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

DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For

B.TECHELECTRONICS AND INSTRUMENTATION ENGINEERING

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

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COURSE STRUCTURE - R19

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
Total Credits			**16**	**0**	**12**	**19**

I Year – II SEMESTER

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	ES1206	Basic Electrical Engineering	3	0	0	3
6	ES1216	Electronic components & Measuring Instruments 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
Total Credits			**15**	**0**	**12**	**21**

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II Year - I Semester

S.No.	Subjects	Category	L	T	P	Credits
1	Electronic Devices and Circuits	PC	3	0	0	3
2	Signals and Systems	PC	3	0	0	3
3	Switching Theory and Logic Design	PC	3	0	0	3
4	Transducer Technology	PC	3	0	0	3
5	Data structures	ES	3	0	0	3
6	Managerial Economics and Financial Analysis	HS	3	0	0	3
7	Electronic Devices and Circuits Lab	LC	0	0	3	1.5
8	Data Structures lab	LC	0	0	3	1.5
9	Constitution of India	MC	3	0	0	0
	Total Credits					**21**

II Year - II Semester

S.No.	Subjects	Category	L	T	P	Credits
1	Electronic Circuit Analysis	PC	3	0	0	3
2	Electromagnetic Waves and Transmission Lines	PC	3	0	0	3
3	Control Systems	PC	3	0	0	3
4	Python programming	ES	3	0	0	3
5	Basics of sensor technology	PC	3	0	0	3
6	Electronic Measurements and Instrumentation	PC	3	0	0	3
7	Electronic Circuit Analysis LAB	LC	0	0	3	1.5
8	Instrumentation LAB – l	LC	0	0	3	1.5
	Total Credits					**21**

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III Year - I Semester

S.No.	Subjects	Category	L	T	P	Credits
1	Signal Conditioning Circuits	PC	3	0	0	3
2	Integrated Circuits and applications	PC	3	0	0	3
3	Microprocessor and Microcontrollers	PC	3	0	0	3
4	Process Control Instrumentation	PC	3	0	0	3
5	Professional Elective (PE1)	PE	3	0	0	3
6	Process control Instrumentation Lab	LC	0	0	3	1.5
7	Integrated Circuits and applications - Lab	LC	0	0	3	1.5
8	Microprocessor and Microcontrollers Lab	LC	0	0	3	1.5
9	Professional Ethics & Human Values	MC	3	0	0	0
10	Mini Project with Hardware Development	PR	0	0	3	1.5
	Total Credits					**21**

III Year -II Semester

S.No.	Subjects	Category	L	T	P	Credits
1	Digital Signal Processing	PC	3	0	0	3
2	VLSI Design	PC	3	0	0	3
3	Industrial Instrumentation	PC	3	0	0	3
4	Professional Elective (PE-II)	PE	3	0	0	3
5	Open Elective (OE-I)	OE	3	0	0	3
6	Data Acquisition System	PC	3	0	0	3
7	Digital Signal Processing Lab	LC	0	0	3	1.5
8	Industrial Instrumentation Lab	LC	0	0	3	1.5
9	Intellectual Property Rights (IPR) & Patents	MC	3	0	0	0
	Total Credits					**21**

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IV Year- I Semester

S.No.	Subjects	Category	L	T	P	Credits
1	Management and Organizational Behavior	HS	3	0	0	3
2	Biomedical Instrumentation	PC	3	0	0	3
3	Digital Image and video Processing	PC	3	0	0	3
4	Professional Elective (PE-III)	PE	3	0	0	3
5	Professional Elective (PE-IV)	PE	3	0	0	3
6	Instrumentation lab- II	LC	0	0	3	1.5
7	VLSI Lab	LC	0	0	3	1.5
8	Project - Part I	PR	0	0	6	3
	Total Credits					**21**

IV Year - II Semester

S.No.	Subjects	Category	L	T	P	Credits
1	Professional Elective (PE-V)	PE	3	0	0	3
2	Open Elective (OE2)	OE	3	0	0	3
3	Project - Part II	PR	0	0	18	9
	Total Credits					**15**

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Professional Elective I
1. Quality and Reliability Engineering
2. EMI/EMC
3. Calibration and Standard
4. Digital System Design using HDL

Professional Elective II
1. Digital control systems
2. Virtual Instrumentation
3. Telemetry and Telecontrol
4. Digital IC Design

Professional Elective III
1. Embedded Systems
2. Analytical Instrumentation
3. Artificial Intelligence and Machine Learning
4. Analog IC Design

Professional Elective IV
1. Robotics & Automation
2. Optoelectronics & Laser Instrumentation
3. Industrial Internet of Things
4.Low power VLSI Design

Professional Elective V
1. Industrial data communication
2. Power plant Instrumentation
3. Instrumentation practices in industries
4. VLSI Testing & Testability

OPEN ELECTIVES FOR EIE:
Open Elective 1:
1. Data Mining
2. Power Electronics
3. MEMS and its applications
4. Artificial Neural Networks

Open Elective 2:
1. 3D Printing
2. Block chain Technology
3. Cyber Security & Cryptography

OPEN ELECTIVES OFFERED BY EIE:
OE 1 Principles of measurement and instrumentation
OE 2 Digital Sensors

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I Year - I Semester		L	T	P	C
		3	0	0	3
English (HS1101)					

Introduction

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

Course Objectives

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

Learning Outcomes

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

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

Unit-I:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications
Lesson-2: Deliverance by Premchandfrom "**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.

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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-II:

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

Lesson-2: Bosom Friend by Hira Bansodefrom "**The Individual Society",** Pearson Publications. (Non-detailed)

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

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

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

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

Grammar: Use of articles and zero article; prepositions.

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

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Unit-III:

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-IV:

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

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

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

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

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

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

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

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

Pronunciation: Contrastive Stress

Unit-V:

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

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

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

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

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

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

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

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

Pronunciation: Stress in compound words

Prescribed text books for theory:

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) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

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I Year - I Semester		L	T	P	C
		3	0	0	3
Mathematics-I (BS1101) **(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: (10 hrs)

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

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

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

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form.
Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

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

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^nV(x) – Method of Variation of parameters. Applications: LCR circuit, Simple Harmonic motion.

UNIT IV: Partial differentiation: (10 hrs.)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables. Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT V: Multiple integrals: (8 hrs.)

Double and Triple integrals – Change of order of integration – Change of variables.
Applications: Finding Areas and Volumes.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd 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, 10th Edition, Wiley-India.
2. **Joel Hass, Christopher Heil and Maurice D. Weir,** Thomas calculus, 14th Edition, Pearson.
3. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press, 2013.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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I Year - I Semester		L	T	P	C
		3	0	0	3
APPLIED CHEMISTRY (BS1106)					

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

Polymerization: -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_2-O_2, CH_3OH-O_2, 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 protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, special paints).

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

- **Explain** the theory of construction of battery and fuel cells.
- **Categorize** the reasons for corrosion and study some methods of corrosion control.

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UNIT III: MATERIAL CHEMISTRY

Part I : Non-elementalsemiconducting 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 their uses.
- **Understand** liquid crystals and superconductors.
- **Understand** the preparation of semiconductors.

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 computational chemistry
- **Understand** importance molecular machines

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.

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 Publication Co.

Reference Books:

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

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I Year - I Semester		L	T	P	C
		3	0	0	3
PROGRAMMING FOR PROBLEM SOLVING USING C (ES1101)					

COURSE OBJECTIVES:

The objectives of Programming for Problem Solving Using C are

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

UNIT-I

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

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

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

UNIT-II

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

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

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

UNIT-III

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

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

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

UNIT-IV

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

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

Processor Commands: Processor Commands

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UNIT-V

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers toFunctions, 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, 2nd edition , Pearson

REFERENCES:

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill
2. Programming in C, Ashok N. Kamthane, AmitKamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

COURSE OUTCOMES:

Upon the completion of the course the student will learn

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

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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

I Year - I Semester		L	T	P	C
		1	0	3	2.5
ENGINEERING DRAWING (ES1103)					

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

Unit-IV
Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.
Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

Unit-V
Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.
Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.
Computer Aided Design, Drawing practice using Auto CAD, creating 2D&3D drawings of objects using Auto CAD

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

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TEXT BOOKS:

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

REFERENCE BOOKS:

1. Engineering Drawing by K.L. Narayana& P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, 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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I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGLISH LAB (HS1102)					

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 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.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
APPLIED CHEMISTRY LAB (BS1107)					

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

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of copper (II) using standard hypo 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 Mg^{+2} presentin an antacid.
12. Determination of $CaCO_3$ present in an egg shell.
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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I Year - I Semester		L	T	P	C
		0	0	3	1.5
PROGRAMMING FOR PROBLEM SOLVING USING C LAB (ES1102)					

Course Objectives:

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

Exercise 1:

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

Exercise 2:

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

Exercise 3:

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

Exercise 4:

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

Exercise 5:

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

Exercise 6:

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

Exercise 7:

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

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.

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Exercise 9:

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

Exercise 10:

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

Exercise 11:

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

Exercise 12:

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

Exercise 13:

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

Exercise 14:

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

Exercise 15:

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

Exercise 16:

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

Course Outcomes:

By the end of the Lab, the student

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

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I Year - I Semester		L	T	P	C
		3	0	0	0
ENVIRONMENTAL SCIENCE (MC1101)					

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.

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-sports 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. -Public awareness.

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, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

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

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I Year - II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS - II (BS1202) **(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 Eigen vectors: (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: (10 hrs)

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.

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Singular values of a matrix, singular value decomposition (Ref. Book – 1).

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UNIT III: Iterative methods: (8 hrs)

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

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 $1/3^{rd}$ and $3/8^{th}$ 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^{rd} 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^{th} 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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I Year - II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS - III (BS1203) **(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 (without 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: **(8 hrs.)**

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: (10 hrs.)

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, 43rd 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, 10th Edition, Wiley-India.
2. **Dean. G. Duffy,** Advanced Engineering Mathematics with MATLAB, 3rd 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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I Year - II Semester		L	T	P	C
		3	0	0	3
APPLIED PHYSICS (BS1204)					

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 ofPhysical Opticsphenomena like Interference and Diffraction required to design instruments with higher resolution.
- Understand the physics of Semiconductors and their working mechanism for their utility in sensors.
- To impart the knowledge of materials with characteristic utility in appliances.

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 – Schröedinger Time Independent and Time Dependent wave equations – Particle in a potential box.

Unit Outcomes:

The students will be able to

- Explain the fundamental concepts of quantum mechanics.
- Analyze the physical significance of wave function.
- Apply Schrödinger's wave equation for energy values of a free particle.

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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.
- summarize various types of solids based on band theory.

UNIT-IV **(9hrs)**

SEMICONDUCTOR PHYSICS: Introduction– Intrinsic semiconductors - 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.

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 - Dielectic 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 di-electrics.
- interpret Lorentz field and Claussius- Mosotti relation in dielectrics.

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- 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 AjoyGhatak, 6th Edition McGraw Hill Education, 2017.
3. "Solid State Physics" by A.J.Dekker, Mc Millan Publishers (2011).

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I Year- II Semester		L	T	P	C
		3	0	0	3
NETWORK ANALYSIS(ES1209)					

UNIT – I

Introduction to Electrical Circuits: Network elements classification, Electric charge and current, Electric energyand 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)

A.C 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 DCexcitation, 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 ofcoupled circuits, Natural current, Dot rule of coupled circuits, conductively coupled equivalent circuits- problem solving.

UNIT – IV

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

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

UNIT – V

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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 2nd edition, Asia publishing house.
2. Basic Circuit Analysis by DR Cunninghan, 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 periods' waveforms.
- To understand the two port network parameters.
- To understand the properties of LC networks and filters.

COUSE OUTCOME:

- gain the knowledge on basic network elements.
- will analyze the RLC circuits behavior in detailed.
- 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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I Year - II Semester		L	T	P	C
		3	0	0	3
BASIC ELECTRICAL ENGINEERING (ES1211)					

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

Course Educational Objectives:

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

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

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

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

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

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

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

TEXT BOOKS:

1. Principles of Electrical Machines by V.K. Mehta & Rohit Mehta, S.Chand publications
2. Theory & performance of Electrical Machines by J.B.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,2nd edition
3. Basic Electrical Engineering by Nagsarkar,Sukhija, Oxford Publications,2nd edition

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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

I Year- II Semester		L	T	P	C
		0	0	2	1
ELECTRONIC COMPONENTS & MEASURING INSTRUMENTS WORKSHOP (ES1216)					

I. Identification of components
II. Laboratory equipment
III. Soldering practice
IV. PCB Layout
V. Testing of Components
VI. CRO
VII. fiber optical kit
VIII. various types of Transducers

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 regulators types.
- Testing of above components using Multi metros.

II. Laboratory Equipment:

A) Meters:-

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

B) Laboratory Function Generators and Audio Oscillators.
C) Power Supplies.
D) RF generators.
E) Different Types of Transformers.
(Power, AF, RF, etc..)

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III. Soldering practice

Tools kit including soldering iron
Tools Kit:

- Insulated nose player
- Insulated cutting player
- Screw driver kit
- Electrical tester
- Soldering iron, Lead, Flex

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

VII Acquaintance of fiber optical kit-Transmitter & receiver

VIII Acquaintance with various types of Transducers

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I Year- II Semester		L	T	P	C
		0	0	3	1.5
BASIC ELECTRICAL ENGINEERING LAB (ES1208)					

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 analyze 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 iun 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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I Year - II Semester		L	T	P	C
		0	0	3	1.5
APPLIED PHYSIC LAB(ES1205) **(Any 10 of the following listed 15 experiments)**					

LIST OF EXPERIMENTS:

1. Determination of wavelength of a source-Diffraction Grating-Normal incidence.
2. Newton's rings – Radius of Curvature of Plano - Convex Lens.
3. Determination of thickness of a spacer using wedge film and parallel interference fringes.
4. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
5. Energy Band gap of a Semiconductor p - n junction.
6. Characteristics of Thermistor – Temperature Coefficients
7. Determination of dielectric constant by charging and discharging method
8. Determination of resistivity of semiconductor by Four probe method.
9. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
10 Measurement of magnetic susceptibility by Gouy's method.
11. Dispersive power of diffraction grating.
12. Resolving Power of telescope
13. Resolving power of grating
14. Determination of Hall voltage and Hall coefficients of a given semiconductor using Hall effect.
15. Variation of dielectric constant with temperature.

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I Year - II Semester		L	T	P	C
		0	0	2	1
COMMUNICATION SKILLS LAB (HS1203)					

UNIT I:
Oral Activity: JAM, Hypothetical Situations, Self/Peer Profile
Common Errors in Pronunciation, Neutralizing 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- Gajendrea Singh Chauhan, SmitaKashiramka, Cengage Publications.

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I Year - II Semester		L	T	P	C
		0	0	2	1
ENGINEERING EXPLORATION PROJECT(PR1201)					

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 ill-defined 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 Stream4: 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-masking 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.

