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**	**PO2**	**PSO2**
CO2	Gain the knowledge of Number Systems and Logic Gates	**K1**	**PO1**	**PSO1**
CO3	Design Arithmetic Circuits	**K6**	**PO2**	**PSO2**
CO4	Implement Data Processing Circuits	**K3**	**PO2**	**PSO1**
CO5	Design and convert Sequential Logic Circuits	**K6**	**PO2**	**PSO2**

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		**3**							**2**
CO2	**2**							**2**	
CO3		**3**							**3**
CO4		**2**						**2**	
CO5		**3**							**3**

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

UNIT-I: OPERATIONAL AMPLIFIERS – I (12 Hours)

1(a) Operational Amplifiers: Basic differential amplifiers, Op-Amp supply voltage, IC identification, Internal blocks of Op-Amp.

1 (b) Characteristics of ideal and practical Op-Amp (IC 741) its parameter offset voltages and currents, CMRR, slew rate, concept of virtual ground.

- **Assignment**: Research and document the internal block diagram of the **IC 741 Op-Amp**, highlighting the role of each internal block. Explain how supply voltage impacts its operation and identify the key differences between an ideal and practical Op-Amp in terms of offset voltages, currents, and CMRR.
- **Activity**: Perform an **experimental setup** to measure the **slew rate** of the IC 741 operational amplifier. Compare the measured value with the theoretical value and analyze how the concept of virtual ground plays a role in the performance of Op-Amp circuits.

Unit-II OPERATIONAL AMPLIFIERS-II (12 Hours)

2(a) Applications of Op-Amp: Op-Amp as a voltage follower, Inverting amplifier, non-inverting amplifier, and voltage follower.

2(b) Summing amplifier, difference amplifier, comparator, integrator, Differentiator.

- **Activity**: Design and build an **inverting amplifier** and a **non-inverting amplifier** using an Op-Amp. Measure and analyze the gain for different input voltages. Compare the theoretical and experimental results, and discuss the advantages of using Op-Amps in these configurations.
- **Assignment**: Create a **summed audio signal** using a **summing amplifier** circuit. Combine two different audio input signals and observe the output waveform. Discuss the practical applications of summing amplifiers in audio systems and signal processing.

UNIT-III: NUMBER SYSTEMS, CODES AND LOGIC GATES (12 Hours)

a) Number systems - Conversion of binary to decimal system and vice versa. Binary addition and subtraction (1's and 2's complement methods). BCD code and Gray code - Conversions

b) Logic Gates: Basic logic gates, NAND and NOR as universal gates, exclusive-OR gate, Laws of Boolean algebra - Simplification of Boolean Expressions using Boolean Laws, De Morgan's laws-statement and proof.

- **Activity**: Practice converting between binary and decimal systems by solving a set of problems that include binary addition and subtraction using 1's and 2's complement methods. Also, perform BCD to Gray code conversions and vice versa. Create a report summarizing the steps and results for each conversion.
- **Assignment**: Build truth tables for basic logic gates (AND, OR, NOT) and use NAND and NOR gates as universal gates to replicate the functions of all other gates. Simplify given Boolean expressions using Boolean algebra and De Morgan's laws, and present the step-by-step process for simplification.

UNIT-IV: ARITHMETIC CIRCUITS & DATA PROCESSING CIRCUITS 9 hrs

a) Half Adder and Full Adder, Half and Full Subtractor, 4-bit binary Adder/Subtractor.

b) Multiplexers - 2 to 1 and 4 to 1, De-multiplexers: 1 to 2, 1 to 4 Demultiplexer, Decoders: 1 of 2, 2 of 4 decoders, Encoders: 4 to 2, 8 to 3 Encoder,

- **Activity**: Design and simulate a **4-bit binary adder/subtractor** circuit using logic gates. Explain the working principles of both the **Half Adder and Full Adder**, as well as the **Half Subtractor and Full Subtractor**. Use a circuit simulation software (such as Multisim or LogicWorks) to verify the correctness of your design.
- **Assignment:** Implement a **4-to-1 multiplexer** and a **1-to-4 de-multiplexer** using basic logic gates. Demonstrate how these circuits function by preparing truth tables and simulating them in a digital logic tool. Additionally, explain the role of **encoders** and **decoders** in data transmission and processing with practical examples.

