PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
Autonomous
Siddhartha Nagar, Vijayawada–520010
Re-accredited at 'A+' by the NAAC

Course Code				**23PHMAP234**			
Title of the Course				**ANALOG AND DIGITAL ELECTRONICS**			
Offered to:				**B.Sc. Hons Physics**			
L	**0**	**T**	**0**	**P**	**2**	**C**	**1**
Year of Introduction:	**2024-25**			**Semester:**			**3**
Course Category:	**MAJOR**			**Course Relates to:**	**L, R, N & G**		
Year of Revision:	**NA**			**Percentage:**	**NA**		
Type of the Course:				**EMPLOYABILITY & SKILL DEVELOPMENT**			
Crosscutting Issues of the Course :				**NA**			
Pre-requisites, if any				**BASIC ELECTRONICS**			

Course Description:

This lab course provides hands-on experience with operational amplifiers, number systems, logic gates, arithmetic circuits, data processing circuits, and sequential logic circuits. Students will explore basic differential amplifiers, internal Op-Amp blocks, and applications such as voltage followers and amplifiers. They will learn binary-to-decimal conversions, Boolean algebra, and logic gate operations. The course covers arithmetic circuits like adders and subtractors, as well as multiplexers, demultiplexers, decoders, and encoders. Sequential logic circuits, including various types of flip-flops, are also examined. The lab emphasizes practical skills and foundational knowledge essential for understanding and applying electronic circuit principles.

Course Aims and Objectives:

S. NO	**COURSE OBJECTIVES**
1	Study internal blocks, characteristics, and applications of operational amplifiers, including inverting/non-inverting amplifiers, comparators, integrators, and differentiators.
2	Convert between binary/decimal systems, apply Boolean algebra, and work with basic logic gates like NAND, NOR, and exclusive-OR.
3	Create and analyze half/full adders and subtractors, and 4-bit binary adders/subtractors.
4	Build and understand multiplexers, demultiplexers, decoders, and encoders for data processing.
5	Design and convert RS, SR, JK, D, T, and Master-Slave flip-flops for sequential circuits and code converters.

Course Outcomes

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

CO NO	COURSE OUTCOME	BTL	PO	PSO
CO1	Understand Op-Amps	**K2**	**1**	**1**
CO2	Gain the knowledge of Number Systems and Logic Gates	**K1**	**2**	**1**
CO3	Design Arithmetic Circuits	**K6**	**4**	**2**
CO4	Implement Data Processing Circuits	**K3**	**2**	**1**
CO5	Design and convert Sequential Logic Circuits	**K3**	**4**	**1**

For BTL: K1: Remember; K2: Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

CO-PO MATRIX									
CO NO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**
CO1	**2**							**2**	
CO2		**1**							**1**
CO3				**3**					**3**
CO4		**3**						**2**	
CO5				**3**				**3**	

Use the codes 3, 2, 1 for High, Moderate and Low correlation Between CO-PO-PSO respectively

Course Structure

This lab list covers the key areas of an **ANALOG AND DIGITAL ELECTRONICS** course, providing hands-on practice with technology

Unit I: OPERATIONAL AMPLIFIERS – I

1. To study the operational amplifier as an inverting feedback amplifier with verifying gain

   The **task** is to study an operational amplifier (op-amp) in an inverting feedback configuration, where the input signal is inverted and amplified. You will verify the amplifier's gain by comparing the theoretical gain (based on resistor values) with the experimentally measured output signal gain.

Unit-II: OPERATIONAL AMPLIFIERS-II

2. To study the operational amplifier as a non-inverting feedback amplifier with verifying gain

   The **task** is to study a non-inverting operational amplifier, where the output signal maintains the same phase as the input, and verify its gain experimentally

3. To study operational amplifiers as an adder

   The **task** is to study how an operational amplifier functions as an adder, summing multiple input signals and producing a combined output signal.

4. To study operational amplifiers as a subtractor

   The **task** is to study how an operational amplifier functions as a subtractor, taking multiple input signals and producing an output based on their differences.

5. To study operational amplifiers as a differentiator

   The **task** is to study how an operational amplifier functions as a differentiator, producing an output proportional to the rate of change (derivative) of the input signal.

6. To study operational amplifier as an integrator

   The **task** is to study how an operational amplifier functions as an integrator, producing an output signal proportional to the integral of the input signal over time.

UNIT-III: **NUMBER SYSTEMS, CODES AND LOGIC GATES**

7. Logic Gates- OR, AND, NOT and NAND gates. Verification of Truth Tables.

   The **task** involves studying and verifying the operation of basic logic gates—OR, AND, NOT, and NAND gates—by examining their behavior with different input combinations. You will verify their respective truth tables, which define the output for every possible input, ensuring they function as expected.