TASKS TO BE DONE:

Task 1: Everyone is a Designer

- Understand class objectives & harness the designer mindset

Task 2: The Wallet/Bag Challenge and Podcast

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

Task 3: Teams & Problems

- Start Design Challenge and learn about teams & problems through this
- Foster team collaboration, find inspiration from the environment and learn how to identify problems

Task 4: Empathizing

- Continue Design Challenge and learn empathy

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- Learn techniques on how to empathize with users
- Go to the field and interview people in their environments
- Submit Activity Card

Task 5: Ideating

- Continue Design Challenge and learn how to brainstorm effectively
- Encourage exploration and foster spaces for brainstorming
- Submit Activity Card

Task 6: Prototyping

- Continue Design Challenge and learn how to create effective prototypes
- Build tangible models and use them as communication tools
- Start giving constructive feedback to classmates and teammates
- Submit Activity Card

Task 7: Testing

- Finish Design Challenge and iterate prototypes and ideas through user feedback
- Evolve ideas and prototypes through user feedback and constructive criticism
- Get peer feedback on individual and group performance
- Submit Activity Card

Task 8:

- Final Report Submission and Presentation

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 Thinking Concept.

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 (Harper Business, 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 (frog design); 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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		3	**0**	**0**	**3**
ELECTRONIC DEVICES AND CIRCUITS					

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 understandthe 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 understandthe purpose of transistor biasing and its significance.
- Small signal equivalent circuit analysis of BJT and FET transistor amplifiers and compares 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(Stunt inductor), π-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 asan 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, characteristicsμ, g_m, r_d, parameters, MOSFET-types, construction, operation,characteristics, comparison between JFET and MOSFET.

UNIT- IV:

Transistor Biasing and Thermal Stabilization : Need for biasing, operating point, load line analysis,BJT biasing- methods, basic stability, fixed bias, collector to base bias, self bias, Stabilization against variations in V_{BE}, Ic, and β, Stability factors, (S,S',S''), Bias compensation, Thermal runaway, Thermal stability, FET Biasing- methods and stabilization.

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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 FETamplifiers.

TEXT BOOKS:
1.Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition,2007
2. Electronic Devices and Integrated Circuits – B.P. Singh, Rekha, Pearson publications, 2006
3. Electronics devices & circuit theory- Robert L.Boylestad and LouiNashelsky, 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 Circuits-K. Lal Kishore, BS Publications, Fourth Edition, 2016.
3. Electronic Devices and Circuits-Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, 4th Edition, 2008.

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
SIGNALS and SYSTEMS					

OBJECTIVES:

The main objectives of this course are given below:

- To study about signals andsystems.
- 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 andsystems.

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 complexfunctions. Related Problems.

UNIT–II:

FOURIER SERIES AND FOURIERTRANSFORM: Fourier series representation ofcontinuous 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 risetime.

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

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sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Passsampling, 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, 2ndEdn,1997
3. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2ndEdition,2007

REFERENCES:

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

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

SWITCHING THEORY AND LOGIC DESIGN

COURSE OBJECTIVES:

The main objectives of this course are given below:

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

BOOLEAN THEOREMS AND LOGIC OPERATIONS:

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

UNIT – II:

MINIMIZATION TECHNIQUES:

Minimization and realization of switching functions usingBoolean 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-a-head adder circuit, Design code converts using Karnaugh method and draw the complete circuit diagrams.

UNIT – III:

COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI &LSI:

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

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INTRODUCTION OF PLD's:
PLDs:PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

UNIT – IV:
SEQUENTIAL CIRCUITS I:
Classification of sequential circuits (synchronous and asynchronous), operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop toanother flip-flop. Design of 5ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift, register.Study the following relevant ICs and their relevant functions 7474,7475,7476,7490,7493,74121.

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

TEXT BOOKS:
1. Switching and finite automata theory Zvi.KOHAVI,Niraj.K. Jha 3rdEdition,Cambridge University Press.
2. Digital Design by M. MORRIS Mano, Michael D Ciletti,4th edition PHI publication.
3. Switching theory and logic design by Hill and Peterson**,** Mc-Graw Hill TMH edition.

REFERENCES:
1. Fundamentalsof Logic Design by Charles H. Roth Jr, Jaico Publishers
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.
5. TTL 74-Series data book.

OUTCOMES:
At the end of this course the student will able to:
- 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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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

II Year- I Semester		L	T	P	C
		3	0	0	3
TRANSDUCER TECHNOLOGY					

OBJECTIVES:
The main objectives of this course are:

- Learn and Understand different Functional elements of an Instrument and various sensors.
- Learn and Understand different methods for measurement of Velocity, Acceleration, Force and Torque.
- Compare different pressure measurement techniques.
- Learn and Understand various parameters like flow, Temperature and radiation

UNIT-I:
INTRODUCTION TO MEASUREMENT SYSTEMS: Functional Elements of an Instrument, Sensor Classification – Passive – R, L, C types and Active sensors. General Input Output Configuration, Methods of Correction.
GENERALIZED PERFORMANCE CHARACTERISTICS OF INSTRUMENTS: Static characteristics and Dynamic characteristics of a measurement system, Calibration and standards, Errors in Measurement, Statistical analysis. Zero, first and second order system and their response.

UNIT – II:
VELOCITY, ACCELERATION, FORCE AND TORQUE MEASUREMENT:
Relative velocity – Translational and Rotational velocity measurement – Revolution counters and Timers – Magnetic and Photoelectric pulse counting, stroboscopic methods - Accelerometers of different types - Gyroscopes, piezoelectric sensors. Force measurement – Different methods –Torque measurement – Dynamometers- Gyroscopic Force and Torque Measurement – Vibrating wire Force transducer

UNIT – III:
PRESSURE MEASUREMENT: Basics of Pressure measurement – Deadweight Gages and Manometers types – Force-Balance and Vibrating Cylinder Transducers – High- and Low-Pressure measurement – McLeod Gauge, Knudsen Gauge, Momentum Transfer Gauges, Thermal Conductivity Gauges, Ionization Gazes, Dual Gauge Techniques.

UNIT – IV:
FLOW MEASUREMENT: Head type, Area type (Rota meter), electromagnetic type, Positive displacement type, mass flow meter, ultrasonic type, vertex shedding type, Hotwire anemometer type, Laser Doppler Velocity meter.

UNIT – V:
TEMPERATURE, RADIATION AND OTHER PARAMETERS MEASUREMENTS: Resistive temperature detectors (RTDs), Thermistors, Thermocouples. Radiation Fundamentals, Total radiation pyrometer, Optical Pyrometer, Liquid Level: Resistance gauge, capacitance gauge, ultrasonic method, Float type. Humidity measurement, Strain-Strain gauge, Displacement-LVDT.

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TEXT BOOKS:

1. Measurement Systems – Applications and Design – by Doeblin E.O., 4/e, McGraw Hill International, 1990.
2. Principles of Industrial Instrumentation – Patranabis D. TMH. End edition 1997.

REFERENCES:

1. Process Instruments and Control Handbook – by Considine D.M., 4/e, McGraw Hill International, 1993.
2. Mechanical and Industrial Measurements – by Jain R.K., Khanna Publishers, 1986.
3. Instrument Technology, vol. I – by Jones E.B., Butterworths, 1981.

OUTCOMES:

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

- Classify different sensors.
- Analyze the performance characteristics of instruments.
- Identify the types of flow and use different transducers for flow measurement.
- Identity the sensors for Velocity, Acceleration, Force and Torque Measurement.
- Analyze the sensors for temperature, radiation and humidity measurements.

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II Year - I Semester		L	T	P	C
		3	0	0	3
DATA STRUCTURES					

OBJECTIVES:
The main objectives of this course are:

- Learn and Understand Exploring basic data structures such as stacks and queues.
- Learn and understanda variety of data structures such as hash tables, search trees, tries, heaps, graphs.
- Perform sorting and compare different pattern matching algorithms

UNIT – I:
INTRODUCTION TO DATA STRUCTURES:Abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks-Operations, array and linked representations of stacks, stack applications, Queues-operations, array and linked representations.

UNIT- II:
DICTIONARIES:linear list representation, skip list representation, operations - insertion, deletion and searching. Hash Table Representation: hash functions, collision resolution-separate chaining, open addressing-linear probing, quadratic probing, double hashing, rehashing, extendible hashing.

UNIT-III:
SEARCH TREES: Binary Search Trees, Definition, Implementation, Operations- Searching, Insertion and Deletion, AVL Trees, Definition, Height of an AVL Tree, Operations – Insertion, Deletion and Searching, Red –Black, Splay Trees.

UNIT- IV:
GRAPHS: Graph Implementation Methods. Graph Traversal Methods. Sorting: Heap Sort, External Sorting- Model for external sorting, Merge Sort.

UNIT-V:
PATTERN MATCHING AND TRIES: Pattern matching algorithms-Brute force, the Boyer –Moore algorithm, the Knuth-Morris-Pratt algorithm, Standard Tries, Compressed Tries, Suffix tries.

TEXTBOOKS:

1. Fundamentals of Data Structures in C, 2nd Edition, E. Horowitz, S. Sahni and Susan Anderson Freed, Universities Press.
2. Data Structures using C – A. S. Tanenbaum, Y. Langsam, and M.J. Augenstein, PHI/Pearson Education.

REFERENCES:

1. Data Structures: A Pseudocode Approach with C, 2nd Edition, R. F. Gilberg and B.A. Forouzan, Cengage Learning.

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

- Select the data structures that efficiently model the information in a problem.
- Assess efficiency trade-offs among different data structure implementations or combinations.
- Implement and know the application of algorithms for sorting and pattern matching.
- Design programs using a variety of data structures, including hash tables, binary and general tree structures, search trees, tries, heaps, graphs, and AVL-trees.

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II Year - I Semester		L	T	P	C
		3	0	0	3
MANAGERIAL ECONOMICS & FINANCIAL ANALYSIS					

Course Objectives:
The main objectives of this course are:

- 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.

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)

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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(payback period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index).

REFERENCES:

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

Course Outcomes:

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

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- 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 Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

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II Year - I Semester		L	T	P	C
		0	0	3	1.5
ELECTRONIC DEVICES AND CIRCUITS LAB					

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 (Colour Codes), 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 passivecomponents.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Multimeter, Function Generator, Regulated Power Supply andCRO.

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

1. P-N Junction DiodeCharacteristics
   Part A: Germanium Diode (Forward bias& Reverse bias)
   Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics
   Part A: V-ICharacteristics
   Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)
   Part A: Half-waveRectifier
   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: DrainCharacteristics
   Part B: Transfer Characteristics
6. SCRCharacteristics
7. UJTCharacteristics
8. TransistorBiasing
9. CRO Operation and itsMeasurements
10. BJT-CEAmplifier
11. Emitter Follower-CCAmplifier
12. FET-CSAmplifier

Equipment required:

1. Regulated Powersupplies
2. Analog/Digital Storage Oscilloscopes
3. Analog/Digital FunctionGenerators
4. DigitalMulti-meters
5. Decade RésistanceBoxes/Rheostats
6. Decade CapacitanceBoxes
7. Ammeters (Analog orDigital)
8. Voltmeters (Analog orDigital)
9. Active & Passive ElectronicComponents

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II Year -I Semester		L	T	P	C
		0	0	3	1.5
DATA STRUCTURES LAB					

LIST OF EXPERIMENTS:

1.Write program that uses functions to perform the following operations on singly linked list
   i) Creation ii) Insertion iii) Deletion iv) Traversal
2.Write program that uses functions to perform the following operations on doubly linked list
   i) Creation ii) Insertion iii) Deletion iv) Traversal
3.Write program that uses functions to perform the following operations on circular linked list
   i) Creation ii) Insertion iii) Deletion iv) Traversal
4. Write a program that implement stack (its operations) using
   i) Arrays ii) Pointers
5. Write a program that implement Queue (its operations) using
   i) Arrays ii) Pointers
6. Write a program that implements the following sorting methods to sort a given list of integers in ascending order
   i) Bubble sort ii) Selection sort iii) Insertion sort
7. Write a program that use both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers:
   i) Linear search ii) Binary search
8. Write a program to implement the tree traversal methods.
9. Write a program to implement the graph traversal methods.
10. Write a C program for implementing Knuth-Morris-Pratt pattern matching algorithm.

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II Year - I Semester		L	T	P	C
		3	0	0	0
CONSTITUTION OF INDIA					

Course Objectives:

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

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 Indianconstitution
- Apply the knowledge on directive principle of statepolicy
- Analyze the History, features of Indianconstitution
- Evaluate Preamble Fundamental Rights andDuties

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, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers andFunctions;

Learning outcomes:-

After completion of this unit student will

- Understand the structure of Indiangovernment
- Differentiate between the state and centralgovernment
- Explain the role of President and PrimeMinister
- Know the Structure of supreme court and Highcourt

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 stategovernment
- Analyze the role Governor and ChiefMinister
- Explain the role of stateSecretariat
- Differentiate between structure and functions of statesecretariat

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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

UNIT-IV

A.Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: 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 localAdministration
- Compare and contrast district administration role andimportance
- Analyze the role of Myer and elected representatives ofMunicipalities
- Evaluate Zillapanchayat block levelorganisation

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 applyknowledge
- Contrast and compare the role of Chief Election commissioner andCommissiononerate
- Analyze role of state electioncommission
- Evaluate various commissions of viz SC/ST/OBC andwomen

References:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd..NewDelhi
2. SubashKashyap, Indian Constitution, National BookTrust
3. J.A. Siwach, Dynamics of Indian Government &Politics
4. D.C. Gupta, Indian Government andPolitics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government andPoliticsHans
7. J. Raj IndianGovernmentandPolitics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd..NewDelhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press2012

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resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. 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 democraticIndia.
- Understand the functioning of three wings of the government ie.,executive, legislative andjudiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and localself-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustainingdemocracy.
  1. Know the sources, features and principles of IndianConstitution.
  2. Learn about Union Government, State government and itsadministration.
  3. Get acquainted with Local administration and PachayatiRaj.
  4. Be aware of basic concepts and developments of HumanRights.
  5. Gain knowledge on roles and functioning of ElectionCommission

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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
ELECTRONIC CIRCUIT ANALYSIS					

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- π common emitter transistor model, Hybrid π conductance's, Hybrid π capacitances, validity of hybrid π 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**, c**ascaded transistor amplifier and its analysis, analysis of two stage RC coupled amplifier, high input resistance transistor amplifier circuits and their analysis-Darlington pair amplifier, Cascode amplifier, Boot-strap emitter follower, Differential amplifier using BJT.

UNIT -III:

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

UNIT-IV:

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

UNIT-V:

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Power Amplifiers: Classification of amplifiers(A to H), Class A power Amplifiers, Class B Push-pull amplifiers, Complementary symmetry push pull amplifier, Class AB power amplifier, Class-C power amplifier, Thermal stability and Heat sinks.
Tuned Amplifiers: Introduction, Q-Factor, small signal tuned amplifier, capacitance 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, McGraw-Hill, 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.

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 multi stage 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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II Year - II Semester		L	T	P	C
		3	0	0	3

ELECTROMAGNETIC WAVES AND TRANSMISSION LINES

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 pointing theorem
- Wave characteristics in different media for normal and oblique incidence
- Implement various concepts of transmission lines and impedance measurements

UNIT-I:
Transmission Lines-I: Types, Parameters, T&π Equivalent Circuits, Transmission Line Equations,Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and GroupVelocities, 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; ImpedanceTransformations,λ/8,λ/4 andλ /2 Lines – Smith Chart – Construction and Applications, Quarter wave transformer,Single Stub Matching, Illustrative Problems.

