity and Acceleration Sensors:** Capacitive Accelerometers, Piezoresistive Accelerometers, Piezoelectric Accelerometers, Thermal Accelerometers, Heated-Plate Accelerometer, Heated-Gas Accelerometer, Gyroscopes, Piezoelectric Cables

**Applications:** Case studies in manufacturing industries, robotics

**UNIT – IV**

**Flow Sensors:** Pressure Gradient Technique, Thermal Transport, Ultrasonic, Electromagnetic, and Micro flow, Coriolis Mass Flow, Acoustic Sensors: Resistive Microphones, Fiber-Optic, Piezoelectric, Solid-State microphone, Light & Radiation Sensors: Photodiodes, Phototransistor, Photo resistors, Thermal detectors



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**Chemical Sensors:** Metal-Oxide Chemical, ChemFET, Electro-chemical, Potentiometric, Conduct metric, Amperometric, Optical Chemical, Mass Detector

**Applications:** Case studies in processing industries, oil and gas industries, water SCADA, pharmaceutical industries

**UNIT – V**

**Introduction to wireless sensor networks,** Challenges for wireless sensor networks, Applications for wireless sensor networks, enabling technologies for wireless sensor networks.

**Single node architecture** – Hardware components, Energy consumption of Sensor nodes (only Operation states with different power consumption, Relationship between computation and communication, Power consumption of sensor and actuators is included), Deployment environments

**Sensor Network Architecture** - Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, Gateway-concepts.

**TEXT BOOKS:**

1. Measurement and Instrumentation Principles - Morris, AlanS
2. An Introduction to Error Analysis by John R.Taylor
3. Sensor Technology Handbook, John S.Wilson
4. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" John-Wiley,First-Edition-2014.

**REFERENCE BOOKS**

1. Mechanical Measurements – Beckwith, Marangoni,Lienhard
2. Measurement of Systems - Application and design - Earnest O.Doeblin
3. Electronic Instrumentation and Measurement Technique - Albert DHelfrick
4. Kazem Sohraby, Daniel Minoli, &Taieb Znati, “Wireless Sensor Networks- Technology, Protocols, AndApplications”, John Wiley,2007.

**Course Outcomes :**The student will be able to

- Understand measuring parameters, measuring systems, effects ofenvironment, characteristics and parameters to be considered for designing aninstrument
- Understand different types of sensors/transducers, working principles,selection procedure, applications of sensingsystems
- Understand Challenges and applications of sensors and sensornetworks
- Select a sensor/sensing system for arequirement
- Test, install and collect the data from a group ofsensors.
- Derive sensor-based solution for differentapplications.





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<b>ADVANCED DIGITAL SIGNAL PROCESSING</b> (Professional Elective 3)					

**Course Objectives:**

The main objectives of the course are

- To study about discrete time systems and to learn about FFT algorithms.
- To study the design techniques for FIR and IIR digital filters
- To study the finite word length effects in signal processing
- To study the properties of random signal, Multirate digital signal processing and about QMF filters

**UNIT –I:** Review of DFT, FFT, IIR Filters and FIR Filters: Introduction to filter structures (IIR & FIR). Implementation of Digital Filters, specifically 2nd Order Narrow Band Filter and 1st Order All Pass Filter. Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Back ward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

**UNIT - II:** Non-Parametric Methods: Estimation of spectra from finite duration observation of signals, Nonparametric Methods: Bartlett, Welch & Blackman-Tukey methods, Comparison of all Non-Parametric methods

**UNIT – III:** Parametric Methods: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models – Yule-Walker & Burg Methods, MA & ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.

**UNIT –IV:** Multi Rate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion. Examples of up-sampling using an All Pass Filter.

**UNIT –V:** Applications of Multi Rate Signal Processing: Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Sub-band Coding of Speech Signals, Quadrature Mirror Filters, Transmultiplexers, Over Sampling A/D and D/A Conversion.





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**TEXT BOOKS:**

1. J.G.Proakis & D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms & Applications”, 4th Edition,PHI,2008.
2. Alan V Oppenheim & Ronald W Schaffer, “Discrete Time signal processing “, PHI. 2nd Edition,1999.
3. Emmanuel C. Ifeache, Barrie. W. Jervis, “DSP – A Practical Approach”, 2nd Edition, PearsonEducation,2000.

**REFERENCE BOOKS:**

1. S. M .Kay, “Modern spectral Estimation: Theory & Application “, 1988,PHI.
2. P.P.Vaidyanathan, “Multi Rate Systems and Filter Banks”, PearsonEducation.
3. Kaluri V. Rangarao, Ranjan K. Mallik, “Digital Signal Processing: A Practitioner’s Approach”, ISBN: 978-0-470-01769-2, 210 pages, November 2006 JohnWeley.
4. S.Salivahanan, A.Vallavaraj, C.Gnanapriya, “Digital Signal Processing”,2000,TMH

**Course Outcomes:**

On completion of the course, students will be able to:

- Comprehend the DFT, FFT and IIR filters.
- To study the modern digital signal processing algorithms and applications.
- Have an in-depth knowledge of use of digital systems in real time applications
- Acquire the basics of multi rate digital signal processing and apply the algorithms for wide area of recent applications.
- Analyze the power spectrum estimation and Comprehend the Finite word length effects in Fixed point DSP Systems.



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<b>AUGMENTED REALITY</b> <b>(Professional Elective 3)</b>					

**OBJECTIVE:**

The course is designed to impart the fundamentals of augmented reality (AR), and teach how to build an AR experience.

**UNIT – I:**

Introduction to Augmented Reality: Definition and Scope, a brief history of Augmented Reality, Examples, Other related fields: Virtual Reality, Mixed Reality Continuum, Ubiquitous Computing.