8. Verification of De Morgan’s Theorems.

   The complement of a conjunction (AND) is equivalent to the disjunction (OR) of the complements: $\overline{A.B} = \overline{A} + \overline{B}$

   The complement of a disjunction (OR) is equivalent to the conjunction (AND) of the complements: $\overline{A + B} = \overline{A}.\overline{B}$

UNIT-IV: **ARITHMETIC CIRCUITS & DATA PROCESSING CIRCUITS**

9. Construction of Half adder and Full adders-Verification of truth tables

   In digital electronics, a Half Adder and a Full Adder are fundamental components used to perform binary addition. Let’s go through how they work, how their truth tables are verified, and some practical applications.

   Half Adder:

   A Half Adder is a basic building block used to add two single-bit binary numbers (A and B). It produces two outputs:

   Sum (S): Result of the addition.

   Carry (C): Carry generated if the sum exceeds the value of one bit.

   Truth Table for Half Adder:

   Truth Table

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	1	1

Construction of Half Adder

Sum (S): Implemented using an XOR gate. S=A⊕B

Carry (C): Implemented using an AND gate. C=A·B

Full Adder:

A Full Adder is more advanced because it takes three inputs: two bits (A and B) and a Carry-in (C-in) from a previous addition. It also produces two outputs:

Sum (S): Result of the addition.

Carry (C-out): Carry output for the next addition.

Truth Table for Full Adder:

A	B	C in	Sum (S)	Carry (C-out)
0	**0**	**0**	**0**	**0**
0	**0**	**1**	**1**	**0**
0	**1**	**0**	**1**	**0**
0	**1**	**1**	**0**	**1**
1	**0**	**0**	**1**	**0**
1	**0**	**1**	**0**	**1**
1	**1**	**0**	**0**	**1**
1	**1**	**1**	**1**	**1**

Logic:

Sum (S) is the result of an XOR operation with all inputs**:** S=A⊕B⊕Cin

Carry (C-out) is generated using a combination of AND and OR gates:

Cout=(A·B)+(Cin·(A⊕B))

Verification of Truth Tables:

To verify these truth tables practically:

Build the Circuit:

- Use XOR gates for the sum operation and AND gates for the carry.
- For the Full Adder, connect the carry output of one adder to the carry input of the next adder in a sequence.

Test the Inputs and Outputs:

Apply all possible combinations of inputs (A, B, and C-in for the Full Adder) and verify the outputs match the truth tables.

10. Multiplexer and De-multiplexer

    Multiplexers (MUX) and De-multiplexers (DEMUX) are essential digital devices used in communication systems and digital electronics to manage data efficiently by controlling the flow of multiple input/output lines.

11. Encoder and Decoder

    Encoders and Decoders are essential components in digital electronics that are used for data conversion, encoding, and decoding of binary signals. Let's dive into their operations, truth tables, and applications.

UNIT-V: **SEQUENTIAL LOGIC CIRCUITS & CODE CONVERTERS**

12. Flip flops

    Flip-flops are fundamental building blocks in digital electronics that act as memory elements. They store a single bit of binary information (0 or 1) and maintain their state until triggered by a control signal. Unlike combinational circuits, flip-flops are sequential circuits, meaning their output depends not only on the current input but also on the previous state.

    1. **SR (Set-Reset) Flip-Flop**
    2. **JK Flip-Flop**
    3. **D (Data or Delay) Flip-Flop**
    4. **T (Toggle) Flip-Flop**

Verification of Flip-Flop Operation:

To verify the operation of flip-flops:

1. Build the Circuit: Use logic gates or a pre-built flip-flop IC.
2. Apply Input Signals: Provide different combinations of inputs (S, R, J, K, D, or T) and observe the output.
3. Clock Pulse: For clocked flip-flops, provide a clock signal and ensure the output changes only on the specified clock edge or level.
4. Compare with Truth Table: Check if the actual output matches the expected output from the truth table.

Note :

1. 9 (NINE) experiments are to be done and recorded in the lab. These experiments will be evaluated in CIA.
2. For certification minimum of 7 (Seven) experiments must be done and recorded by student who had put in 75 % of attendance in the lab.
3. 15 marks = 15 marks for CIA
4. 35 marks for practical exam.

The marks distribution for the Semester End practical examination is as follows:

Formula/ Principle / Statement with explanation of symbols	05
Diagram/Circuit Diagram / Tabular Columns	05
Setting up of the experiment and taking readings/Observations	10
Calculations (explicitly shown) + Graph + Result with Units	05
Procedure and precautions	05
Viva-voce	05
Total Marks:	35

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