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

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

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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 Education 2006
2. Engineering Electromagnetic – William H. Hayt Jr. and John A. Buck, TMH, 7th ed., 2006.
3. Electromagnetic Field Theory and Transmission Lines: G SasiBhushanaRao, Wiley India 2013.
4. Networks,LinesandFieldsJohn D. Ryder,Second Edition, PearsonEducation, 2015.

OUTCOMES:

At the end of this course the student can able to

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

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II Year - II Semester		L	T	P	C
		3	0	0	3
CONTROL SYSTEMS					

OBJECTIVES:
The main objectives of this course are:

- 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 necessaryanalysis.
- To develop the acquaintance in analyzing the system response in time-domain and frequency domain in terms of various performanceindices.
- To analyze the system in terms of absolute stability and relative stability by differentapproaches.
- To design different control systems for different applications as per givenspecifications.
- 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 100
ROOT LOCUS TECHNIQUE: The root locus concept - construction of root loci-effects of adding poles and zeros to G(s)H(s) on the root loci.

UNIT-IV
FREQUENCY RESPONSE ANALYSIS: Introduction, Correlation between time and frequency response, Polar Plots, Bode Plots, Nyquist Stability Criterion.

UNIT-V
CLASSICAL CONTROL DESIGN TECHNIQUES: Compensation techniques -Lag, Lead, Lead-Lag Controllers design infrequency Domain, PID Controllers. State Space Analysis of Continuous Systems Concepts of state, state variables and state model, derivation of state models from block

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diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and its Properties –Concepts of Controllability and Observability.

TEXTBOOKS:

1. Automatic Control Systems 8th edition– by B. C. Kuo 2003–John Wiley and son's.
2. Control Systems Engineering – by I. J. Nagrath and M. Gopal, New Age International(P) Limited, Publishers, 2nd edition.

REFERENCES:

1. Modern Control Engineering – by Katsuhiko Ogata – Prentice Hall of India Pvt. Ltd., 3rd edition, 1998.
2. Control Systems by A. Nagoorkani, RBA publications,3 Edition.
3. Control Systems by A. Anand Kumar, PHI, 2 Edition.

OUTCOMES:

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

- This course introduces the concepts of feedback and its advantages to various controlsystems.
- 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 alsointroduced.

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II Year - II Semester		L	T	P	C
		3	0	0	3
PYTHON PROGRAMMING					

OBJECTIVES:
The main objectives of this course are:

- To develop a basic understanding of programming and Python programming language.
- Learn to apply the programming concepts to fundamental problems.
- To get exposure to various problems solving approaches.
- To acquire knowledge about Scripting Language.
- To expose students to application development and prototyping using Python.

UNIT-I:
INTRODUCTION: History of Python, Need of Python Programming, Applications Basics of Python Programming Using the REPL(Shell), Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation. Types - Integers, Strings, Booleans.

UNIT-II:
OPERATORS AND EXPRESSIONS: Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations
Data Structures Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions.

UNIT-III:
CONTROL FLOW: - if, if-elseif-else, for, while, break, continue, pass.
Functions - Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions(Function Returning Values), Scope of the Variables in a Function - Global and Local Variables.

UNIT-IV:
MODULES: Creating modules, import statement, from import statement, name spacing,Python packages, Introduction to PIP, Installing Packages via PIP, Using Python Packages Error and Exceptions: Difference between an error and Exception, Handling Exception, try except block, Raising Exceptions, User Defined Exceptions, Object Oriented Programming OOP in Python: Classes, 'self-variable', Methods, Constructor Method, Inheritance, Overriding Methods, Data Hiding,

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UNIT-V:
BRIEF TOUR OF THE STANDARD LIBRARY: Operating System Interface - String Pattern Matching, Mathematics, Internet Access, Dates and Times, Data Compression, Multi-Threading, GUI Programming, Turtle Graphics
TESTING: Why testing is required? Basic concepts of testing, Unit testing in Python, Writing Test cases, Running Tests.

TEXT BOOKS:
1. Python Programming: A Modern Approach, VamsiKurama, Pearson.
2. Learning Python, Mark Lutz, Orielly.

REFERENCES:
1. Think Python, Allen Downey, Green Tea Press
2. Core Python Programming, W.Chun, Pearson.
3. Introduction to Python, Kenneth A. Lambert, Cengage

OUTCOMES:
At the end of this course the student can able to:
- Analyze the programming concepts with an interpreted Language.
- Build software applications for real needs.
- Acquire knowledge for prior Introduction to testing software
- Making Software easily right out of the box.

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II Year - II Semester		L	T	P	C
		3	0	0	3
BASICS OF SENSOR TECHNOLOGY					

OBJECTIVES:
The main objectives of this course are:

- Acquire knowledge on: Measuring Parameters and Measuring Systems.
- To Effects of Environment, characteristics and parameters to be considered for designing an instrument.

UNIT-I:
INSTRUMENT DEFINITION & BLOCKS, Types of instruments: Manual and Automatic, Self-generating and Power operated, Proximity and non-Proximity, Analogue and Digital types, Typical application of instrument systems, Basic control systems
MEASURES OF LOCATION AND DISPERSION: Arithmetic mean,Mode, Median, Standard deviation(SD), Properties of SD, Uses of SD;
APPLICATION: Measuring different parameters using different types of instruments(E.g. Psychrometer for thermal comfort levels, Mercury and digital barometer, Analog and Digital Weighting Machines, Body temperature using digital and analog thermometers).

UNIT-II:
STATIC CHARACTERISTICS: Range, Resolution, Sensitivity, Accuracy, Uncertainty, Response time, Repeatability, Hysteresis, Linearity, Reproducibility, Threshold, Precision, Operating environment.
DYNAMIC CHARACTERISTICS: Formulation of system equations, Harmonics, Transient and Random input, signals compensations, Order of instruments - Zero, first, Second and Nth order.
APPLICATION: Selecting an instruments/Sensor for a requirement (E.g.: Sensors for Weather monitoring, Sensors for Smoke/Fire detection, Sensors for Water Quality measurements)

UNIT-III:
STANDARDIZATIONSof Mechanical measurements (mass, displacement, Velocity, acceleration, torque, flow, level, temperature, pressure etc.,) and Electrical measurements, Specification of instruments.
APPLICATION: Determine the specifications of instrument/sensors based on measurement requirement. (E.g.: Flow sensors for HVAC systems, Carbon Dioxide sensors for Indoor Air Quality monitoring)

UNIT-IV:
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.
APPLICATIONS: Periodic laboratory and field calibrations of sensors (E.g.: Temperature and humidity sensors, Carbon dioxide sensors, Level sensors)

UNIT-V:
ERROR ANALYSIS: Errors as uncertainties, Sources of errors and estimating errors – Incomplete definition of measurement, Failure for account for factor, Environmental factors, failure to calibrate, Physical variations, parallax errors, Errors when reading scales, Errors of digital instruments. Estimating

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errors for a single measurement and repeated measurements, standard error, significant figures. Reporting errors – number of significant digits, absolute and relative errors, Calculations with errors – Sums and differences, products and quotients, multiplying by constant, powers, Propagation of error, upper and lower bound method.

APPLICATIONS: Estimating the errors from calibration data, Estimating error propagation during design of interfacing circuits.

TEXTBOOKS:

1. Measurement and Instrumentation Principles - Morris, Alan S.
2. Mechanical Measurements – Beckwith, Marangoni, Lienhard.
3. Measurement of systems - Application and design - Earnest O. Doeblin.

REFERENCES:

1. Electronic Instrumentation and Measurement Technique - Albert D Helfrick.
2. An Introduction to Error Analysis by John R. Taylor.

OUTCOMES:

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

- Select an instrument for a measurement.
- Use the instrument without errors, collect data and record observations.
- Use statistical methods to summarize and report data.
- Perform calibration for the instruments for estimating errors

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

ELECTRONIC MEASUREMENTS AND INSTRUMENTATION

OBJECTIVES:
The main objectives of this course are:

- Learn and understandfunctioning 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 understandthe use of various measuring techniques for measurement of different physical parameters using different classes of transducers.

UNIT-I:
PERFORMANCE CHARACTERISTICS OF INSTRUMENTS,
STATICCHARACTERISTICS: Accuracy, Resolution, Precision, expected value, Error, Sensitivity. Dynamic Characteristics; speed of response, Fidelity, Lag and Dynamic error. Types of errors in measurements and their analysis. Design of multi-range AC, DC meters (voltmeter &ammeter) and ohmmeter (series &shunt type) using D'arsonval movement. True rms meter.

UNIT-II:
SPECIFICATIONS AND DESIGNING ASPECTS OF SIGNAL GENERATORS- AF sine and square wave signal generators, Function Generators, Random noise generators, Arbitrary waveform generators. Wave Analyzers, Harmonic Distortion Analyzers, Spectrum Analyzers, Digital Fourier Analyzers.

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

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

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

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TEXTBOOKS:

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

REFERENCES:

1. Electronic Instrumentation & Measurements - David A. Bell, PHI, Edition.
2. Electrical and Electronic Measurement and Instrumentation A.K. Sawhney. Dhanpat Rai & Co.

OUTCOMES:

At the end of this course the student can 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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II Year - II Semester		L	T	P	C
		0	0	3	1.5
ELECTRONIC CIRCUIT ANALYSIS LAB					

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 giventransistor.
2. Voltage-Series FeedbackAmplifier
3. Current-Shunt FeedbackAmplifier
4. RC Phase Shift/Wien BridgeOscillator
5. Hartley/ ColpittsOscillator
6. Two Stage RC CoupledAmplifier
7. Darlington Pair Amplifier
8. Bootstrapped Emitter Follower
9. Class A Series-fed PowerAmplifier
10. Transformer-coupled Class A PowerAmplifier
11. Class B Push-Pull PowerAmplifier
12. Complementary Symmetry Class B Push-Pull PowerAmplifier
13. Single Tuned VoltageAmplifier
14. Double Tuned VoltageAmplifier

Equipment required:

Software:

i. Multisim/ Equivalent Industrial Standard Licensed simulation softwaretool.
ii. Computer Systems with requiredspecifications

Hardware Required:

1. Regulated Powersupplies
2. Analog/Digital Storage Oscilloscopes
3. Analog/Digital FunctionGenerators
4. DigitalMultimeters
5. Decade RésistanceBoxes/Rheostats
6. Decade CapacitanceBoxes
7. Ammeters (Analog orDigital)
8. Voltmeters (Analog orDigital)
9. Active & Passive ElectronicComponents

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II Year - II Semester		L	T	P	C
		0	0	3	1.5
INSTRUMENTATION LAB - 1					

(Minimum 10 experiments should be conducted)

1. RTD – characteristics
2. Thermocouple – characteristics
3. LVDT – characteristics.
4. Displacement measurement using inductive pickup/ capacitive pickup.
5. Inductive and capacitive transducers.
6. RPM indicator using Strobotron/Gyroscope
7. Acceleration transducer.
8. Pressure measurement using Bourdon tube
9. Piezoelectric transducer.
10. Measurement of R, L and C using bridge circuits.
11. Measurement of Level using Capacitance Transducer.
12. Measurement of Humidity.
13. Measurement of strain using strain gauge

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III Year- I Semester		L	T	P	C
		3	0	0	3
SIGNAL CONDITIONING CIRCUITS					

OBJECTIVES:
The main objectives of this course are:

- Learn and understand signal conditioning for Resistive, Inductive and Capacitive variations sensors.
- Identify different elements of signal conditioning circuits.
- Able to identify various signal conditioning circuits for self-generating and other Sensors.

UNIT-I:
SIGNAL CONDITIONING FOR RESISTIVE SENSORS: Measurement of resistance, Voltage dividers - amplifiers for voltage dividers, wheat stone bridge- balance measurements-deflection measurements- sensitivity, linearity, analog linearization of resistive sensor bridges. Grounding and Isolation, sensor bridge calibration and compensation. Kelvin Bridge.

UNIT-II:
SIGNAL CONDITIONING FOR INDUCTIVE VARIATION SENSORS: Problems and alternatives, ac bridges - measurement of inductance – Hey Bridge, Maxwell's bridge, Anderson Bridge. carrier amplifiers and coherent detection – fundamentals and structure, application to the LVDT, variable oscillators, resolver - to - digital and digital – to - resolver converters.

UNIT-III:
SIGNALCONDITIONING FOR CAPACITIVE VARIATIONSENSORS: Measurement of Capacitance - Schering Bridge, DeSautyBridge. Specific signal conditioners for capacitive sensors. Phase sensitive detectors for capacitive sensors, sensitivity, linearity, capacitive bridge analog linearization.

UNIT-IV:
ELEMENTS OF SIGNAL CONDITIONING CIRCUITS:
Inverting and non-inverting amplifiers, difference amplifier, integrator and differentiator circuits, V-to-I and I-to-V converters, instrumentation amplifier, Log and Anti log amplifiers, Schmitt Trigger, Comparators, Multivibrators, 555 timer, Precision rectifiers. Active filters, interference types and reduction.

UNIT-V:
SIGNAL CONDITIONING CIRCUITS FOR SELF-GENERATING AND OTHER SENSORS: Chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.
Signal Conditioning Circuits for Thermometers based on semiconductor junctions- Magneto diodes – Photodiodes-Sensors based on MOSFET Transistors-Charge-Coupled and CMOS Image Sensors-Fiber Optic Sensors and Ultrasonic based sensors.

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TEXT BOOKS:

1. Sensors and Signal Conditioning: Ramon PallásAreny, John G. Webster; 2nd edition, John Wiley and Sons,2000.
2. Sensors and Transducers – D. Patranabis, TMH 2003

REFERENCES:

1. Instrument Transducers – An Introduction to Their Performance and Design – by Herman K.P. Neubrat, Oxford University Press.
2. Measurement System: Applications and Design – by E.O. Doeblin, McGraw Hill Publications.
3. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987

OUTCOMES:

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

- Measure Resistance of a circuits using different methods.
- Apply different methods for measurement of Inductance and Capacitance.
- Analyze formulate and select suitable sensor for a given application.
- Apply knowledge of signal conditioning circuits to design optical and other transducers signal conditioning.

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III Year- I Semester		L	T	P	C
		3	0	0	3
INTEGRATED CIRCUITS AND APPLICATIONS					

OBJECTIVES:
The main objectives of this course are given below:

- 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: InternalBlock 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, ACamplifier, 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, 2nd Edition, 2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.
3. Linear Integrated Circuits by Salivahan-3rd-Edition, McGraw Hill,2018

REFERENCES:

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma;SK Kataria& Sons; 2nd Edition,2010
2. Operational Amplifiers & Linear Integrated Circuits–R.F. Coughlin& Fredrick Driscoll, PHI, 6th Edition, 2000.
3. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition,2011.
4. Linear Integrated Circuits, by Ganesh Babu T.R and Suseela B. Scitech, 5th -Edition, 2014.