Understanding Virtual Space: Defining visual space and content, defining position and orientation in three dimensions, navigation

**UNIT – II:**

Understanding human senses and their relationship to Output/Input Devices: The mechanics of sight – visual pathway, spatial vision and depth cues, The mechanics of hearing, mechanics of feeling, Multimodal displays, Visual perception, Requirements and Characteristics, Spatial display model, Visual displays

**UNIT – III:**

Sensors for tracking position, orientation and motion – Tracking, calibration and registration, coordinate systems, characteristics of tracking technology, Stationary tracking systems, Mobile sensors, optical tracking, sensor fusion, Computer vision for augmented reality – market tracking, multiple-camera infrared tracking, natural feature tracking by detection, incremental tracking, simultaneous localization and mapping, outdoortracking

Devices to enable navigation and interaction – 2D versus 3D interaction and navigation, the importance of a manual interface, hand and gesture tracking, whole body tracking, gaming and entertainment interfaces, navigating with mind.

**UNIT – IV:**

Software architectures – AR application requirements, software engineering requirements, Distributed object systems, dataflow, scene graphs, developer support.

Applications of Augmented and Virtual Reality: Gaming and Entertainment, Architecture and construction, Health and medicine, Aerospace and defence, education, information control and big data visualization, Tele-robotics and telepresence.

**UNIT – V:**

Human factors, legal and social considerations – human factor considerations, legal and social considerations, The future of AR – what may drive business cases, an AR developer's wish list, taking AR outdoors, interfacing with smart objects, confluence of VR and AR, augmented humans, AR as dramatic medium, AR as social computing platform.



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**TEXTBOOKS:**

1. Augmented Reality – Principles and Practice, Dieter Schmalstieg and Tobias Höllerer, 1<sup>st</sup> Edition, Addison-Wesley
2. Practical Augmented Reality – A guide to the technologies, applications, and human factors for AR and VR, Steve Aukstakalnis, 1<sup>st</sup> Edition, Addison-Wesley
3. Understanding Augmented Reality, Concepts and Applications, Alan B. Craig, 1<sup>st</sup> Edition, Morgan Kaufman

**REFERENCE BOOKS:**

1. Handbook of Virtual Environments: Design, Implementation, and Applications, Kelly S. Hale and Kay M. Stanney, 2<sup>nd</sup> Edition, CRC Press
2. Designing Virtual Systems: The Structured Approach, Gerard Jounghyun Kim, Springer
3. Spatial Augmented Reality: Merging Real and Virtual Worlds, Oliver Bimber and Ramesh Raskar, 1<sup>st</sup> Edition, A K Peters/CRC press.

**Course Outcomes:**

At the end of the course, students will

- Understand the basics of Augmented Reality
- Understand human senses and their relationship to devices
- Understand various application scenarios of AR
- Understand software architecture



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SOFTWARE RADIO</b> <b>(Professional Elective4)</b>					

**Pre-requisite(s):** Basic knowledge of signal processing, concepts in wireless Communication and networks.

**Course Objectives:** This course enables the students to:

- Understand the basic components of software defined radio.
- Understand the distortion parameters and nonlinear Distortion in Transmitted Signals.
- Calculate power requirement in power amplifier for SDR.
- Understand Digital Pre-distortion Techniques for Linear/Nonlinear Distortion.
- Appraise Digital Pre-distortion Techniques.

**UNIT 1:** Basic components of software defined radios, Software defined radio architectures Part A, Software defined radio architectures- Part B.

**UNIT 2:** Distortion parameters, Sources and metrics of distortion in a transceiver, Nonlinear distortion and nonlinearity specifications, Power amplifiers: Nonlinear Distortion in Transmitted Signals.

**UNIT 3:** Power amplifier Line-up for linearity & power requirement calculations, Linearization Techniques for nonlinear distortion in SDR.

**UNIT 4:** Predistortion Techniques for nonlinear distortion in SDR.

**UNIT 5:** Digital Predistortion Techniques for Linear/Nonlinear Distortion.

**Textbook:**

1. Jeffrey H. Reed “Software Radio: A Modern Approach to radio Engineering”, Pearson Education Asia, 2002

**References:**

1. Sanjay Kumar, “Wireless Communication the Fundamental and Advanced Concepts” River Publishers, Denmark, 2015 (Indian reprint)
2. [https://onlinecourses.nptel.ac.in/noc18\\_ec01/preview](https://onlinecourses.nptel.ac.in/noc18_ec01/preview).

**Course Outcomes:** After the completion of this course, students will be to:

- Able to analyze the basic components of software defined radio.
- Demonstrate understanding about distortion parameters and nonlinear Distortion in Transmitted Signals
- Able to calculate power requirement in power amplifier for SDR
- Demonstrate understanding about Digital Pre-distortion Techniques for Linear/Nonlinear Distortion
- Design and analyze the various algorithms used for software defined radio.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>LOW POWER VLSI DESIGN</b> (Professional Elective 4)					

**Course Objectives:**

- Known the low power low voltage VLSI design
- Understand the impact of power on system performances.
- Known about different Design approaches.
- Identify suitable techniques to reduce power dissipation in combinational and sequential circuits.

**UNIT –I:**

**Fundamentals:** Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects – Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

**UNIT –II:**

**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 -III**

**Low-Power Design Approaches:** Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches. 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 –IV:**

**Low-Voltage Low-Power Adders:** Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques – Trends of Technology and Power Supply Voltage.

**Low-Voltage Low-Power Multipliers:** Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Introduction to Wallace Tree Multiplier.