UNIT-V: SEQUENTIAL LOGIC CIRCUITS & CODE CONVERTERS 9 hrs

5(a) Sequential digital circuits: Flip-flops, RS, Clocked SR, JK.

5(b) D, T, Master-Slave, Flip-flop, Conversion of Flip-flops.

- **Activity**: Design and simulate different **flip-flops (RS, JK, D, and T)** using digital logic simulation software. Test the behavior of each flip-flop under various input conditions and create a comparison table. Write a report explaining the working principles of each flip-flop and highlight differences in their functionality and practical use.
- **Assignment**: Perform the **conversion of one type of flip-flop into another** (e.g., convert an **SR flip-flop into a JK flip-flop or a D flip-flop into a T flip-flop**). Document the step-by-step conversion process and provide truth tables and diagrams to explain how the conversion is achieved. Include examples of real-world applications for the converted flip-flop.

Reference:

B.Sc., Unified Physics – Analog and Digital Electronics; Course 8 Dr.S.L Gupta, Sanjeev Gupta , Jaiprakash Nath Publications (2024)

Reference Books:

1. B.Sc., Physics, Vol.3, Telugu Akademy, Hyderabad
2. Principles of Electronics, V.K. Mehta, S.Chand& Co.,
3. Digital Principles and Applications, A.P. Malvino and D.P.Leach, McGrawHill Edition.

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SEMESTER -END QUESTION PAPER STRUCTURE

Course Code & Title of the Course:	**23PHMAL234:ANALOG AND DIGITAL ELECTRONICS**
Offered to:	**B.Sc. Hons Physics**
Category:	**SEMESTER: 3**
Max. Marks	**70**
Max.Time	**3 Hrs**

Section A: Short Answer Questions (20 Marks)

Answer All questions. Each question carries 4 Marks.

1. (A) Write a short note on the slew rate and concept of virtual ground of an OP-AMP. (CO1, K3)

(OR)

(B) Draw the block diagram of an OP-Amp. (CO1, K3)

2. (A) Explain how an OP Amp acts as a voltage follower. (CO2, K3)

(OR)

(B) Draw the summing amplifier using an OP-Amp and explain its operation (CO2, K3)

3. (A) Explain how the NAND gate can act as a universal gate (CO3, K2)

(OR)

(B) Explain the procedure of 2's complement of binary addition (CO3, K2)

4. (A) The CMRR of a differential amplifier is 55db if its gain in differential mode A_d is 1200, then calculate its gain in common mode Am=? (CO1, K3)

(OR)

(B) In an inverting OP-AMP, the input resistor R_1=20KΩ and feedback resistor R_F=100KΩ. Calculate the output voltage (Input Voltage 1 Volt) (CO1, K3)

5. (A) (i) Convert $(625)_{10}$ into a binary number

(ii) Convert $(110111)_2$ into decimal number (CO3, K3)

(OR)

(B) Show that the logic expression $\overline{AB}(A+B)=\overline{A}B+A\overline{B}$ (CO3, K3)

Section B: Long Answer Questions (5X10=50 Marks)

Answer All questions. Each question carries 10 Marks.

6. (A) What is an Operational amplifier? Give the comparison between ideal practical OP-Amp. (CO1, K1)

(OR)

(B) Briefly explain basic differential amplifiers and IC identification of an OP-Amp. (CO1, K1)

7. (A) Explain inverting and non-inverting amplifiers and obtain the expression for their output voltages (CO2, K2)

(OR)

(B) Explain how the operational amplifier acts as an Integrator and Differentiator (CO2, K2)

8. (A) State and prove De Morgan Laws (CO3, K2)

(OR)

(B) Explain logic gates with truth tables (CO3, K2)

9. (A) Explain the construction and working of half and full adders with truth tables (CO3, K3)

(OR)

(B) Distinguish between the multiplexer and De-multiplexers. Explain the 8:1 Multiplexer. (CO3, K3)

10. (A) Draw the logic circuits and truth tables of RS & Clocked RS flip flops (CO5, K2)

(OR)

(B) Explain the conservation of RS to JK & JK to T flip-flops (CO5, K2)

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