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

- 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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III Year- I Semester		L	T	P	C
		3	0	0	3
MICROPROCESSOR AND MICROCONTROLLERS					

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

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TEXTBOOKS:

1. Microprocessors and Interfacing – Programming and Hardware by Douglas V Hall, SSSP Rao, Tata McGraw Hill Education Private Limited, 3rd Edition.
2. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2011 2-Edition.
3. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors by Joseph You

REFERENCES:

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.
2. Cortex -M3 Technical Reference Manual

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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		3	**0**	**0**	**3**
PROCESS CONTROL INSTRUMENTATION					

OBJECTIVES:

The main objectives of this course are:

- Identify and monitor process parameters of various processes.
- Understand the principles of controllers, degrees of freedom, and control valves.
- Recognize these principles written in form of mathematical equations for various control applications.
- Apply these equations to analyze problems by making good assumptions and learn systematic engineering method to solve practical process control problems.

UNIT-I:

PROCESS DYNAMICS: Process variables – Load variables – Dynamics of simple pressure, flow, level and temperature process – interacting and non-interacting systems – continuous and batch process – self-regulation – Servo and Regulator operation - problems.

UNIT-II:

CONTROL ACTIONS AND CONTROLLERS AND TYPES OF CONTROLLERS: BASIC control actions -characteristics of two position, three position, Proportional, Single speed floating, Integral and Derivative control modes – PI, PD, PID control modes – Problems -types of controllers - Pneumatic, Hydraulic and Electronic Controllers to realize various control actions.

UNIT- III:

CONTROLLER SETTINGS AND TUNING OF CONTROLLERS: Evaluation criteria – 1/4th decay ratio, IAE, ISE, ITSE, ITAE - determination of optimum settings for mathematically described process using time response and frequency response-tuning of controllers- process curve reaction method – continuous oscillation method – damped oscillation method –problems.

UNIT-IV:

FINAL CONTROL ELEMENTS AND CONTROL VALVES: I/P Converter, P/I converter - pneumatic, electric and hydraulic actuators – valve Positioned - Control valves – characteristic of control valves – valve body – Globe, Butterfly, diaphragm, Ball valves – Control valve sizing – Cavitation, flashing - problems.

UNIT-V:

MULTILOOP CONTROL SYSTEM: Feed forward control – Feed Forward Feedback Controller (FFFBC) – Ratio control – Cascade control – Split range – Multivariable control and examples from distillation column, Boiler system and heat exchanger.

TEXT BOOKS:

1. Automatic Process Control – by Eckman D.P., Wiley Eastern Ltd., New Delhi, 1993.

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2. Process Control Instrumentation technology by CurtisD.Johnson, 8th-Edition PHI Publishers.

REFERENCES:

1. Chemical Process Control: An introduction to Theory and Practice – by Stephanopoulos, Prentice Hall, New Delhi,1999
2. Process Control, Third Edition – Liptak B.G., Chilton Book Company, Pennsylvania, 1995
3. Process control – by Pollard A., Heinemann Educational Books, London,1971.
4. Process Control – Harriott P., TMH,1991.

OUTCOMES:

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

- Apply fundamental knowledge of mathematics to modeling and analysis of fluid flow, level, pressure, temperature problems.
- Conduct experiments in pipe flows and open-channel flows and interpreting data from model studies to prototype cases. Documenting them in engineering reports.
- Understand the possible disasters caused by an incorrect Design/Analysis in hydraulic, pneumatic engineering system.
- Apply multiloop control systems in various process industries.

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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

III Year- I Semester		L	T	P	C
		3	0	0	3
QUALITY AND RELIABILITY ENGINEERING (PROFESSIONAL ELECTIVE – I)					

OBJECTIVES:

The main objectives of this course are:

- The aim of this course is to provide students with a basic understanding of the approaches and techniques to assess and improve process and/or product quality and reliability.
- The objectives are to introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring.
- To understand techniques of modern reliability engineering tools.

UNIT-I:

QUALITY VALUE AND ENGINEERING– quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design, quality costs – quality improvement.

UNIT-II:

Statistical process control $\overline{X}$, R, p, c charts, other types of control charts, process capability, process capability analysis, process capability index. (SQC tables can be used in the examination).

UNIT-III:

Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans.

UNIT-IV:

Loss function, tolerance design – N type, L type, S type; determination of tolerance for these types. Online quality control – variable characteristics, attribute characteristics, parameter design.

Quality function deployment – house of quality, QFD matrix, total quality management concepts. Quality information systems, quality circles, introduction to ISO 9000 standards.

UNIT-V:

Reliability – Evaluation of design by tests - Hazard Models, Linear, Rayleigh, Weibull. Failure Data Analysis, reliability prediction based on Weibull distribution, Reliability improvement.

Reliability of series, parallel, standby systems & complex systems, Reliability prediction and system effectiveness.

Maintainability, availability, economics of reliability engineering, replacement of items, maintenance costing and budgeting, reliability testing.

TEXT BOOKS:

1. Statistical Quality Control: A Modern Introduction Montgomery Wiley 7th Edition.
2. 'Reliability Engineering', E. Bala Guruswamy, Tata McGraw Hill.
3. Quality Engineering in Production SystemsG Taguchi, - McGraw Hill.

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REFERENCES:

1. Quality planning & Analysis, Frank.M. GrynaJr. Jurans McGraw Hill.
2. Reliability Engineering, LS Srinath Affiliated East West Pvt. Ltd.,
3. Quality and Performance Excellence: James R Evans, Cengage learning

OUTCOMES:

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

- Understand quality and reliability concept, beware of some basic techniques for quality improvement, and acquire fundamental knowledge of statistics and probability.
- Apply control charts to analyze and improve the process quality.
- Design a simple sampling plan, construct its OC curve and evaluate its effectiveness on a given sampling process

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		3	**0**	**0**	**3**
EMI / EMC **(PROFESSIONAL ELECTIVE – I)**					

OBJECTIVES:

The main objectives of this course are:

- Student shall be able to understand the root causes for Electromagnetic Noise (EMI), its sources.
- Shall be able to understand the effects of EMI and the required precautions to be taken/to be discussed with his peer group.
- Shall be able to understand the different measurement techniques of EMI (for conducted and normal) and their influences in detail.

UNIT-I:

NATURAL AND NUCLEAR SOURCES OF EMI / EMC: Introduction, Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI / EMC, Natural and Nuclear sources of EMI.

UNIT-II:

EMI FROM APPARATUS, CIRCUITS AND OPEN AREA TEST SITES: Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter modulation, cross talk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Open area test sites and measurements.

UNIT-III:

RADIATED AND CONDUCTED INTERFERENCE MEASUREMENTS: Anechoic chamber, TEM cell, GH TEM Cell, characterization of conduction currents / voltages, conducted EM noise on power lines, conducted EMI from equipment, Immunity to conducted EMI detectors and measurements.

UNIT-IV:

ESD, GROUNDING, SHIELDING, BONDING AND EMI FILTERS: Principles and types of grounding, shielding and bonding, characterization of filters, power lines filter design. ESD, Electrical fast transients / bursts, electrical surges.

Introduction, EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, opto-isolators, Transient and Surge Suppression Devices.

UNIT-V:

EMC STANDARDS- NATIONAL / INTERNATIONAL: Introduction, Standards for EMI and EMC, MIL-Standards, IEEE/ANSI standards, CISPR/IEC standards, FCC regulations, Euro norms, British Standards, EMI/EMC standards in JAPAN, Conclusions.

TEXT BOOKS:

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1. Engineering Electromagnetic Compatibility by Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 – 9.

REFERENCES:

1. Introduction to Electromagnetic Compatibility, NY, John Wiley, 1992, by C.R. Pal.

OUTCOMES:

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

- Distinguish effects of EMI and counter measures by EMC-techniques.
- Apply the knowledge gained in selecting proper gadget/device/appliance/system, as per EMC-norms specified by regulating authorities.
- Choose career in the fields of EMI/EMC as an Engineer/Researcher/Entrepreneur in India/abroad.

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		3	**0**	**0**	**3**
CALIBRATION AND STANDARD (PROFESSIONAL ELECTIVE I)					

OBJECTIVES:

The main objectives of this course are:

- Learn and understand structure and use of a measurement system.
- Able to learn and understand various components of a calibration system.
- Able to describe the basic attributes of making good measurements.
- Able to learn and understand the units of measure and various instruments used in parameters measurements.

UNIT-I:

STANDARDS: Standards, Definition of standard units. International standards. Primary standards. Secondary standards. Working standards. Voltage standard-primary standard-saturated Weston cell, secondary standard-unsaturated Weston cell, Zener diode laboratory standard. Resistance standard. Current standard. Capacitance standard-primary-vacuum and gas filled, secondary-solid dielectric, ceramic capacitor. Inductance standard-mutual inductance-Campbell primary standard, self-inductance standard. Time and frequency standards- atomic standards-caesium beam standard, hydrogen maser standard, Rubidium vapour standard, quartz crystal standard.

UNIT-II:

CALIBRATION: Define calibration, Principle of calibration, control of calibration environment, calibration chain and traceability, calibration records. Calibration accuracy versus installed accuracy.
Testing and calibration. Measurement reliability. Primary calibration, Secondary calibration. Direct calibration. Indirect calibration. Routine calibration. Calibration curve, Static calibration. Dynamic calibration, Self-calibration requirements.

UNIT-III:

CALIBRATION EXPERIMENT AND EVALUATION OF RESULTS: Calibration of a DC voltmeter, DC ammeter, Ohm meter and an Oscilloscope.

UNIT-IV:

CALIBRATION OF PRESSURE, FLOW, TEMPERATURE AND TRANSDUCERS:
Calibration of transducers- pressure- calibration and testing by dead weight tester, frequency response tester, shock tube. Temperature- international practical temperature scales.
Liquid Flowmeters-In-situ method-insertion point velocity, dilution gauging, Laboratory method-master meter, volumetric method, gravimetric method, pipe prover method.

UNIT-V:

CALIBRATION OF MOTION, ACCELERATION, FORCE, VIBRATION, MASS AND TORQUE TRANSDUCERS: Calibration of motion measuring devices: sinusoidal motion method, transient motion method and comparison method. Force – dynamic force calibration. Acceleration-reciprocity method, optical interferometry.

TEXT BOOKS:

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1.Measurement and Instrumentation: Theory and Application by Alan S. Morris, Reza Langar.
2.Measurement, Instrumentation, and Sensors Handbook, Second Edition: Spatial ... edited by John G. Webster, HalitEren

REFERENCES:

1. Jone's Instrument Technology Volume1 Mechanical measurements, fourth edition, BH,2003.
2. A course in Electrical and Electronic measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai & Co.2011.
3. Electronic Instruments and Instrumentation technology, M.M.S. Anand, PHI, 2005.
4. Instrumentation, Measurement and Analysis, second edition, B.C. Nakra, K.K. Chaudhry, TMH, 2004.

OUTCOMES:

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

- Possess the knowledge about various parameters standards and calibration methodology.
- Demonstrate the necessity skills for calibration and testing of different instruments.
- Classify different calibration methods for liquid flow meters.

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		3	**0**	**0**	**3**
DIGITAL SYSTEM DESIGN USING HDL (PROFESSIONAL ELECTIVE-I)					

OBJECTIVES:

The main objectives of this course are:

- Learn and understand the architectures of Field-programmable Gate Arrays.
- Translate a software application into hardware logic for FPGA architectures.
- Design synthesizable systems based on industry-standard coding methods.
- Build testbenches 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, Testbench Formation in Verilog, Structure of a Verilog Testbench 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 Memory, Application on Data Storage Elements, FPGA Building Blocks Used in Data Storage Elements.

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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^2C) 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, Bora Tar "Digital System Design with FPGA Implementation Using 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 and ZvonkoVranesic, TMH, 2005.
3. A Verilog Primer – J. Bhasker, BSP, 2003.

OUTCOMES:

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

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

III Year- I Semester		L	T	P	C
		0	0	3	1.5

PROCESS CONTROL INSTRUMENTATION LAB

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Process control lab contains 10 experiments; the overall course objective is to provide knowledge on controllers on different processes, final control elements, multi loops and process tuning.

(Minimum 10 experiments should be conducted)

1. Flow level control unit.
2. Temperature level control unit.
3. Servo and regulator operation.
4. Realization of control actions: Pneumatic controllers. Hydraulic controllers.
5. Electronic controllers.
6. Process tuning – Process reaction curve method.
7. Process tuning – continuous and damped oscillation method.
8. Operation of flow loop in plant.
9. Input convertor – Pneumatic actuator.
10. Input convertor – Hydraulic actuator.
11. Control valve characteristics (Different types).
12. Multi loop control systems – Ratio Control.
13. Multi loop control systems – Cascade Control.

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III Year- I Semester		L	T	P	C
		0	0	3	1.5
INTEGRATED CIRCUITS AND APPLICATIONS -LAB					

PART A: Digital IC Applications:

1. Verification of truth tables of Logic gates
   Two input (i) OR (ii) AND (iii) NOR (iv) NAND (v) Exclusive OR (vi) Exclusive NOR.
2. Design a simple combinational circuit with four variables and obtain minimal SOP expression and verify the truth table using Digital Trainer Kit
3. Verification of functional table of 3 to 8line Decoder / De-multiplexer
4. Verification of functional tables of
   (i) J K Edge triggered Flip – Flop
   (ii) J K Master Slave Flip – Flop
   (iii)D Flip – Flop
5. Design a four-bit ring counter using D Flip – Flops / JK Flip Flop and verify Output.
6. Construct 7 Segment Display Circuit Using Decoder and 7 Segment LED and test it.

PART-B: Linear IC Applications

1. OP AMP Applications – Adder, Subtractor, Comparator Circuits
2. Integrator and Differentiator Circuits.
3. Waveform Generator using single OP-AMP with variable duty cycle
4. IC 555 Timer – Monostable Operation Circuit, A stable Operation Circuit
5. IC 566 – VCO Applications.
6. Design of Dual Power Supply using 78XX and 79XX (use full wave Bridge Rectifier with shunt capacitance filters).

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III Year- I Semester		L	T	P	C
		0	0	3	1.5
MICROPROCESSOR AND MICROCONTROLLERS LAB					

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-BCDnumbers.
   b. Multiplication and Divisionoperations.
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

7. Finding number of 1's and number of 0's in a given 8-bitnumber
8. Average of numbers.
9. Program and verify Timer/ Counter in 8051.
10. Interfacing Traffic Light Controller to 8051
11. UART operation in 8051
12. 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

13. Write anassembly program to multiply of 2 16-bit binary numbers.
14. Write an assembly program to find the sum of first 10 integer numbers.
15. Write a program to toggle LED every second using timer interrupt.

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III Year- I Semester		L	T	P	C
		3	0	0	0
PROFESSIONAL ETHICS & HUMAN VALUES					

OBJECTIVES
The main objectives of this course are

- To give basic insights and inputs to the student to inculcate Human values to grow as a responsible human being with proper personality.
- Professional Ethics instils the student to maintain ethical conduct and discharge their professional duties.

UNIT- I
HUMAN VALUES:Morals, Values and Ethics – Integrity –Trustworthiness - Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Value Time – Co-operation – Commitment – Empathy – Self-confidence – Spirituality- Character.