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**UNIT –V:**

**Low-Voltage Low-Power Memories:** Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Pre-charge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

**TEXT BOOKS:**

1. CMOS Digital Integrated Circuits – Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.
2. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering, 1<sup>st</sup> edition, 2004

**REFERENCE BOOKS:**

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011
2. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000.
3. Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press, 2002.
4. Leakage in Nanometer CMOS Technologies – Siva G. Narendran, Anatha Chandrakasan, Springer, 2005.

**Course Outcomes:**

Upon completing this course, the student will be able to

- Understand the need of Low power circuit design.
- Attain the knowledge of architectural approaches.
- Analyze and design Low-Voltage Low-Power combinational circuits.
- Known the design of Low-Voltage Low-Power Memories



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>EMBEDDED SYSTEMS</b> <b>(Professional Elective 4)</b>					

**Course Objectives:**

The main objectives of this course are given below:

- The basic concepts of an embedded system are introduced.
- The various elements of embedded hardware and their design principles are explained.
- Different steps involved in the design and development of firmware for embedded systems is elaborated.
- Internals of Real-Time operating system and the fundamentals of RTOS based embedded firmware design is discussed.
- Fundamental issues in hardware software co-design were presented and explained.
- Familiarize with the different IDEs for firmware development for different family of processors/controllers and embedded operating systems.
- Embedded system implementation and testing tools are introduced and discussed.

**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.



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**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, Deassembler/Decompiler, 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.

**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.

**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:

- Understand the basic concepts of an embedded system and able to know an embedded system design approach to perform a specific function.
- The hardware components required for an embedded system and the design approach of an embedded hardware.
- The various embedded firmware design approaches on embedded environment.
- 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>DSP PROCESSORS and ARCHITECTURES</b> (Professional Elective 4)					

**Course Objectives:**

- To recall the various techniques of digital signal processing.
- To introduce the architectural features of programmable DSP Processors of Texas Instruments (TI) and Analog devices (AD).
- To understanding the practical examples of DSP Processor architectures.
- To develop programming knowledge by using Instruction set of DSP Processors.
- To know the interfacing techniques to I/O devices and memory.

**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, ADSP-2181 high performance Processor.

Introduction to Black fin Processor - The Black fin 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



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**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: Woon-Seng Gan, Sen M. Kuo, Wiley-IEEE Press, 2007

**REFERENCE BOOKS:**

1. Digital Signal Processors, Architecture, Prog and Applications-B. Venkataramani and M. Bhaskar, 2002, TMH.
2. DSP Processor Fundamentals, Architectures & Features – Lapsley et al. 2000, S. Chand & Co.
3. Digital Signal Processing App Using the ADSP-2100 Family by The Applications Engineering Staff of Analog Devices, DSP Division, Edited by Amy Mar, PHI
4. The Scientist and Engineer's Guide to Digital Signal Processing by Steven W. Smith, Ph.D., California Technical Publishing, ISBN 0-9660176-3-3, 1997.

**Course Outcomes:**

Upon the completion of course, student able to

- Understand the basic concepts of Digital Signal Processing.
- To differentiate the architectural features of General purpose processors and DSP processors.
- Understand the architectures of TMS320C54xx devices and ADSP 2100 DSP devices.
- Write the simple assembly language programs by using instruction set of TMS320C54xx.
- To interface the various devices to DSP Processors.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MULTI MEDIA COMMUNICATION</b> <b>(Professional Elective 4)</b>					

**Course objectives:** This course will enable students to

- Define the Multimedia Communication Models
- Explain Multimedia Transport in Wireless Networks
- Solve the Security issues in multimedia networks
- Illustrate real-time multimedia network applications.
- Explain different network layer based application.

**Unit-I:** Introduction and tools used for MM content development , Media interaction, bimodality of human speech, Lip reading, speech driven talking heads, Lip synchronization, Lip tracking, Audio to visual mapping.

**Unit-II:** Biomodal person verification, Joint AV coding, Multimedia processing, Digital media, Signal processing elements, Challenges in MM processing, Perceptual coding of Digital Audio.

**Unit-III:** Transform audio coders, Image coding, video coding, Water marking techniques, Organization, Storage and retrieval, ANNs for MMSP.

**Unit-IV:** Distributed MM systems, Multimedia processors, Multimedia OS, Multimedia communication standards, MPEG-1, MPEG-2, MPEG-4, MPEG-7.

**Unit-V:** Real time multimedia across Internet, packet audio/video multimedia transport across IP/ATM Network, Wireless multimedia, mobile multimedia access for internet, multimedia PCS.

**Text Book:**

1. Multimedia Communication Systems: Techniques and Standards, KR RAO et al, Pearson, 2002.
2. Insight into Mobile Multimedia Communication : D. BULL et al, Academic Press, 1999
3. Multimedia Systems Design : PK ANDLEIGH , K. THAKKAR, PHI, 2002
4. Multimedia, TAY VAUGHAN, 5/e, TMH, 2001

**Course Outcomes:**

- Develop the multimedia content using multimedia tools
- Understand various audio, video and joint coding techniques.
- Identify the requirements of real time multimedia transfer on IP networks.
- Study different types of multimedia processors



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IV Year - I Semester		<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>INTERNET OF THINGS LAB</b>					

**List of Experiments:**

1. Introduction to Raspberry Pi Board/ Arduino/NodeMCU.
2. Familiarization with ARM keil MDK for programming and debugging an application on the PSoC 4 BLE chip and perform necessary software installation.
3. To interface Push button/Digital sensor (IR/LDR) with ARM keil MDK on PSoC 4 BLE chip and write a program to turn ON LED when push button is pressed or at sensor detection.
4. Set up a Bluetooth Low Energy (namely Bluetooth Smart) connection between the PSoC BLE kit and a smart phone and use an app to send and receive data to and from the BLE Pioneerkit.
5. To interface capacitor sensor (touch sensor) with smart phone and write a program to turn RGB LED ON/OFF when '1'/'0' is received from smart phone using Bluetooth.
6. Automatic street light control to control the street light (Turn on and off based on the light) using Arduino/ Node MCU/RaspberryPi
7. Smoke Detection using MQ-2 GasSensor
8. Detecting obstacle with IR Sensor and Arduino/ Node MCU/RaspberryPi
9. Arduino board interfacing with the temperature and humidity sensor and prints the output on LCD / serialmonitor
10. Write an Arduino program for interfacing Arduino board with the Ultrasonic sound sensor and print the output on Serialmonitor.

