

# GUJARAT TECHNOLOGICAL UNIVERSITY

## BIOMEDICAL ENGINEERING (03)

ANALOG CIRCUITS-II

SUBJECT CODE: 2140305

B.E. 4<sup>th</sup> SEMESTER

**Type of course:** Advanced device modeling and circuit design

**Prerequisite:** Basic knowledge of Diode, BJT, and MOSFET, JFET, Opamp and systems like amplifier, oscillator and feedback circuits.

**Rationale:** to prepare the students with detailed knowledge of design of basic analog pre-processing circuits for amplification, filtering & shielding purposes & also familiarize them with various display devices & PCB designing.

### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

### Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	INSTRUMENTATION AND ISOLATION AMPLIFIERS Instrumentation Amplifier, DC amplifiers, Pulsed excitation amplifier, AC carrier amplifier. Isolation amplifiers:-Carrier Type Isolation Amplifier, Opto Isolators/Optical Coupling, Transformer Coupled Isolation Amplifiers, Fiber Optic Isolation Amplifier, Isolated DC Amplifier, Chopper Stabilized Amplifier, Differential Chopper Amplifier, Linear power supplies, Switching power supplies, Inductor-less switching power supplies, Reverse battery protection, Problems associated with power supplies.	10	20%
2	GROUNDING AND SHIELDING TECHNIQUES Capacitive and Inductive crosstalk, EM coupling and interference, grounding considerations, shielding theory and techniques, Power supply noise reduction and filtering, Over-voltage and Electrostatic discharge (ESD) protection techniques. Mechanisms for Cooling, Mechanisms for Cooling, Design of Heat Sink Selection, Input Guarding, Safety Standards In Medical Electronic Amplifiers.	8	15%
3	OP AMP NOISE THEORY AND APPLICATIONS Introduction, RMS versus P-P Noise, Noise Floor, Signal-to-Noise Ratio, Multiple Noise Sources, Noise Units, Noise Corner Frequency. Types of Noise:- Shot Noise, Thermal Noise, Flicker Noise, Burst Noise, Avalanche Noise. Noise Colors: -White Noise, Pink Noise, Red/Brown Noise, Op Amp Noise.	8	20%
4	DESIGN TECHNIQUES FOR ACTIVE FILTER	8	20%

	Introduction, Fundamentals of Low-Pass Filters , Butterworth Low-Pass Filters, Tschebyscheff Low-Pass Filters, Bessel Low-Pass Filters, Quality Factor Q, Low-Pass Filter, High-Pass Filter, Band-Pass Filter, Band-Rejection Filter, All-Pass Filter, Notch filter, Practical Design of Filter Circuit Biasing, Capacitor Selection Component Values, Op Amp Selection.		
5	<b>INTRODUCTION TO COMMUNICATION SYSTEMS</b> Analog and digital communication systems Modulation, Need for modulation. Amplitude modulation: Frequency spectrum, representation of AM, modulation index, power relations in AM wave, AM Generation, modulated transistor amplifier, AM Transmitter and receiver. Frequency modulation: Mathematical representation of FM – Frequency - FM generation – Direct and indirect methods – FM Transmitters, FM demodulation techniques - FM Receivers. Phase modulation: Need for pulse modulation, different types, Pulse Width Modulation, Pulse Position Modulation and Pulse Code Modulation.	8	15%
6	<b>DATA DISPLAY AND RECORDING SYSTEM</b> CRO, Single Beam, Dual Trace, Double Beam CRO, Storage CRO, DSO, Analog And Digital Recorders, Signal Analyzer, frequency Analyzer, function generator, Magnetic Recorder, GPB & PCB Circuit design and component selection, create schematic PCB layout, PCB assembly using MULTISIM software	6	10%

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
10%	45%	15%	15%	15%

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**

- 1) Ralph Morrison”, Grounding And Shielding Technique”, Fourth Edition, John Wiley,1998
- 2) Kim R. Fowler “Electronic Instrument Design”, USA Oxford University Press
- 3) Electronics Device and circuits by S Salivahanan and N Suresh Kumar, McGraw Hill Publication [Second Edition or Higher Edition].
- 4) Gayakward- Opamps and Linear Integrated Circuits , Prentice Hall India
- 5) Ron Mancini “Opamp for Everyone” ,Texas Instrument
- 6) Kaustubh V. Gitapathi “ Electronic and Instrument Design” Chintan Publication

**Course Outcomes:**

After successful completion of the course students should be able to:

1. Demonstrate an ability to design Instrumentation and Isolation Amplifiers.
2. Design and understand the concept of Grounding and Shielding Techniques and demonstrate knowledge of Safety Standards in Medical Electronic Amplifiers.

3. Understand the different types of noise and design various types of filters to remove unwanted signals.
4. Describe the different types of communication system.
5. Demonstrate knowledge of Data Display and Recording System and design the PCB circuit.
6. Provide an engineering approach to develop a electronics circuit used in biomedical measurement systems.

### **List of Experiments:**

To design **Instrumentation and Isolation Amplifiers**

1. To design Instrumentation Amplifier.
2. To design Isolation Amplifiers.
3. To study different techniques for grounding.
4. To design low –pass and high-pass filters.
5. To design band-pass and notch filter.
6. To study about different types of modulation techniques.
7. To study about data display and recording system.
8. To study about various types of noise.
9. To perform Power supply noise reduction and filtering.
10. To design the electronic circuit using PCB Layout.

**Design based Problems (DP)/Open Ended Problem: Electronic circuit design for given requirements**

**Major Equipment:** Electronic Components, DSO, CRO, Function Generator, Multisim Software, Tina Software

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.