UNIT-II
PRINCIPLES FOR HARMONY: Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias - Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

UNIT- III
ENGINEERING ETHICS AND SOCIAL EXPERIMENTATION: History of Ethics - Need of Engineering Ethics - Senses of Engineering Ethics- Profession and Professionalism —Self Interest - Moral Autonomy – Utilitarianism – Virtue Theory - Uses of Ethical Theories - Deontology- Types of Inquiry –Kohlberg's Theory - Gilligan's Argument –Heinz's Dilemma - Comparison with Standard Experiments — Learning from the Past –Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law - Role of Codes – Codes and Experimental Nature of Engineering.

UNIT-IV
ENGINEERS' RESPONSIBILITIES TOWARDS SAFETY AND RISK:
Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/sInvoluntary Risk – Consequences - Risk Assessment – Accountability – Liability - Reversible Effects - Threshold Levels of Risk - Delayed v/sImmediate Risk - Safety and the Engineer Designing for Safety – Risk-Benefit Analysis-Accidents.

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UNIT-V

ENGINEERS' DUTIES AND RIGHTS: Concept of Duty - Professional Duties – Collegiality - Techniques for Achieving Collegiality – Senses of Loyalty - Consensus and Controversy - Professional and Individual Rights –Confidential and Proprietary Information - Conflict of Interest-Ethical egoism - Collective Bargaining – Confidentiality - Gifts and Bribes - Problem Solving-Occupational Crimes-Industrial Espionage- Price Fixing-Whistle Blowing.

Global Issues:

Globalization and MNCs –Cross Culture Issues - Business Ethics – Media Ethics - Environmental Ethics – Endangering Lives - Bio Ethics - Computer Ethics - War Ethics – Research Ethics -Intellectual Property Rights.

REFERENCES:

1. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
2. Ethics in Engineering by Mike W. Martin and Roland Schinzinger - Tata McGraw-Hill – 2003.
3. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana - Maruthi Publications.
4. Engineering Ethics by Harris, Pritchard and Rabins, Cengage Learning, New Delhi.
5. Human Values & Professional Ethics by S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
6. Engineering Ethics & Human Values by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd – 2009.
7. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press.
8. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill - 2013
9. Human Values And Professional Ethics by Jayshree Suresh and B. S. Raghavan, S.Chand Publications.

OUTCOMES

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

- It gives a comprehensive understanding of a variety issues that are encountered by every professional in discharging professional duties.
- It provides the student the sensitivity and global outlook in the contemporary world to fulfil the professional obligations effectively.

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III Year- I Semester		L	T	P	C
		0	0	3	1.5
MINI PROJECT WITH HARDWARE DEVELOPMENT					

Mini Project Evaluation Procedure for EIE

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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III Year- II Semester		L	T	P	C
		3	0	0	3
DIGITAL SIGNAL PROCESSING					

OBJECTIVES:

The main objectives of this course are:

- 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, Systemfunction.

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 Samplingtechnique, 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, Multiport memory, VLIW architecture, Pipelining, Special addressing modes, On-Chip Peripherals.

ARCHITECTURE OF ARM PROCESSORS: Technical details of ARM Processors, Introduction to 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: JohnG.Proakis, Dimitris G.

Manolakis, Pearson Education/PHI, 2007.
2. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI.
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.

REFERENCES:

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 Edition 2006.

OUTCOMES:

At the end of 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 features of Digital Signal Processors.

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III Year- II Semester		L	T	P	C
		3	0	0	3
VLSI DESIGN					

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 CMOSDesign: Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Choosing a Logic Style, Gate Design in the Ultra Deep-Submicron Era.
Latch Versus Register, Latch based design, timing decimation, positive feedback, 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 SholehEshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. Design of Analog CMOS Integrated Circuits by BehzadRazavi , McGraw Hill, 2003
3. Digital Integrated Circuits, Jan M. Rabaey, AnanthaChandrakasan and Borivoje Nikolic,2nd 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, 1st edition, 2016.
3. FinFETs and other multi-gate transistors,ColingeJP, 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 Rulesand 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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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

III Year- II Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL INSTRUMENTATION					

OBJECTIVES:
The main objectives of this course are:

- Understand the basic knowledge of the physical parameters like Pressure, Temperature, flow, level, density and viscosity employed in different Industries.
- Acquire sound knowledge about various techniques used for the measurement of industrial parameters.
- Understand the construction and working of measuring instruments.
- Analyze need and necessity of measuring instruments.

UNIT-I:
METROLOGY: Measurement of length - Gauge blocks – Plainness – Area using Simpson's rule, Planimeter Diameter – Roughness – Angle using Bevel protractor, sine bars and Clinometer – Mechanical, Electrical, Optical and Pneumatic Comparators. Optical Methods for length and distance measurements using Optical flats and Michelson Interferometer.
VELOCITY AND ACCELERATION MEASUREMENT: Relative velocity – Translational and Rotational velocity measurements – Revolution counters and Timers -Magnetic and Photoelectric pulse counting stroboscopic methods. Accelerometers-different types, Gyroscopes-applications.

UNIT-II:
FORCE MEASUREMENT: Force measurement – Different methods –Gyroscopic Force Measurement – Vibrating wire Force transducer.
PRESSURE MEASUREMENT: Basics of Pressure measurement –Manometer types – Force-Balance and Vibrating Cylinder Transducers – High- and Low-Pressure measurement – McLeod Gauge, Knudsen Gauge, Momentum Transfer Gauge, Thermal Conductivity Gauge, Ionization Gauge, Dual Gauge Techniques, Deadweight Gauges, Hydrostatic Pressure Measurement

UNIT-III:
FLOW MEASUREMENT AND LEVEL MEASUREMENT: Flow Meters- Head type, Area type (Rota meter), electromagnetic type, Positive displacement type, mass flow meter, ultrasonic type, vertex shedding type, Hotwire anemometer type, Laser Doppler Velocity-meter. Basic Level measurements – Direct, Indirect, Pressure, Buoyancy, Weight, Capacitive Probe methods

UNIT-IV:
DENSITY, VISCOSITY AND OTHER MEASUREMENTS: Density measurements – Strain Gauge load cell method – Buoyancy method - Air pressure balance method Gamma ray method – Vibrating probe method.

Units of Viscosity, specific gravity scales used in Petroleum Industries, Different Methods of

measuringconsistency and Viscosity –Two float viscorator –Industrial consistency meter.Sound-Level Meters, Microphones, Humidity Measurement

UNIT-V:

CALIBRATION AND INTERFACING: Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density Viscosity Sensors, Variable Frequency Drive

TEXT BOOKS:

1. Measurement Systems – Applications and Design – by Doeblin E.O., 4/e, McGraw Hill International 1990.
2. Principles of Industrial Instrumentation – Patranabis D. TMH. End edition1997.

REFERENCES:

1. Process Instruments and Control Handbook – by Considine D.M., 4/e, McGraw Hill International, 1993.
2. Mechanical and Industrial Measurements – by Jain R.K., Khanna Publishers 1986.
3. Instrument Technology, vol. I – by Jones E.B., Butterworths1981.

OUTCOMES:

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

- Analyze various process transducers.
- Compare and distinguish temperature standards, thermocouples and pyrometry techniques.
- Analyze area flow meters, mass flow meters and perform calibration.
- Compare various types of level measurements adopted in industry environment.

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III Year- II Semester		L	T	P	C
		3	0	0	3
DIGITAL CONTROL SYSTEMS (PROFESSIONAL ELECTIVE–II)					

OBJECTIVES:

The main objectives of this course are:

- Understand and learn stability analysis of Digital control systems.
- To design the controllability and observability of digital control systems.
- To study Digital PID Controllers.

UNIT-I:

SAMPLING AND RECONSTRUCTION: Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampledsignal to continuous-time signal.

THE Z – TRANSFORMS: Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z –Transforms, the inverse Z – transforms, Modified Z- Transforms.

Z-PLANE ANALYSIS OF DISCRETE-TIME CONTROL SYSTEM: Z-Transform method for solving difference equations; Pulse transforms function, block diagramanalysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips andComplementary Strips.

UNIT-II:

STATE SPACE ANALYSIS: State Space Representation of discrete time systems, Pulse Transfer Function Matrix solvingdiscrete time state space equations, State transition matrix and its Properties, Methods forComputation of State Transition Matrix, Discretization of continuous time state – spaceequations.

UNIT-III:

CONTROLLABILITY AND OBSERVABILITY: Concepts of Controllability and Observability, Tests for controllability and Observability,Duality between Controllability and Observability, Controllability and Observability conditionsfor Pulse Transfer Function.

STABILITY ANALYSIS: Stability Analysis of closed loop systems in the Z-Plane, Jury stability test – Stability Analysisby use of the Bilinear Transformation and Routh Stability criterion, Stability analysis usingLyapunov theorems.

UNIT-IV:

DESIGN OF DISCRETE TIME CONTROL SYSTEM BY CONVENTIONAL METHODS: Design of digital control based on the frequency response method – Bilinear Transformation andDesign procedure in the W-plane, Lead, Lag and Lead-Lag compensators and digital PIDcontrollers. Design digital control through deadbeat response method.

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UNIT-V:

STATE FEEDBACK CONTROLLERS AND OBSERVERS: Design of state feedback controller through pole placement – Necessary and sufficientconditions, Ackerman's formula, State Observers – Full order and Reduced order observers.Introduction to Kalman filters, State estimation through Kalman filters, introduction to adaptiveControls.

TEXTBOOKS:

1. "Discrete-Time Control systems" K. Ogata - - Pearson Education/PHI, 2nd Edition.
2. "Digital Control and State Variable Methods"M. Gopal - - TMH

REFERENCES:

1. "Digital Control Systems"-Kuo - Oxford University Press, 2nd Edition, 2003.
2. "Digital Control Engineering"- M. Gopal -

OUTCOMES:

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

- Distinguish between observability and controllability.
- Design PID controllers.
- Design controllers and observers for linear discrete time control systems so that their performance meet design metrics criteria.

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III Year- II Semester		L	T	P	C
		3	0	0	3
VIRTUAL INSTRUMENTATION (PROFESSIONAL ELECTIVE–II)					

OBJECTIVES:

The main objectives of this course are:

- Develop virtual instruments for specific application using Lab VIEW software.
- Ease the programming required to make computer interact with real world.
- To acquire, analyze and display the throughput of any compactable system.
- Knowledge to connect with third party software and hardware.

UNIT-I:

VIRTUAL INSTRUMENTATION: An introduction, Historical perspective, advantages, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT-II:

PROGRAMMING TECHNIQUES: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, and math script.

UNIT-III:

INTERFACE REQUIREMENTS: Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI, VISA and IVI, Data Acquisition Hardware.

UNIT-IV:

APPLICATION OF VIRTUAL INSTRUMENTATION: Application of Virtual Instrumentation: Instrument Control using RS-232C and IEEE488, Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, Active X programming, publishing measurement data in the web.

UNIT-V:

TOOLSETS: Distributed I/O modules, Control Design and Simulation, Digital Signal processing tool kit, Image acquisition and processing, Motion control.

TEXTBOOKS:

1. LabVIEW Graphical Programming, Gary Johnson, Second edition, McGraw Hill, New York, 1997.
2. LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 1997.

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REFERENCES:

1. PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.
2. LabVIEW advanced programming technique, Rick Bitter, 2nd Edition, CRC Press,2005
3. Virtual Instrumentation using LabVIEW, Jovitha Jerome, 1stEdition, PHI,2001.

OUTCOMES:

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

- Create Virtual Instrument using LabVIEW software for various fields of applications like Control system, Signal Processing and Image processing etc.
- Create effective Virtual Instrument that shall use minimum memory space and work effectively with any processor.
- Interface the computer with DAQ to monitor process and control real world applications.
- Analyze the throughput using the tools in Lab VIEW software.

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III Year- II Semester		L	T	P	C
		3	0	0	3
TELEMETRY AND TELECONTROL (PROFESSIONAL ELECTIVE–II)					

OBJECTIVES:

The main objective of this course is:

- Able to design telemetry system.
- To make students understand the application of telemetry techniques to Instrumentation.
- Analyze the frequency and time division multiplexed systems.

UNIT-I:

TELEMETRY PRINCIPLES: Introduction, Functional blocks of Telemetry system, Methods of Telemetry – Non-Electrical, Electrical, Pneumatic and Frequency.

SYMBOLS AND CODES: Bits and Symbols, Time function pulses, Line and Channel Coding, Modulation Codes. Inter symbol Interference.

UNIT-II:

FREQUENCY& TIME DIVISION MULTIPLEXED SYSTEMS: FDM, IRIG Standard, FM and PM Circuits, Receiving end, PLL, TDM - PAM, PAM /PM and TDM – PCM Systems. PCM reception. Differential PCM Introduction, QAM, Protocols.

UNIT-III:

SATELLITE TELEMETRY: General considerations, TT & C Service, Digital Transmission systems, TT & C Subsystems, Telemetry, and Communications.

MODERN TELEMETRY: Zigbee, Ethernet.

UNIT-IV:

OPTICAL TELEMETRY: Optical fibers Cable – Sources and detectors – Transmitter and Receiving Circuits, Coherent Optical Fiber Communication System.

UNIT-V:

TELECONTROL METHODS: Analog and Digital techniques in Telecontrol, Telecontrol apparatus – Remote adjustment, Guidance, and regulation – Telecontrol using information theory – Example of a Telecontrol System.

TEXTBOOKS:

1. Telemetry Principles – D. Patranabis, TMH
2. Telecontrol Methods and Applications of Telemetry and Remote Control – by Swoboda G., Reinhold Publishing Corp., London, 1991.

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REFERENCES:

1. Handbook of Telemetry and Remote Control – by Gruenberg L., McGraw Hill, New York, 1987.
2. Telemetry Engineering – by Young R.E., Little Books Ltd., London, 1988.
3. Data Communication and Teleprocessing System – by Housley T., PH Intl., Englewood Cliffs, New Jersey, 1987.

OUTCOMES:

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

- Design phase locked loop, mixers and Time division multiplexed systems.
- Appreciate the application of different telemetry systems and control to any process.
- Compare the performance of various wired and wireless communication protocols.

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III Year- II Semester		L	T	P	C
		3	0	0	3
DIGITAL IC DESIGN (PROFESSIONAL ELECTIVE–II)					

OBJECTIVES:

The main objectives of this course are:

- The student will be able to understand the MOSDesign.
- Students can learn and understand Combinational MOS Logic Circuits and Sequential MOS LogicCircuits.
- 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 arrayorganization.

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.

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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 NANDflash.

TEXTBOOKS:

1. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, AnanthaChandrakasan, Borivoje Nikolic, 2nd Ed., PHI.
2. Digital Integrated Circuit Design – Ken Martin, Oxford University Press,2011.