**Equipment required for Laboratories:**

Arduino/Node MCU/Raspberry Pi + PSoC 4 BLE Bluetooth Low Energy Pioneer Kit + Hardware, MQ-2 Gas Sensor, Ultrasonic sound sensor.



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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>MICROWAVE AND OPTICAL COMMUNICATION ENGINEERING LAB</b>					

**Minimum Twelve Experiments to be conducted:**

**Part-A (Any 7 Experiments (8 & 9 Compulsory))**

1. Reflex Klystron Characteristics.
2. Gunn Diode Characteristics.
3. Attenuation Measurement.
4. Directional Coupler Characteristics.
5. Impedance and Frequency Measurement.
6. Scattering parameters of Circulator.
7. Scattering parameters of Magic Tee.
8. Radiation Pattern of Horn and Parabolic Antennas.
9. Synthesis of Microstrip antennas (Rectangular Structure) Using any Industry standard Simulation Software.

**Part – B (Any 5 Experiments) :**

10. Characterization of LED.
11. Characterization of Laser Diode.
12. Intensity modulation of Laser output through an optical fiber.
13. Measurement of Data rate for Digital Optical link.
14. Measurement of NA.
15. Measurement of losses for Analog Optical link.

**Equipment required for Laboratories:**

1. Regulated Klystron Power Supply, Klystron mount
2. VSWR Meter
3. Micro Ammeter
4. Multimeter
5. CRO
6. GUNN Power Supply, Pin Modulator
7. Crystal Diode detector
8. Micro wave components (Attenuation)
9. Frequency Meter
10. Slotted line carriage
11. Probe detector
12. Wave guide shorts
13. SSTuner
14. Directional Coupler
15. E, H, Magic Tees
16. Circulators, Isolator
17. Matched Loads



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18. Pyramidal Horn and Parabolic Antennas
19. Turntable for Antenna Measurements
20. Fiber Optic Analog Trainer based LED
21. Fiber Optic Analog & Trainer based laser
22. Fiber Optic Trainer
23. Fiber cables - (Plastic, Glass)



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>WIRELESS COMMUNICATION</b> (Professional Elective 5)					

**Course Objectives:**

The student will be introduced to:

- The Aim of this course is to introduce the fundamental technologies for wireless Communication and networking
- Introducing the concepts of Multiple Access Schemes
- Introducing the comprehensive exposure to the fast-evolving high-tech fields of Wireless communications
- It introduces the latest technologies such as CDMA, OFDM, and MIMO, which form the bedrock of 3G/4G wireless networks

**UNIT I**

Introduction to 3G/4G Wireless Communications: Introduction, 2G Wireless Standards, 3G Wireless Standards, 4G Wireless Standards, Overview of Cellular Service Progression Principles of Wireless Communications: The Wireless Communication Environment, Modeling of Wireless Systems, System Model for Narrowband Signals, Rayleigh Fading Wireless Channel, BER Performance of Wireless Systems: SNR in a Wireless System, BER in Wireless Communication System, Rayleigh BER at High SNR. Intuition for BER in a Fading Channel. Channel Estimation in Wireless Systems, Diversity in Wireless Communication.

**UNIT II**

Code Division for Multiple Access (CDMA): Introduction to CDMA, Basic CDMA Mechanism, Fundamentals of CDMA Codes, Spreading Codes based on Pseudo-Noise (PN) Sequences, Correlation Properties of Random CDMA Spreading Sequences, Multi-User CDMA, Advantages of CDMA.

**UNIT III**

Multiple-Input Multiple-Output Wireless Communications: Introduction to MIMO Wireless Communications, MIMO System Model, MIMO Zero-forcing (ZF) Receiver, MIMO MMSE Receiver, Singular Value Decomposition (SVD) of the MIMO Channel, Singular Value Decomposition (SVD) and MIMO Capacity

**UNIT IV**

Orthogonal Frequency-Division Multiplexing: Introduction, Motivation and Multicarrier Basics, OFDM Example, Bit-Error Rate (BER) for OFDM, MIMO-OFDM, Effect of Frequency Offset in OFDM, OFDM – Peak-to-Average Power Ratio (PAPR), SC-FDMA.

**UNIT V**

Satellite-Based Wireless Systems: Introduction, Satellite Orbits, Use of Satellites for Communication, Satellites and Transponders, Signal and Noise Calculations, Systems



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Using Geostationary Satellites, Systems Using Low-Earth-Orbit Satellites, Systems Using Medium Earth-Orbit Satellites.

**TEXTBOOKS:**

1. Principles of Modern Wireless Communication Systems – Aditya K Jagannathan, McGraw Hill publishers, 2017
2. Wireless Communication Technology – Blake, Delmar/Cengage Learning India, first Edition, 2012

**REFERENCES:**

1. Wireless Communications and Networking – Vijay K. Garg, Morgan Kaufmann, 2007

**Course Outcomes:**

After going through this course, the student will be able to

- Know about the Wireless systems and Standards (1G/2G/3G systems).
- Concept and analysis of CDMA-based wireless networks.
- Understand the concepts of Multiple-Input Multiple-Output (MIMO).
- Understand the modern wireless systems using OFDM.
- Analysis of Satellite-Based Wireless systems.