REFERENCES:

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

OUTCOMES:

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

- Understand the concepts of MOSDesign.
- Design and analysis of Combinational and Sequential MOSCircuits.
- Extend the Digital IC Design to DifferentApplications.
- Understand the Concepts of Semiconductor Memories, Flash Memory, RAM arrayorganization

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III Year- II Semester		L	T	P	C
		3	0	0	3
DATA MINING (OPEN ELECTIVE-1)					

OBJECTIVES:

The main objectives of this course are:

- Students will be enabled to understand and implement classical models and algorithms in data warehousing and data mining.
- 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)**

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

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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: VikramPudi 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
   (NPTEL course by Prof.Pabitra Mitra)
6. 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

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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DEPARTMENT OFELECTRONICS AND INSTRUMENTATION ENGINEERING

III Year- II Semester		L	T	P	C
		3	0	0	3
POWER ELECTRONICS (OPEN ELECTIVE-1)					

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 – 120^0 conduction and 180^0 conduction modes of operation – Sinusoidal pulse width modulation –single-phase Current Source Inverter (CSI)- single-phase AC-AC voltage regulator with R and RL load.

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 Hill publications
3. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India

REFERENCE BOOKS:

1. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009

2. Elements of Power Electronics–Philip T.Krein. Oxford publishers.

3. Power Electronics – by P.S.Bhimbra, Khanna Publishers.

OUTCOMES:

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

- Explain the characteristics of various power semiconductor devices and understand the gate driver circuits.
- Explain the operation of single-phase full wave converters and perform harmonic analysis.
- Explain the operation of three phase full–wave converters and perform harmonic analysis.
- Analyze the operation of different types of DC-DC converters.
- Explain the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.

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		3	0	0	3

MEMS AND ITS APPLICATIONS
Open Elective (OE1)

OBJECTIVES:

The main objectives of this course are given below:

- 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, shaped 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 martials, Silicon as a substrate material. Silicon compounds, Silicon piezo resistors, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers, Packing 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

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

- 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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		3	0	0	3
ARTIFICIAL NEURAL NETWORKS (OPEN ELECTIVE-1)					

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, Kohenen 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.

TEXT BOOKS:

1. B. Yegnanarayana" Artificial neural networks" PHI, New Delhi.
2. S.N. Sivanandam, S.N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", TATA MCGraw- Hill publications.
3. J.M. Zurada," Introduction to Artificial neural systems" –Jaico publishing.

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REFERENCE BOOKS:

1. S.Rajasekaran and G.A.Vijayalakshmipai "Neural Networks. Fuzzy Logic and genetic Algorithms".
2. James A Freeman and Davis Skapura" Neural Networks Algorithm, applications and programming Techniques", Pearson Education, 2002.
3. Simon Hakins "Neural Networks " Pearson Education.

OUTCOMES:

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

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

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III Year- II Semester		L	T	P	C
		3	0	0	3
DATA ACQUISITION SYSTEM					

OBJECTIVES:
The main objectives of this course are:

- Understand and learn single and multichannelData Acquisition System.
- Acquire basic skills on capturing experimental data.
- Understand and learn digital to analog and analog to digital conversiontechniques.
- Understand and learn on-linear data convertor techniques andapplications.
- Understand and learn monolithic data convertors and error budget ofData Acquisition System.

UNIT-I
INTRODUCTION: Objective of a Data Acquisition System, single channel Data Acquisition System, Multi-channel Data Acquisition System,ComponentsUsed in Data Acquisition System– Converter Characteristics-Resolution-Non-linearity,settling time, Monotonicity.

UNIT-II
ANALOG TO DIGITAL CONVERTERS (ADCS): Classification of A/D converters, Parallelfeedback – Successive approximation – Ramp comparison – Dual slopeintegration – Voltage to frequency – Voltage to Time – Logarithmic types of ADCS.
NON-LINEAR DATA CONVERTERS (NDC): Basic NDC configurations – Some commonNDACS and NADCS – Programmable non-linear ADCS – NADC using optimal sized ROM –High speed hybrid NADC – PLS based NADC – Switched capacitor NDCS.
ADC APPLICATIONS: Data Acquisition systems – Digital signal processing systems – PCMvoice communication systems – Test and measurement instruments – Electronic weighingmachines.

UNIT-III
DIGITAL TO ANALOG CONVERTERS (DACS): Principles and design of – Parallel R–2R, weighted resistor, inverted ladder, D/A decoding – Codes other than ordinary binary.
DATA CONVERTER APPLICATIONS: DAC applications – Digitally programmable V/I source – Arbitrary waveform generators – Digitally programmable gain amplifiers – Analogmultipliers/ dividers – Analog delay lines.

UNIT-IV
Monolithic data converters: typical study of monolithic DACS and ADCS. Interfacing ofDACS and ADCS to a microprocessor,

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UNIT-V

Error budget of DACS and ADCS: Error sources, error reduction and noise reductiontechniques in Data Acquisition System. Error budget analysis Of Data Acquisition System, case study of a DAC and an ADC.

TEXT BOOKS:

1. Electronic data converters fundamentals and applications – Dinesh K. Anvekar, B.S. Sonde –Tata McGraw Hill.
2. D/A and A/D converters a user's handbook of -E.R. Hnateck,Wiley
3. Data converters by G.B.Clayton.

REFERENCES:

1. Electronic Analog/ Digital conversions – Hermann Schmid – Tata McGraw Hill.
2. Electronic instrumentation by HS Kalsi- TMH 2nd Edition, 2004.

OUTCOMES:

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

- Differentiate between single and multichannelData Acquisition System.
- Describe the functional blocks of data acquisition system.
- Operation of different DACs, ADCs and non-linear ADCs.
- Understandsof data convertor and monolithic data convertors and theirapplications.
- Gets aware of error budget analysis ofData Acquisition System.

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III Year- II Semester		L	T	P	C
		0	0	3	1.5
DIGITAL SIGNAL PROCESSING LAB					

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

PART-A

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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III Year- II Semester		L	T	P	C
		0	0	3	1.5
INDUSTRIAL INSTRUMENTATION LAB					

List of Experiments:

1. Calibration of Pneumatic pressure to Current (P to I) and Current to Pneumatic Pressure (I to P)Converters
2. Measurement of RPM using Opto-coupler and comparing it with troboscope
3. Measurement of precision Angular Velocity and RPM of a rotating Disk
4. Measurement of Velocity, Acceleration and Vibration using Piezo- electric transducer
5. Measurement of Humidity
6. Measurement of intensity of Light
7. Measurement of Sound Level.
8. Measurement of Viscosity of Edible Oil using Redwood Viscometer
9. Measurement of Viscosity of Crude Oil using Saybolt Viscometer
10. Measurement of Density
11. MEMS based Accelerometer
12. Design of signal conditioner for MEMS based Accelerometer
13. MEMS based Gyroscope
14. Design of signal conditioner for MEMS based Gyroscope

Note: Experiments based on Industrial Bus Protocols

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III Year- II Semester		L	T	P	C
		3	0	0	0
INTELLECTUAL PROPERTY RIGHTS (IPR) & PATENTS					

Course Objectives:

- To know the importance of Intellectual property rights, which plays a vital role in advanced Technical and Scientific disciplines
- Imparting IPR protections and regulations for further advancement, so that the students can familiarize with the latest developments

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 Property Rights.

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 Protection Act.

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 related Innovations

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.

Text Books:

1) Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi.
2) Deborah E.Bouchoux: Intellectual Property, Cengage Learning, New Delhi.

References:

1) PrabhuddhaGanguli: Intellectual Property Rights, Tata Mc-Graw –Hill, New Delhi
2) Richard Stim: Intellectual Property, Cengage Learning, New Delhi.
3) Kompal Bansal &Parishit Bansal Fundamentals of IPR for Engineers, B. S. Publications (Press).
4) Cyber Law - Texts & Cases, South-Western's Special Topics Collections.
5) R.Radha Krishnan, S.Balasubramanian: Intellectual Property Rights, Excel Books. New Delhi.
6) M.Ashok Kumar and MohdIqbal Ali: Intellectual Property Rights, Serials Pub.

Course Outcomes:

- IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seek Patents

- Studentget an insight on Copyrights, Patents and Software patents which are instrumental for further advancements

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IV Year- I Semester		L	T	P	C
		3	0	0	3
MANAGEMENT AND ORGANIZATIONAL BEHAVIOR					

OBJECTIVES:
The main objectives of this course are:

- To familiarize with the process of management and to provide basic insight into select contemporary management practices.
- To provide conceptual knowledge on functional management Human resource management, strategic management and OrganizationalBehaviour.

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 elementsand marketing strategies.

UNIT-III:
STRATEGIC MANAGEMENT: Strategic Management and Contemporary Strategic Issues: Mission, Goals, Objectives, Policy, Strategy, Programmers, 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 BEHAVIOUR: Perception-Perceptual process- Impression management- Personality development – Socialization – Attitude- Process- Formation- Positive attitude- Change – Learning – Learning organizations- Reinforcement Motivation – Process- Motives – Theories of Motivation: Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation.

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UNIT-V:

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

TEXTBOOKS:

1. Organizational Behavior by SubbaRao.P, Himalaya Publishing House. Mumbai.
2. Organizational Behaviour by Fred Luthans, TMH, New Delhi.
3. Fundamentals of Management, Robins, Stephen P, Pearson, India.

REFERENCES:

1. Marketing Management by Kotler Philip & Keller Kevin Lane, 12/e, PHI, 2007
2. Essentials of Management by Koontz &Weihrich, 6/e, TMH, 2007
3. Production and Operations Management by KanishkaBedi, Oxford University Press, 2007.

OUTCOMES:

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

- After completion of the Course the student will acquire the knowledge on management functions, global leadership and organizational behaviour.
- Will familiarize with the concepts of functional management project management and strategic management.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
BIOMEDICAL INSTRUMENTATION					

OBJECTIVES:

The main objectives of this course are:

- Understand bio systems and medical systems from an engineeringperspective.
- Elucidate the methods to monitor the activity of the heart, brain, eyes andmuscles.
- Introduce therapeutic equipment for intensive and criticalcare.
- Outline medical imaging techniques and equipment for certain diagnosis and therapies.

UNIT-I:

BIO POTENTIAL SIGNALS AND ELECTRODES: Bio-signals and their characteristics, Organization of cell, Nernst equation of membrane, Resting and Action potentials, Bio-amplifiers, characteristics of medical instruments, problems encountered with measurements from living systems, Bio-potential electrodes – Body surface recording electrodes, Internal electrodes, micro electrodes, Bio-chemical transducers – reference electrode, the pH electrodes, Blood gas electrodes.

UNIT-II:

CARDIOVASCULAR INSTRUMENTATION: Heart and cardiovascular system Heart electrical activity, blood pressure and heart sounds, cardiovascular measurements electro cardiograph-electrocardiogram, ECG Amplifier, Electrodes and leads, ECG recorder principles. Types of ECG recorders. Principles of blood pressure and blood flow measurement.

UNIT-III:

NEUROLOGICAL INSTRUMENTATION: Neuronal communication, electro encephalogram (EEG), EEG Measurements EEG electrode-placement system, interpretation of EEG, EEG system Block diagram, pre- amplifiers and amplifiers EMG block diagram and Stimulators.

UNIT-IV:

EQUIPMENT'S FOR CRITICAL CARE:Therapeutic equipment - Pacemaker, Defibrillator, Shortwave diathermy, Hemodialysis machine. Respiratory Instrumentation - Mechanism of respiration, Spirometry, Pneumotachograph, Ventilators.

UNIT-V:

PRINCIPLES OF MEDICAL IMAGING: Radiography, computed Radiography, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine, Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), Ultrasonography, Introduction to Telemedicine.

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TEXT BOOKS:

1. Hand-book of Biomedical Instrumentation – by R.S. Khandpur, McGraw-Hill,2003.
2. Medical Instrumentation, Application and Design – by John G. Webster, JohnWiley.

REFERENCES:

1. Biomedical Instrumentation and Measurements – by Leslie Cromwell, F.J.Weibell, E.A. Pfeiffer, PHI.
2. Principles of Applied Biomedical Instrumentation – by L.A. Geoddes and L.E. Baker, John Wiley andSons.
3. Introduction to Biomedical equipment technology-by Joseph Carr andBrown.

OUTCOMES:

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

- Identify significant biological variables at cellular level and ways to acquire different bio-signals.
- Identify the techniques to acquire record and primarily understand physiological activity of the human body through cell potential, ECG, EEG, BP and blood flow measurement andEMG.
- Describe the working of various medical instruments and criticalcare equipment.
- Comparevarious imaging techniques including CT, PET, SPECT and MRI used in diagnosis of various medicalconditions.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
DIGITAL IMAGE AND VIDEO PROCESSING					

OBJECTIVES:

The main objectives of this course are:

- Tointroducefundamentalsofdigitalimageprocessingandstudyimagetransforms
- To demonstrate digital image processing techniques in spatial and frequency domains
- To study and compare various image compressionalgorithms
- To study advanced image analysis methods: image segmentation, morphological image processing, & imagerestoration

UNIT-I:

FUNDAMENTALS OF IMAGE PROCESSING: Digital Image Fundamentals, Basic steps of Image Processing System, Sampling and Quantization of an image, relationship between pixels, Imaging Geometry.

IMAGE TRANSFORMS: 2 D- Discrete Fourier Transform, Discrete Cosine Transform (DCT), Haar Transform, Hadamard Transform, Hoteling Transform and slanttransform.

UNIT-II:

IMAGE ENHANCEMENT: Spatial domain methods: 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.

UNIT-III:

IMAGE SEGMENTATION: Segmentation concepts, Point, Line and Edge Detection, Edge Linking using Hough Transform, Thresholding, Region Basedsegmentation.

WAVELET BASED IMAGE PROCESSING: Introduction to wavelet Transform, Continuous wavelet Transform, Discrete wavelet Transform, Filter banks, Wavelet based image compression.

UNIT-IV:

IMAGE COMPRESSION: Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, Runlength coding, Bit plane coding, Transform coding, Predictive coding, JPEG 2000Standards.

UNIT-V:

IMAGE RESTORATION: Image Restoration Degradation model, Algebraic approach to restoration, Inverse Filtering, Least Mean square filters.

MORPHOLOGICAL IMAGE PROCESSING: Dilation and Erosion, Opening and closing, the hit or miss Transformation, Overview of Digital Image WatermarkingMethods.

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TEXTBOOKS:

1. Digital Image Processing- Rafael C. Gonzalez and Richard E.Woods, 3rd Edition, Pearson,2008.
2. Digital Image Processing- S.Jayaraman, S Esakkirajan, T Veerakumar, TMH, 2010.

REFERENCES:

1. Digital Image Processing-William K.Pratt, 3rdEdition, John Willey,2004.
2. Digital Image Processing using MATLAB - Rafael C. Gonzalez, Richard E.Woods and Steven L.Edding 2nd, TMH.2010.
3. Digital Image Processing and Computer Vision-Somka,Hlavac,Boyl, CengageLearning,2008
4. Introduction to image Processing and Analysis – John C. Russ, J. Christian Russ,CRCPress, 2010.

OUTCOMES:

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

- Acquire, represent the digital image andtransforms.
- Apply various intensity-based image processingtechniques.
- Apply various pixel position-based image processingtechniques

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IV Year- I Semester		L	T	P	C
		3	0	0	3
EMBEDDED SYSTEMS **PROFESSIONAL ELECTIVE -III**					

OBJECTIVES:

The main objectives of this course are:

- 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.

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.

TEXTBOOKS:

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.