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>VLSI TESTING &amp; TESTABILITY</b> (Professional Elective 5)					

**Course Objectives:**

- To impart knowledge on the basic faults that occur in digital systems
- To describe fault detection techniques in combinational circuits.
- To outline procedures to generate test patterns for detecting single stuck faults in combinational and sequential circuits.
- To explain design for testability techniques with improved fault coverage.
- To introduce BIST concepts and specific architectures.
- To give exposure to approaches for introducing BIST into logic circuits, memories and embedded cores.

**UNIT I**

Introduction to Test and Design for Testability (DFT) Fundamentals Modelling: Modelling digital circuits at logic level, register level and structural models, Levels of modelling. Logic Simulation: Types of simulation, Delay models, Element evaluation, Hazard detection, Gate level event driven simulation.

**UNIT II**

Fault Modelling – Logic fault models, Fault detection and redundancy, Fault equivalence and fault location. Single stuck and multiple stuck – Fault models. Fault simulation applications, General techniques for Combinational circuits.

**UNIT III**

Testing for single stuck faults (SSF), Automated test pattern generation (ATPG/ATG) for SSFs in combinational and sequential circuits, Functional testing with specific fault models, Vector simulation – ATPG vectors, formats, Compaction and compression, Selecting ATPG Tool.

**UNIT IV**

Design for testability – testability trade-offs, techniques. Scan architectures and testing – controllability and Observability generic boundary scan, full integrated scan, storage cells for scan design. Board level and system level DFT approaches. Boundary scan standards. Compression techniques – different techniques, syndrome test and signature analysis

**UNIT V**

Built-in self-test (BIST): BIST Concepts and test pattern generation. Specific BIST Architectures – CSBL, BEST, RTS, LOCST, STUMPS, CBIST, CEBS, RTD, SST, CATS, CSTP, BILBO, Brief ideas on some advanced BIST concepts and design for self-test at board level. Memory BIST (MBIST): Memory test architectures and techniques – Introduction to memory test, Types of memories and integration, Embedded memory testing model. Memory test requirements for MBIST, Brief ideas on embedded core testing



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**TEXT BOOKS:**

1. Miron Abramovici, Melvin A. Breur, Arthur D. Friedman, Digital Systems Testing and Testable Design, Jaico Publishing House, 2001.
2. Alfred Crouch., Design for Test for Digital ICs & Embedded Core Systems, Prentice Hall.

**REFERENCES:**

1. Robert J. Feugate, Jr., Steven M. Mentyn, Introduction to VLSI Testing, Prentice Hall, Englehood Cliffs, 1998.
2. Bushnell, M., and Agrawal, Vishwani D, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Kluwer Academic Publishers, 2002

**Course Outcomes:**

- Model digital circuits at logic and RTL levels
- Simulate digital ICs in the presence of faults and evaluate the given test set for fault coverage
- Generate test patterns for detecting single stuck faults in combinational and sequential circuits
- Identify schemes for introducing testability into digital circuits with improved fault coverage
- Compare different approaches for introducing BIST into logic circuits, memories and embedded cores



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MACHINE LEARNING &amp; ARTIFICIAL INTELLIGENCE</b> (Professional Elective 5)					

**OBJECTIVE:**

To familiarize students with basic concepts, theories and advancements in ML and AI and help them in understanding the mathematics behind algorithms and apply them in real world scenarios

**UNIT – I**

Introduction to ML/AI - AI Foundation, history of AI, latest advancements and applications  
 Machine Learning – I: Linear Regression - Learn to implement linear regression and predict continuous data values, Clustering - Learn how to create segments based on similarities using K-Means and Hierarchical clustering

**UNIT – II**

Machine Learning – II: Naïve Bayes and Logistic regression - Understand how supervised learning is used for classification, Support vector machines - Learn to classify data points using support vectors, decision trees - Tree-based model that is simple and easy to use. Learn the fundamentals on how to implement them

Natural Language Processing: Basics of text processing, lexical processing - Learn to extract features from unstructured text and build machine learning models on text data, syntax and semantics - Conduct sentiment analysis, learn to parse English sentences and extract meaning from them

**UNIT – III**

Deep learning & Neural Networks: Information flow in neural networks - Understand the components and structure of artificial neural networks, Training a neural network - Learn the latest techniques used to train highly complex neural networks, Convolutional neural networks - Use CNN's to solve complex image classification problems, Recurrent neural networks - Study LSTMs and RNN's applications in text analytics, Creating and deploying networks using TensorFlow and Keras (Deep Learning Library) - Build and deploy your own deep neural networks on a website, learn to use Tensor Flow API and Keras.

**UNIT – IV**

Graphical Models: Introduction to Bayesian methods, Graphical models - Study probabilistic way of modelling systems - Markov properties, Factor Graphs and Bayesian belief networks, Learning and Inference - Learn how graphics models are used for supervised and unsupervised learning



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**UNIT – V**

Reinforcement Learning: Introduction to RL, understand how machines can be programmed to learn by themselves, Exact methods - Learn the math behind Exact Statistics - Dynamic Programming, Monte Carlo methods, Temporal Difference Learning, Approximate Methods - Learn policy gradient methods and their applications in learning

**TEXTBOOKS:**

1. Machine Learning, by Tom M Mitchell, Indian Edition, McGraw Hill, first Edition 2017.
2. Deep Learning by Goodfellow, Bengio, Courville. The MIT Press, 2016
3. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill, 3<sup>rd</sup> Edition 2008.

**REFERENCE BOOKS**

1. Understanding Machine Learning: From Theory to Algorithms, by Shai Shalev-Shwartz and Shai Ben-David, 1<sup>st</sup> Edition, Cambridge University Press, 2014.
2. Artificial Intelligence - A Modern Approach by Stuart Russell & Peter Norvig, Prentice Hall, 3<sup>rd</sup> Edition, 2009.

**Course Outcomes:**

The student should be able to:

- Understand machine learning concepts and range of problems that can be handled by machine learning.
- Apply the machine learning concepts in real life problems.
- Understand artificial neural networks concept and apply techniques to train the neural networks
- Understand how graphical models are used for supervised and unsupervised learning
- Understand Reinforcement Learning concept and applications
- Modify the algorithms based on need



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SPEECH PROCESSING</b> (Professional Elective 5)					

**Course Objectives:**

The main objectives of the course are as follows:

- Understand the mechanism of human speech production and articulation
- Understand time and frequency domain methods of speech processing
- Understand linear predictive analysis for speech signals and LPC
- Study the algorithms and models involved for speaker and speech recognition systems

**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



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**Text books:**

1. L. R. Rabiner and 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, Prentice Hall, 2001
2. L.R. Rabiner and B. H. Juang, Fundamentals of speech recognition, Prentice Hall, 1999.

**Course Outcomes:**

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

- Summarize the mechanism of human speech production and articulation
- Identify the time domain speech signal parameters
- Differentiate time and frequency domain methods of speech processing
- Attribute linear predictive analysis for speech signals
- Explain the solutions for LPC equations
- Implement the different algorithms and models involved for speaker and speech recognition systems



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>INDUSTRIAL INTERNET OF THINGS</b> <b>(PROFESSIONAL ELECTIVE-5)</b>					

**Course Objectives:**

The main objectives of this course are:

- Learn and understand the Importance of IoT in industrial applications
- Know how IoT has become a game changer in the new economy where the customers are looking for integrated value.
- Apply the IoT concepts in building solutions to Industrial problems
- Learn and understand the tools and techniques that enable IoT solution and Security aspects.

**UNIT-I**

**INTRODUCTION:** Introduction to IoT, IoT Vs. IIoT, History of IIoT, Components of IIoT - Sensors, Interface, Networks, People & Process, Hype cycle, IOT Market, Trends & future Real life examples, Key terms of IoT- IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining & Manipulation; Role of IIoT in Manufacturing Processes Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges and Benefits in implementing IIoT.

**UNIT-II**

**ARCHITECTURES:** Overview of IoT components, Various Architectures of IoT and IIoT, Advantages & disadvantages, Industrial Internet - Reference Architecture; IIoT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT.

**SENSORS AND INTERFACING:** Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACnet, Current, M2M etc.

**UNIT-III**

**PROTOCOLS AND CLOUD:** Need of protocols; Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, BACnet, BLE, Modbus, SPI, I2C, IIoT protocols –COAP, MQTT, 6LoWPAN, LWM2M, AMPQ IIoT cloud platforms: Overview of COTS cloud platforms, Predix, PTC Thing Worx, Microsoft Azure etc. Data analytics, cloud services, Business models: SaaS, PaaS, IaaS.

**UNIT-IV**

**SECURITY:** Introduction to web security, Conventional web technology and relationship with IIoT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model, Identity establishment, Access control, Message



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integrity, Non-repudiation and availability, Security model for IoT, Network security techniques Management aspects of cyber security.

**ANALYTICS:** IoT Analytics: Role of Analytics in IoT, Data visualization Techniques.

**UNIT-V**

**DIGITAL TWIN:** Introduction to Digital Twin, need for Digital Twin, Elements of Digital Twin, Digital Twin process design and information requirements, Digital twin conceptual architecture - create, communicate, Aggregate, Analyze, Insight, Act, driving business value through digital twin.

**DIGITAL TWIN FOR ASSET:** Digitalizing asset behaviour using simulated mathematical modelling and building Digital Twin - Need, Benefits, Architecture, Models and Use cases - Predictive and Prescriptive maintenance.

**TEXT BOOKS:**

1. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, by Daniel Minoli, Bernd Scholz-Reiter, Florian, Willy Publication
2. Digital Twin Technologies and Smart Cities by Farsi, M., Daneshkhah, A., Hosseinian-Far, A., Jahankhani, H., Springer International Publishing, 2020.
3. Architecting the Internet of Things, by Michahelles, Springer, 2011

**REFERENCES:**

1. The Internet of Things Connecting Objects to the Web” by Hakima Chaouchi, Willy Publications
2. The Internet of Things: Key Applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, 2<sup>nd</sup> Edition, Willy Publications
3. Inside the Internet of Things (IoT), Deloitte University Press
4. Internet of Things- From Research and Innovation to Market Deployment; By Ovidiu & Peter; River Publishers Series
5. Five thoughts from the Father of the Internet of Things; by Phil Wainewright - Kevin Ashton
6. How Protocol Conversion Addresses IIoT Challenges: White Paper By RedLion.
7. <https://www.ge.com/digital/applications/digital-twin>
8. <https://www2.deloitte.com/us/en/insights/focus/industry-4-0/digital-twin-technology-smart-factory.html>

**Course Outcomes:**

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

- Understand the elements of IoT to build a total control plane in an Industrial application
- Apply M2M protocols for development of IoT Applications.
- Learn and understand the concept of digitalization and data acquisition.
- Build smart factory based on the IoT concepts
- Build Industrial Digital Twins.





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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

<b>IV 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>3D PRINTING</b> <b>Open Elective (OE2)</b>					

**Course Objectives:**

The main objectives of this course are:

- The course aims at the importance of Additive Manufacturing, classifications, models, specifications of various Additive Manufacturing Techniques.
- Principles and operation of 3Dp, Various types of 3DP
- Techniques of printing electronics
- To learn the data formats and soft-wares required
- The applications of RP

**UNIT-I**

**Introduction to Prototyping**, Traditional Prototyping Vs Rapid Prototyping (RP), Need for time compression in product development, Distinction between RP and CNC and other related technologies, Classification of RP, commonly used terms, advantages and limitations of rapid prototyping.