OUTCOMES:

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

- Understand the basic concepts of an embedded system and able to know an embedded system designapproach 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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IV Year- I Semester		L	T	P	C
		3	0	0	3
ANALYTICAL INSTRUMENTATION **PROFESSIONAL ELECTIVE -III**					

OBJECTIVES:

The main objectives of this course are:

- Acquire knowledge about equipment for measurement of PH, conductivity and gas analyzers.
- Learn and understand UV-Visible spectroscopy, nuclear magnetic resonance and mass spectrometers.
- Acquire knowledge about Gas and liquid chromatography.
- Compare various nuclear radiation detectors.

UNIT–I:
pH AND CONDUCTIVITY & DISSOLVED COMPONENT ANALYSER: Conductivity meters – pH meters – Dissolved oxygen, hydrogen analysers – Sodium analyser – Silica analyser and sampling systems.

UNIT-II:
GAS ANALYSERS: Thermal conductivity types – CO monitor – Oxygen Analysers - NOX analyser – H2S analyser system and sampling – Industrial analyser circuits, Theory and problems on Beer – Lamberts Law.

UNIT-III:
SPECTROSCOPY: Beer – Lamberts Law, Sources and detectors, UV, VIS Spectrophotometers – Single beam and double beam spectroscopy. IR Spectrophotometer, Sources and detectors, FT IR Spectrometer. Flame spectroscopy - atomic absorption Spectrophotometer – Atomic emission Spectrophotometer.

UNIT-IV:
NMR, ESR AND MASS SPECTROMETERS: Principles and Instrumentation associated with NMR Spectrometers, ESR Spectrometers, and Mass Spectrometers and their applications

UNIT-V:
CHROMATOGRAPHY&NUCLEAR RADIATION DETECTORS: Classification of Gas and liquid chromatography, Principles and Instrumentation associated with Gas and liquid chromatography – sample injection systems, columns, isothermal operation, different detectors,
Ionization chamber, Geiger Muller counter, Proportional Counter, Scintillation counter and Solid-state detectors.

TEXT BOOKS:

1. Instrumental Methods of Analysis – by Willard H.H., Merrit L.L., Dean J.A. and Seattle F.L., CBS Publishing and Distributors, 6/e, 1995.
2. Handbook of Analytical Instruments – by R S Khandpur. TMH

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REFERENCES:

1. Instrument Technology – by Jones B.E., Butterworth Scientific Publ., London, 1987.
2. Mechanical and Industrial Measurements – by Jain R.K., Khanna Publishing, New Delhi, 2/e, 1992.
3. Principles of Instrumental Analysis – by Skoog D.A. and West D.M., Holt Sounder Publication, Philadelphia, 1985.

OUTCOMES:

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

- Measure various parameters like PH, Conductivity, CO, NOX and oxygen using various analyzers
- Compare different Spectrophotometer like UV, VIS and IR
- Distinguish between various Spectrometers.
- Compare various chromatographic techniques.
- Students get knowledge on Ionization chamber, Geiger Muller counter, Proportional Counter, Scintillation counter and Solid-state detectors.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
ARTIFICAL INTELLIGENCE AND MACHINE LEARNING **PROFESSIONAL ELECTIVE -III**					

OBJECTIVES:

The main objective of this course is:

- 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 MACHINE LEARNING / ARTIFICIAL INTELLIGENCE- Artificial Intelligence Foundation, Big questions of Artificial Intelligence, history of Artificial Intelligence, latest advancements

UNIT-II:

MACHINE LEARNING: Linear Regression - Learn to implement linear regression and predict continuous data values, Naïve Bayes and Logistic regression - Understand how supervised learning is used for classification, Clustering - Learn how to create segments based on similarities using K-Means and Hierarchical clustering, 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 Tensor Flow and keras - 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 Dierence Learning, Approximate Methods - Learn policy gradient methods and their applications in learning

TEXTBOOKS:

1. Machine Learning, by Tom M Mitchell, Indian Edition, McGraw Hill
2. Deep Learning by Good fellow, Bengio, Courville. The MIT Press, 2016

REFERENCES:

1. Understanding Machine Learning: From Theory to Algorithms, by Shai Shalev-Shwartzand Shai Ben-David, 1st Edition, Cambridge University Press
2. Artificial Intelligence - A Modern Approach by Stuart Russell & Peter Norvig, Prentice Hall

OUTCOMES:

At the end of this course the student will 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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IV Year- I Semester		L	T	P	C
		3	0	0	3
ANALOG IC DESIGN **PROFESSIONAL ELECTIVE -III**					

OBJECTIVES:

The main objectives of this course are:

- 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.
- To motivate the graduate students to design and to develop the Analog CMOS Circuits for different Analog operations.
- Acquire knowledge about 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.

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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.

TEXT BOOKS:
1. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH 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.

OUTCOMES:
At the end of this course the student will be able to:
- Understand the concepts of MOS Devices and Modeling.
- Design and analyze any Analog Circuits in real time applications.
- Apply the knowledge of Analog Circuit Design to develop Different Applications in Real Time.
- Compare different Open-Loop Comparators and Different Types of Oscillators.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
ROBOTICS & AUTOMATION **PROFESSIONAL ELECTIVE -IV**					

OBJECTIVES:

The main objective of this course is:

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

UNIT-I:

BASIC CONCEPTS: Automation and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system, Dynamic stabilization of Robotics.
POWER SOURCES AND SENSORS: Hydraulic, Pneumatic and electric drivers – Determination HP of motor and gearing ratio, variable speed arrangements, Path Determination - Machinery Vision – Ranging – Laser – Acoustic, Magnetic Fiber Optic and Tactile Sensor

UNIT-II:

MANUPULATORS Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators.
ACTUATORS AND GRIPPERS: Pneumatic, Hydraulic Actuators, Stepper Motor Control Circuits, End Effecter, Various types of Grippers, Design consideration.

UNIT-III:

Differential transformation and manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.
KINEMATICS Forward and Inverse Kinematic Problems, Solutions of Inverse Kinematic problems, Multiple Solution, Jacobian Work Envelop – Hill Climbing Techniques.

UNIT-IV:

PATH PLANNING: Trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion – straight line motion – Robot programming, languages and software packages.

UNIT-V:

CASE STUDY: Multiple Robots – Machine Interface – Robots in Manufacturing and Non-Manufacturing applications – Robot Cell Design Selection of a Robot.

TEXT BOOKS:

1. Industrial Robotics by Groover M P, Pearson Edu.
2. Robotics by Fu K S, McGraw Hill.

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REFERENCES:

1. Robotics by CSP Rao and V.V. Reddy, Pearson Publications
2. Robotics and Control by Mittal R K &Nagrath I J, TMH.
3. An Introduction to Robot Technology by P. Coiffet and M. ChaironzeKogam Page Ltd. 1983 London.
4. Robotic Engineering by Richard D. Klafter, Prentice Hall
5. Introduction to Robotics by John J Craig, Pearson Edu.
6. Robot Dynamics and Control by Mark W. Spong and M. Vidyasagar, John Wiley & Sons.

OUTCOMES:

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

- Perform kinematic and dynamic analyses with simulation.
- Design control laws for a simple robot.
- Integrate mechanical and electrical hardware for a real prototype of robotic device.
- Select a robotic system for given industrial application.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
OPTOELECTRONICS & LASER INSTRUMENTATION (PROFESSIONAL ELECTIVE –IV)					

OBJECTIVES:
The main objective of this course is:

- To expose the students to the basic concepts of optical fibers and their properties.
- To provide adequate knowledge about the Industrial applications of optical fibers.
- To expose the students to the Laser fundamentals.
- To provide adequate knowledge about Industrial application of lasers.
- To provide adequate knowledge about holography and Medical applications of Lasers.

UNIT-I:
OPTICAL FIBERS AND THEIR PROPERTIES: Principles of light propagation through a fiber - Different types of fibers and their properties, fiber characteristics – Absorption losses – Scattering losses – Dispersion –Connectors and splicer's – Fiber termination – Optical sources – Optical detectors.

UNIT-II:
INDUSTRIAL APPLICATION OF OPTICAL FIBERS: Fiber optic sensors – Fiber optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moiré fringes –Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT-III:
LASER FUNDAMENTALS: Fundamental characteristics of lasers – three level and four level lasers – properties of laser – laser modes – resonator configuration – q-switching and mode locking – cavity damping – types of lasers – gas lasers, solid lasers, liquid lasers, semiconductor lasers.

UNIT-IV:
INDUSTRIAL APPLICATION OF LASERS: Laser for measurement of distance, length, velocity, acceleration, current, voltageand Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.

UNIT-V:
HOLOGRAM AND MEDICAL APPLICATIONS: Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynecology and oncology.

TEXTBOOKS:

1. 'Optical Fiber Communication – Principles and Practice' J.M. Senior, Prentice Hall of India, 1985.
2. 'Introduction to OptoElectronics'. Wilson and J.F.B. Hawkes, Prentice Hall of India,2001.

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REFERENCES:

1. 'Optical Fiber Communication', G. Keiser, McGraw Hill, 1995.
2. 'Optical Fiber Communication and Sensors', M. Arumugam, Anuradha Agencies, 2002.
3. 'Industrial Applications of Lasers',John F. Read, Academic Press, 1978.

OUTCOMES:

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

- Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers.
- Apply Laser theory for the selection of lasers for a specify industrial and medical application.
- Apply the knowledge of lasers for industrial, hologram and medical applications.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL INTERNET OF THINGS (PROFESSIONAL ELECTIVE –IV)					

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 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.

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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, byMichahelles, Springer, 2011

REFERENCES:

1. The Internet of Things Connecting Objects to the Web" by HakimaChaouchi,Willy Publications
2. The Internet of Things: Key Applications and Protocols, OlivierHersent, David Boswarthick, Omar Elloumi, 2nd 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 ByRed Lion.
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

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 concepts
- Build Industrial Digital Twins.

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IV Year- I Semester		L	T	P	C
		3	0	0	3
LOW POWER VLSI DESIGN (PROFESSIONAL ELECTIVE –IV)					

OBJECTIVES:

The main objectives of this course are:

- 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,

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Introduction to Wallace Tree Multiplier.

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.

TEXTBOOKS:

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.

REFERENCES:

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, AnathaChandrakasan, Springer,2005.

OUTCOMES:

At the end of 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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IV Year- I Semester		L	T	P	C
		3	0	3	1.5
INSTRUMENTATION LAB – II					

Process control lab contains 10 experiments; the overall course objective is to provide knowledge on different sensors and their measurement.
(Minimum of ten experiments should be conducted.)

List of Experiments:

1. Design and simulation of Analog Circuits using CAD Package.
2. Design of PCBs using Packages and Fabrication of PCB.
3. Linearization of Thermistor using Microprocessor.
4. Study of Level monitoring Instruments using PLC.
   pH measurements.
5. Measurement of Blood Pressure.
6. Calibration of P to I and I to P converters.
7. RPM indicator using Strobostrom/Gyroscope.
8. Measurement of Humidity.
9. Measurement of velocity of liquid using Ultrasonic (Doppler effect) method and also flow measurement.
10. Measurement of Level using Capacitance method/Transducer.
11. Displacement measurement using inductive pickup and capacitive pickup.
12. PID Controller setup (Flow/Temp. Level).

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IV Year- I Semester		L	T	P	C
		3	0	3	1.5
VLSI LAB					

List of Experiments

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

Note 1: The students need to develop VHDL/Verilog 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
2. 4-bit ripple carry and carry look ahead adder using behavioural, dataflow and structural modelling
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 arttechnology libraries can be used while simulating the designs using Industry standardEDA Tools.

Design and Implementation of the following

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

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EDA Tools/Hardware Required:

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

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IV Year- I Semester		L	T	P	C
		0	0	6	1.5
PROJECT –PART I					

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IV Year- II Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL DATA COMMUNICATION (PROFESSIONAL ELECTIVE –V)					

OBJECTIVES:

The main objectives of this course are:

- To educate on the basic concepts of data networks.
- To introduce the basics of inter-networking and serial communications.
- To provide details on HART and Field buses.
- To educate on MODBUS, PROFIBUS and other communication protocol.
- To introduce industrial Ethernet and wireless communication.

UNIT-I:

DATA NETWORK FUNDAMENTALS: Networks hierarchy and switching – Open System Interconnection model of ISO - Data link control protocol - Media access protocol - Command / response - Token passing - CSMA/CD, TCP/IP.

UNIT-II:

INTERNET WORKING and RS 232, RS 485: Bridges - Routers - Gateways - Standard ETHERNET and ARCNET configuration special requirement for networks used for control - RS 232, RS 485 configuration Actuator Sensor (AS) – interface, Device net.

UNIT-III:

HART AND FIELDBUS: Introduction - Evolution of signal standard - HART communication protocol - HART networks - HART commands - HART applications – Fieldbus - Introduction - General Fieldbus architecture - Basic requirements of Fieldbus standard – Fieldbus topology - Interoperability – Interchangeability - Introduction to OLE for process control (OPC).

UNIT-IV:

MODBUS AND PROFIBUS PA/DP/FMS AND FF: MODBUS protocol structure - function codes – troubleshooting Profibus, Introduction, Profibus protocol stack, Profibus communication model - communication objects - system operation - troubleshooting - review of foundation fieldbus - Data Highway.

UNIT-V:

INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION: Industrial Ethernet, Introduction, 10 Mbps Ethernet, 100 Mbps Ethernet - Radio and wireless communication, Introduction, components of radio link - radio spectrum and frequency allocation - radio MODEMs-Introduction to wireless HART and ISA100.

TEXTBOOKS:

1. Practical Industrial Data by Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Networks Design, Installation and Troubleshooting' Newnes Publication, Elsevier First Edition, 2004
2. Computer Buses, William Buchanan, CRC Press, 2000.
3. Data Communications & Networking, A. Behrouz Forouzan,3RD edition, Tata Mc Graw

hill,2006.

REFERENCES:

1. Computer Networks, Andrew S. Tanenbaum, David J. Wetherall, Prentice Hall of India Pvt. Ltd., 5th Edition. 2011.
2. Theodore S Rappaport, Prentice Hall of India 2nd Edition, 2001.
3. Wireless Communication: Principles and Practice, William Stallings, Wireless Communication & Networks, Prentice Hall of India, 2nd Edition, 2005.

OUTCOMES:

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

- Identify network on the basis of various network parameters.
- Assign IP address to the network and network component as per the networks.
- Install various types of network devices and other network hardware for Field and ProfiBUS.
- Troubleshoot problems in hardware/software employed in data communication circuit.

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IV Year- II Semester		L	T	P	C
		3	0	0	3
POWER PLANT INSTRUMENTATION (PROFESSIONAL ELECTIVE –V)					

OBJECTIVES:
The main objectives of this course are:

- Understand the working model of powerplant.
- Understand the necessity of an instrumentation engineer in a powerplant
- Understand different components and their control in powerplants.
- Understand various analyzers used in powerplant.