**UNIT-II**

**Three-Dimensional Printing (3DP)**

Overview of 3DP, 3D Printer, 3D Systems, and Z Corporation, ExOne - Metal and Molding Sand Printer, Metal Line: Direct Metal Printer, Molding Sand Line: Direct Core and Mold-Making Machine, Soligen - Direct Shell Production Casting (DSPC), Voxel jet- 3D Printing System, Optomec - Maskless Mesoscale Material Deposition (M3D),

**UNIT-III**

**Techniques for printing electronics**, printing electronics, 2D-printing technologies- Flexographic, Offset, Gravure, screen printing, Processes in 3D-printing electronics - Improved building process for 3D devices, Fictionalization of 3D surfaces, Current trends in 3D-printed electronics- antennas, flexible electronics, batteries, The market for 3D-printed electronics And integrated machines

**UNIT – IV**

**RAPID PROTOTYPING DATA FORMATS:** STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, Newly Proposed Formats.



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**RAPID PROTOTYPING SOFTWARE'S:** Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, STL View 3 Data Expert and 3 D doctor.

**UNIT –V**

**RP APPLICATIONS:** Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, arts and architecture. RP medical and bioengineering applications: planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices, forensic science and anthropology, visualization of bimolecular.

**TEXT BOOKS:**

1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific,2010.
2. Andreas Gebhardt Jan-Steffen Hotter, Additive Manufacturing: 3D Printing for prototyping and Manufacturing, Hanser Publications, 6915 Valley Avenue, Cincinnati, Ohio.
3. Ian Gibson., David W Rosen., Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer,2010.

**REFERENCE BOOKS:**

1. Rapid Manufacturing / D.T. Pham and S.S.Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/WohlersAssociates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASMEPress
4. Rapid Prototyping / Chua&Liou

**Course Outcomes:**

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

- Identify the importance of RP in presentscenario.
- Gain the knowledge on3DP
- Application of 3DP in electronics.
- Minimize various errors that are occurring during conversion of CADmodels.
- Applications ofRP.



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<b>BLOCKCHAIN TECHNOLOGY</b> <b>Open Elective (OE2)</b>					

**Course Objectives:**

The main objectives of this course are:

- Understand how block chain systems (mainly Bit coin and Ethereum) work and to securely interact withthem,
- Design, build, and deploy smart contracts and distributedapplications,
- Integrate ideas from block chain technology into their ownprojects.

**Unit I:**

**Introduction:** Scenarios, Challenges Articulated, Blockchain, Blockchain Characteristics, Opportunities Using Blockchain, History of Blockchain.

Evolution of Blockchain: Evolution of Computer Applications, Centralized Applications, Decentralized Applications, Stages in Blockchain Evolution, Consortia, Forks, Public Blockchain Environments, Type of Players in Blockchain Ecosystem, Players inMarket.

**Unit II:**

**Blockchain Concepts:** Introduction, Changing of Blocks, Hashing, Merkle-Tree, Consensus, Mining and Finalizing Blocks, Currency aka tokens, security on blockchain, data storage on blockchain, wallets, coding on blockchain: smart contracts, peer-to-peer network, types of blockchain nodes, risk associated with blockchain solutions, life cycle of blockchain transaction.

**Unit III:**

**Architecting Blockchain solutions:**Introduction, Obstacles for Use of Blockchain, Blockchain Relevance Evaluation Framework, Blockchain Solutions Reference Architecture, Types of Blockchain Applications, Cryptographic Tokens, Typical Solution Architecture for Enterprise Use Cases, Types of Blockchain Solutions, Architecture Considerations, Architecture with Blockchain Platforms, Approach for Designing Blockchain Applications.

**Unit IV:**

**Ethereum Blockchain Implementation:** Introduction, Tuna Fish Tracking Use Case, Ethereum Ecosystem, Ethereum Development, Ethereum Tool Stack, Ethereum Virtual Machine, Smart Contract Programming, Integrated Development Environment, Truffle Framework, Ganache, Unit Testing, Ethereum Accounts, MyEtherWallet, Ethereum Networks/Environments, Infura, Etherscan, Ethereum Clients, Decentralized Application, Metamask, Tuna Fish Use Case Implementation, OpenZeppelinContracts



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**Unit V:**

**Hyperledger Blockchain Implementation:** Introduction, Use Case – Car Ownership Tracking, Hyperledger Fabric, Hyperledger Fabric Transaction Flow, FabCar Use Case Implementation, Invoking Chaincode Functions Using Client Application.

Advanced Concepts in Blockchain: Introduction, InterPlanetary File System (IPFS), Zero-Knowledge Proofs, Oracles, Self-Sovereign Identity, Blockchain with IoT and AI/ML Quantum Computing and Blockchain, Initial Coin Offering, Blockchain Cloud Offerings, Blockchain and its Future Potential.

**TEXT BOOKS:**

- 1) “Blockchain for Enterprise Application Developers”, Ambadas, Arshad SarfarzAriff, Sham - Wiley
- 2) “Mastering Bitcoin: Programming the Open Blockchain”, Andreas M. Antonopoulos, O’Reilly

**REFERENCES:**

- 1) Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions, Joseph Bambara, Paul R. Allen, Mc GrawHill.
- 2) Blockchain: Blueprint for a New Economy, Melanie Swan, O’Reilly

**E-RESOURCES:**

<https://github.com/blockchainedindia/resources>

**Course Outcomes:**

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

- Demonstrate the foundation of the Block chain technology and understand the processes in payment and funding.
- Identify the risks involved in building Block chain applications.
- Review of legal implications using smart contracts.
- Choose the present landscape of Blockchain implementations and Understand Cryptocurrency markets
- Examine how to profit from trading cryptocurrencies.



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<b>CYBER SECURITY &amp; CRYPTOGRAPHY</b> <b>Open Elective (OE2)</b>					

**Course Objectives:**

- Able to identify security risks and take preventive steps
- To understand the forensics fundamentals.
- To understand the evidence capturing process.
- To understand the preservation of digital evidence.

**Unit I : Introduction to Cybercrime:** Introduction, Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Cybercriminals, Classifications of Cybercrime, Cyberstalking, Cybercafe and Cybercrimes, Botnets. Attack Vector, Proliferation of Mobile and Wireless Devices, Security Challenges Posed by Mobile Devices, Attacks on Mobile/Cell Phones, Network and Computer Attacks,

**Unit II: Tools and Methods :** Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, Sniffers, Spoofing, Session Hijacking Buffer over flow, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks, Identity Theft (ID Theft), Foot Printing and Social Engineering, Port Scanning, Enumeration

**Unit III : Cyber Crime Investigation:** Introduction, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Hands on Case Studies. Encryption and Decryption Methods, Search and Seizure of Computers, Recovering Deleted Evidences, Password Cracking.

**Unit IV: Computer Forensics and Investigations:** Understanding Computer Forensics, Preparing for Computer Investigations. Current Computer Forensics Tools: Evaluating Computer Forensics Tools, Computer Forensics Software Tools, Computer Forensics Hardware Tools, Validating and Testing Forensics Software, Face, Iris and Fingerprint Recognition, Audio Video Analysis, Windows System Forensics, Linux System Forensics, Graphics and Network Forensics, E-mail Investigations, Cell Phone and Mobile Device Forensics

**Unit V: Cyber Crime Legal Perspectives:** Introduction, Cybercrime and the Legal Landscape around the World, The Indian IT Act, Challenges to Indian Law and Cybercrime Scenario in India, Consequences of Not Addressing the Weakness in Information Technology Act, Digital Signatures and the Indian IT Act, Amendments to the Indian IT Act, Cybercrime and Punishment, Cyberlaw, Technology and Students: Indian Scenario.



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**TEXT BOOKS:**

1. Sunit Belapure Nina Godbole “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, WILEY, 2011.
2. Nelson Phillips and Enfinger Stuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi, 2009.

**REFERENCE BOOKS:**

1. Michael T. Simpson, Kent Backman and James E. Corley, “Hands on Ethical Hacking and Network Defence”, Cengage, 2019.
2. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi.
3. Alfred Basta, Nadine Basta, Mary Brown and Ravinder Kumar “Cyber Security and Cyber Laws”, Cengage, 2018.

**Web References:**

1. CERT-In Guidelines- <http://www.cert-in.org.in/>
2. <https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks> [ Online Course]
3. <https://computersecurity.stanford.edu/free-online-videos> [ Free Online Videos]
4. Nikolai Zeldovich. 6.858 Computer Systems Security. Fall 2014. Massachusetts Institute of Technology: MIT OpenCourseWare, <https://ocw.mit.edu>. License: Creative Commons BY-NC-SA.

**Course Outcomes:**

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

- Explain the computer forensics fundamentals.
- Describe the types of computer forensic technology
- Analyze various computer forensic systems.
- Illustrate the methods for data recovery, evidence collection and data seizure.



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**OPEN ELECTIVES OFFERED BY ECE**



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<b>PRINCIPLES OF COMMUNICATION</b> <b>Open Elective (OE1)</b>					

**Course objectives:**

This course will enable students to:

- Understand simple systems for generating and demodulating AM, DSB, SSB and VSB signals
- Understand the concepts in Angle modulation for the design of communications systems
- Study simple systems for generating and demodulating frequency modulated signals
- Learn the concepts of random process and various types of noise.
- Study the performance of the communication system in presence of noise.
- Learn pulse modulation and sampling techniques

**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,

**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.





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**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**

**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

**Text books:**

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.

**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, SP Sapre, Second Edition TMH, 2007.

**Course Outcomes:**

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

- Analyze the performance of analog modulation schemes in time and frequency domains.
- Analyze the performance of angle modulated signals.
- Characterize analog signals in time domain as random processes and noise
- Characterize the influence of channel on analog modulated signals
- Determine the performance of analog communication systems in terms of SNR
- Analyze pulse amplitude modulation, pulse position modulation, pulse code modulation and TDM systems.



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<b>EMBEDDED SYSTEMS</b>					
<b>Open Elective (OE2)</b>					

**Course Objectives:**

The main objectives of this course are given below :

- The basic concepts of an embedded system are introduced.
- The various elements of embedded hardware and their design principles are explained.
- Different steps involved in the design and development of firmware for embedded systems is elaborated.
- Internals of Real-Time operating system and the fundamentals of RTOS based embedded firmware design is discussed.
- Fundamental issues in hardware software co-design were presented and explained.
- Familiarize with the different IDEs for firmware development for different family of processors/controllers and embedded operating systems.
- Embedded system implementation and testing tools are introduced and discussed.

**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 synchronisation.

**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.



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**UNIT-V:**

**EMBEDDED SYSTEM DEVELOPMENT, IMPLEMENTATION AND TESTING:**The integrated development environment, Types of files generated on cross-compilation, Deassembler/Decompiler, 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.

**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.

**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:

- Understand the basic concepts of an embedded system and able to know an embedded system design approach to perform a specificfunction.
- The hardware components required for an embedded system and the design approach of an embeddedhardware.
- The various embedded firmware design approaches on embeddedenvironment.
- Understand how to integrate hardware and firmware of an embedded system using real time operatingsystem.