UNIT-I:
AN OVERVIEW OF POWER GENERATION: Introduction-various sources of Electrical Energy - Non-conventional Energy sources- Wind power, solar power, tidal power, geothermal power, magnetohydrodynamic (MHD) Power, Fuel Cells, Biomass Power, Conventional energy sources- hydropower, nuclear power, gas power, steam power (Thermal Power), comparison of various conventional power plants, Importance of instrumentation and control in power Generation – Classification of Instruments in a power plant, objectives of Instrumentation and control.
PIPING AND INSTRUMENTATION DIAGRAM (P AND I DIAGRAM): Examples of ISA Instrumentation diagram symbols, examples of SAMA instrumentation diagram symbols, examples of ISA and SAMA diagram, piping and instrumentation diagramming, Cogeneration of Power-back pressure turbine, pass-out turbine process heat unit, control rooms, thermal or boiler control room, electrical control room, plan of control rooms.

UNIT-II:
INSTRUMENTATION AND CONTROL IN WATER CIRCUIT: Water circuit, boiler feed water circulation- natural circulation, forced circulation, combined circulation, Measurements in Water Circuit- Water Flow Measurement Differential pressure transmitter (DPT),steamflowmeasurement,waterandsteampressure measurements, water and steam temperature measurements, drum water level measurement.
CONTROLS IN WATER CIRCUIT: Boiler drum level control, superheated steam temperature control, steam pressure control, impurities in water and steam- impurities in Raw Water, Effects of Impurities, Measurement of Impurities, feed water treatment.

UNIT-III:
INSTRUMENTATION AND CONTROL IN AIR-FUEL CIRCUIT: Air-Fuel Circuit – Fuels, combustion air, flue gases, waste gases, Measurements in Air- Fuel Circuit – Measurement of flow/quantity, Measurement of Pressures, Measurement of Temperatures, Measurement of level.
CONTROLS IN AIR-FUEL CIRCUIT: Combustion control, furnace Draft Control, Analytical Measurement – Oxygen Measurement in Flue Gas, Measurement of carbon dioxide in flue gas,

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combustibles analyzer (CO+H_2), Infrared flue gas analyzer, smoke detector, dust monitor, closed circuit television, fuel analyzers, chromatography, pollution monitoring instruments.

UNIT-IV:

TURBINE MONITORING AND CONTROL: Introduction – Classification, instrumentation control points of View, Principal parts of steam turbines, Turbine Steam Inlet System – Inlet valve arrangements, inlet measurements, Governors, Turbine Measurements – Process Parameters, mechanical parameters, electrical parameters, Turbine control system – safety control systems, process control systems, Lubrication for turbo-alternator – Lubrication system, Controls in Lubrication system, Turbo-Alternator Cooling System – Lube Oil cooling system, Alternator/Generator cooling system.

UNIT-V:

NUCLEAR POWER PLANT INSTRUMENTATION: Introduction – Instrumentation and Control for Nuclear Power Plant - Important Components of I&C System - Evolution of I&C in NPP – Reactor Control – Methods of Control, Control loops, Functions of control system, Pressurized water reactor (PWR) controls, boiler water reactor (BWR) controls, Liquid metal cooled reactor (LMCR) Control, role of reactor controls during start-up, normal operation and shutdown.

DIGITAL ARCHITECTURES IN NUCLEAR POWER PLANTS- System-level Instrumentation and control architecture, safety related systems, non-safety-related systems, man machine interface system (MMIS), Instrumentation and controls architecture platform.

RADIATION PROTECTION AND MONITORING – Accident at three-mile Island, USA, disaster at Chernobyl nuclear power plant, Ukraine, calamity at Fukushima, Daiichi nuclear power plant, Japan, Radiation Units, Biological Effects of Radiation, Radiation Monitoring, Nuclear Reactor Safety - Reactor protection system, Reactor Tripping, Engineered Safety Features, Surveillance, Diagnostics and Prognostics – Surveillance, Diagnosis, Prognosis.

TEXTBOOKS:

1. Modern Power Station Practice, Volume.6, Instrumentation, Controls and Testing, Pergamon Press, Oxford, 1971.
2. Power Plant Technology, Wakil M.M., McGraw-Hill.

REFERENCES:

1. Standard Boiler Operations-Questions and Answers. Elonka S.M and Kohal A.L., – Tata McGraw Hill, New Delhi,1994.
2. Power Plant Instrumentation by Prof. K. Krishna Swamy, Newage International Publisher.
3. Standard Boiler Operations - Questions and Answers – by Elonka S.M., andKohal A.L., TMH, New Delhi,1994

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OUTCOMES:

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

- Analyze thepower generation technique used in different types of powerplants.
- Analyze different parameters and their control in the powerplant.
- Apply various conceptsof Nuclear powerplants.

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IV Year- II Semester		L	T	P	C
		3	0	0	3
INSTRUMENTATION PRACTICES IN INDUSTRIES (PROFESSIONAL ELECTIVE –V)					

OBJECTIVES:

The main objectives of this course are:

- Identify and quantitatively estimate different materials required for the manufacturing of Cement, Pulp, Paper, food, Power and pharmacy.
- Understand the principles of different manufacturing processes.
- Recognize these principles written inform of mathematical & chemical equations.
- Apply these equations to analyze problems by making good assumptions and learn systematic engineering method to solve practical industrial problems.

UNIT-I:

CEMENT INDUSTRIES: Corrosion AnalysersPorositester Compressive strength measurement, Blast Furnace Temperature Measurement using Radiation Pyrometers.

UNIT-II:

PULP AND PAPER INDUSTRIES:

MANUFACTURE OF PULP: Raw materials, Pulping processes, Craft pulping, Soda pulping, Sulfite pulping, Semi chemical pulping, Mechanical and Thermo mechanical Pulping

MANUFACTURE OF PAPER: Wet Processing, Fourdrinier Machine, Coated Papers, Special Papers. Wet-end Instrumentation: Pressure: Force Balanced, Bell and Limp or Slack type systems, Temperature: Liquid in Glass, Thermal bulbs, Resistance Bulbs, Liquid Density and Specific Gravity: Fixed Volume, Differential Pressure, Nuclear Radiation Level: Liquid Level- Continuous Purge Instrument, Diaphragm box, Float and Cable, Capacitive, Solid Level- Diaphragm solids, Flow: Tapered tube & float type meter, Cylinder & Piston type meter, Weir and Flumes Consistency: Atmospheric with Driven and Atmospheric with Stationary Sensors, pH: pH Electrode system, types of electrodes, Oxidation Reduction Potential (ORP): ORP Electrode system, electrode holders. Freeness: Continuous Sample and Intermittent Sample Systems. Dry-end Instrumentation: Moisture: Conductivity, Resistance, Capacitance, Hygroscopic, And Infrared Absorption type systems, Basis Weight: Transmission type, On-Machine type, Off-Machine type and Backscatter, type systems, Caliper or Thickness: Contacting type- Electrical, Mechanical and Electro Mechanical, Non- Contacting type

UNIT-III:

PETROLEUM INDUSTRIES: Unit Operations: Distillation, Drying Separation Measurements in refineries petrochemical industries –Differential pressure transmitter, Thermocouples Infrared Pyrometer, Mass flow meters, Potentiometric level Transmitter, Vacuum Measurement, Near Infrared Analyzer, Hydro Carbon Dew point meter IR Spectrometry, Mass Spectrometry, Flame Ionization Detectors, Chromatography.

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UNIT-IV:

NUCLEAR POWER PLANT: Introduction, The power plant scheme, Pressure, flow and level measurement, Vibration and expansion measurements, Analysis of impurities in cooling water, Flue Gas analysis, Ultrasonic Thermometry, Radiation Pyrometry, Emittance measurement.

UNIT-V:

FOOD PROCESSING AND ALLIED INDUSTRIES: Chromatography, Spectrometry – Mass Spectrometer, Toxicity meter

TEXT BOOKS:

1. Chemical Process Industries, Austin G.T. Shreeves, McGraw-Hill International student edition, Singapore,1985
2. Pulp and Paper Industry Technology & Instrumentation, Sankar Narayana, P.E., Kothari's Desk book**.**

REFERENCES:

1. An Introduction to Paper Industry Instrumentation, John R Lavigne, Miller Freeman Publications, California, 1985 Series.
2. Process measurement and analysis, Liptak B.G., Third edition, Chilton book Company, 1996.
3. Measurement and Control in Papermaking, Robert J. McGill, Adam Hilger Limited, Bristol, 1980.
4. Process/ industrial instruments and controls hand book, Gregory K. McMillan, Douglas M. Considine.
5. Instrumentation in process industries, Liptak B.G., Chilton book Company,1994.

OUTCOMES:

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

- Apply fundamental knowledge of chemistry &instrumentation to modeling and analysis of different Industrial engineering.
- Understanddisasterscausedbyanincorrectanalysis/designindifferentIndustrial engineering system.
- Students will demonstrate a working knowledge of the basic principles of measuring techniques.
- Demonstrate technical knowledge and skills in the calibration and use of equipment used in different industrial process measurement and control.
- Students will demonstrate a working knowledge of safety practices and skills in trouble-shooting

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IV Year- II Semester		L	T	P	C
		3	0	0	3
VLSI TESTING & TESTABILITY (PROFESSIONAL ELECTIVE –V)					

OBJECTIVES:

The main objectives of this course are:

- 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.

TEXTBOOKS:

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

REFERENCES:

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

OUTCOMES:

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

- 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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		3	0	0	3

3D PRINTING

(OPEN ELECTIVE-II)

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, Functionalization 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.

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/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press
4. Rapid Prototyping / Chua &Liou

OUTCOMES:

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

- Identify the importance of RP in present scenario.
- Gain the knowledge on 3DP
- Application of 3DP in electronics.
- Minimize various errors that are occurring during conversion of CAD models.
- Applications of RP.

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		3	0	0	3
BLOCKCHAIN TECHNOLOGIES **(OPEN ELECTIVE-II)**					

OBJECTIVES:

The main objectives of this course are:

- Understand how block chain systems (mainly Bit coin and Ethereum) work and to securely interact with them,
- Design, build, and deploy smart contracts and distributed applications,
- Integrate ideas from block chain technology into their own projects.

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 in Market.

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, My Ether Wallet, Ethereum Networks/Environments, Infura, Ether scan, Ethereum Clients, Decentralized Application, Meta mask, Tuna Fish Use Case Implementation, Open Zeppelin Contracts

UNIT-V:

HYPERLEDGER BLOCKCHAIN IMPLEMENTATION: Introduction, Use Case – Car Ownership Tracking, Hyperledger Fabric, Hyperledger Fabric Transaction Flow, Fab Car Use Case Implementation, Invoking Chain code Functions Using Client Application.

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Advanced Concepts in Blockchain: Introduction, Inter Planetary 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. Antonpoulos, O'Reilly

REFERENCES:

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

E-RESOURCES:

https://github.com/blockchainedindia/resources

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 Crypto currency markets
- Examine how to profit from trading crypto currencies.

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IV Year- II Semester		L	T	P	C
		3	0	0	3
CYBER SECURITY & CRYPTOGRAPHY (OPEN ELECTIVE-II)					

OBJECTIVES:
The main objectives of this course are given below:

- 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.

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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.

TEXT BOOKS:

1. SunitBelapure Nina Godbole "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", WILEY, 2011.
2. Nelson Phillips and EnfingerSteuart, "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. NickolaiZeldovich. 6.858 Computer Systems Security. Fall 2014. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.

OUTCOMES:

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

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

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IV Year- II Semester		L	T	P	C
		0	0	18	9
PROJECT –PART II					

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OPEN ELECTIVES OFFERED BY EIE

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PRINCIPLES OF MEASUREMENT AND INSTRUMENTATION
(OPEN ELECTIVE-1)

OBJECTIVES:

The main objectives of this course are:

- Acquire knowledge of Basic functional elements of instrumentation.
- Learn and understand fundamentals of electrical and electronic instruments.
- Compare various measurement techniques.
- Learn and understand various storage and display devices.
- Compare various transducers and the data acquisition systems.

UNIT-I:

INTRODUCTION: Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration- Principle and types of analog and digital voltmeters, ammeters.

UNIT-II:

ELECTRICAL AND ELECTRONIC INSTRUMENTS: Principle and types of multi meters – Single and three phase watt meters and energy meters – Magnetic measurements – Determination of B-H curve and measurements of iron loss –Instrument transformers – Instruments for measurement of frequency and phase.

UNIT-III:

COMPARATIVE METHODS OF MEASUREMENTS:D.C potentiometers, D.C (Wheat stone, Kelvin and Kelvin Double bridge) & A.C bridges (Maxwell, Anderson and Schering bridges), transformer ratio bridges, self-balancing bridges. Interference & screening – Multiple earth and earth loops - Electrostatic and electromagnetic Interference – Grounding techniques.

UNIT-IV:

STORAGE AND DISPLAY DEVICES: Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Data Loggers.

UNIT-V:

TRANSDUCERS AND DATA ACQUISITION SYSTEMS: Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers – Piezoelectric, Hall effect, optical and digital transducers – Elements of data acquisition system – Smart Sensors-Thermal Imagers.

TEXTBOOKS:

1. 'A Course in Electrical & Electronic Measurements & Instrumentation', A.K. Sawhney, Dhanpat Rai and Co, 2010.
2. 'A Course in Electronic and Electrical Measurements', J. B. Gupta, S. K. Kataria& Sons, Delhi, 2013.

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3. Measurement Systems – Applications and Design, Doebelin E.O. and Manik D.N, Special Indian Edition, McGraw Hill Education Pvt. Ltd., 2007.

REFERENCES:

1. 'Electronic Instrumentation', H.S. Kalsi, McGraw Hill, III Edition 2010.
2. 'Transducers and Instrumentation', D.V.S. Murthy, Prentice Hall of India Pvt Ltd, 2015.
3. 'Electronic Instrumentation & Measurements', David Bell, Oxford University Press,2013.
4. 'Electrical Measurements', Martin Reissland, New Age International (P) Ltd., Delhi, 2001.
5. Principles of Measurements and Instrumentation, Alan. S. Morris, 2nd Edition, Prentice Hall of India, 2003.

OUTCOMES:

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

- To acquire knowledge on Basic functional elements of instrumentation.
- To understand the concepts of Fundamentals of electrical and electronic instruments.
- Ability to compare between various measurements techniques.
- To acquire knowledge on various storage and display devices.
- To understand the concepts various transducers and the data acquisition systems.
- Ability to model and analyze electrical and electronic Instruments and understand the operational features of display Devices and Data Acquisition System.

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DIGITAL SENSORS
(OPEN ELECTIVE-II)

OBJECTIVES:

The main objective of this course is:

- To make student to acquire the knowledge on types of sensors/transducers, working principles, selection procedure, and 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 and 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.

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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.

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.

TEXTBOOKS:

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

REFERENCE:

1. Mechanical Measurements – Beckwith, Marangoni, Lienhard
2. Measurement of Systems - Application and design - Earnest O. Doeblin
3. Electronic Instrumentation and Measurement Technique - Albert D Helfrick

OUTCOMES:

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

- Understand measuring parameters, measuring systems, effects of environment, characteristics and parameters to be considered for designing an instrument.
- Understand different types of sensors/transducers, working principles, selection procedure, applications of sensing systems.
- Understand Challenges and applications of sensors and sensor networks.
- Select a sensor/sensing system for a requirement.
- Test, install and collect the data from a group of sensors.
- Derive sensor-based solution for different applications.