



MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(AN AUTONOMOUS INSTITUTION)

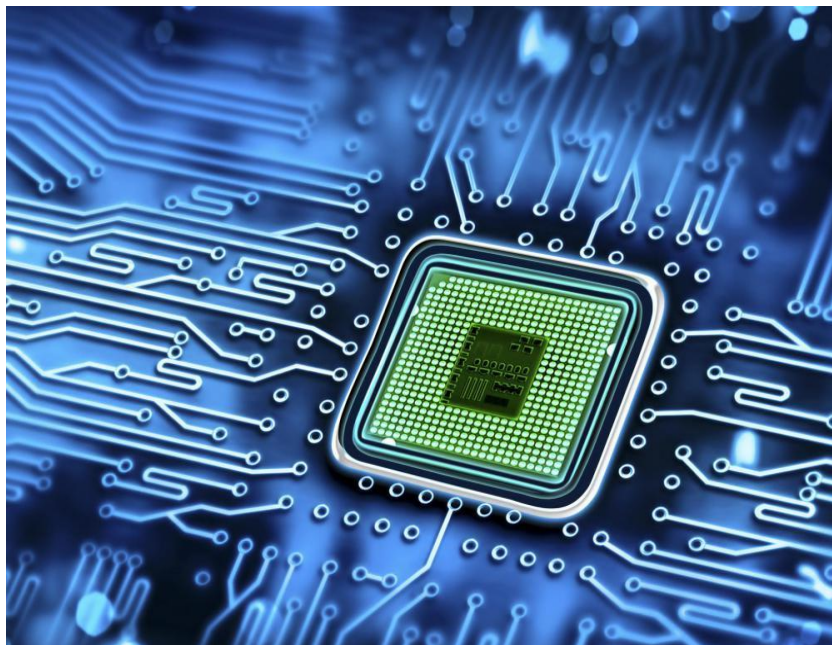
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section 2(f) & 12(B) of the UGC act, 1956

LINEAR AND DIGITAL IC APPLICATIONS
LABORATORY MANUAL

II YEAR II SEMESTER

REGULATION: MLRS R25



AY:2026-2027

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE STRUCTURE, OBJECTIVES & OUTCOMES**COURSE STRUCTURE**

Level	Credits	Periods/week	Prerequisites
UG	1	3	-

Evaluation Scheme:

MID (Internal Lab) Semester Test	30 marks
Day to day evaluation	10 marks
End Semester Lab external Examination	60 marks

The end semester examination shall be conducted with an external examiner and internal examiner.

The external examiner shall be appointed by the principal / Chief Controller of examinations.



MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(AN AUTONOMOUS INSTITUTION)

(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section 2(f) & 12(B) of the UGC act, 1956

DEPARTMENT OF ELECTRONICS AND COMMUNICATION
LINEAR AND DIGITAL IC APPLICATIONS
LABORATORY MANUAL

Virtual lab details

Name of the Virtual Lab: NA
Virtual Lab Host Institute: NA
URL/Link to Lab: NA
Academic Year: NA
Semester: NA

S. No	CONTENTS	Page No
1	CERTIFICATE	i
2	PREFACE	ii
3	ACKNOWLEDGEMENT	iii
4	GENERAL INSTRUCTIONS	iv
5	SAFETY PRECAUTIONS	v
6	INSTITUTE VISION AND MISSION	vi
7	DEPARTMENT VISION MISSION, PROGRAMME EDUCATIONAL OBJECTIVES	vii
8	PROGRAMME OUTCOMES-PROGRAMME SPECIFIC OUTCOMES	vii
9	COURSE STRUCTURE, OBJECTIVES & OUTCOMES	x
10	CO-PO MAPPING	xi
11	EXPERIMENTS	xii
12	Design an Inverting and Non-inverting Amplifier using Op Amp and calculate gain.	1-14
13	Design Adder and Subtractor using Op Amp and verify addition and subtraction process.	15-21
14	Design a Comparator using Op-Amp and draw the comparison results of $A=B$, $A > B$.	22-31
15	Design a Integrator and Differentiator Circuits using IC741 and derive the required condition practically.	32-42
16	Design a Active LPF, HPF cutoff frequency of 2 KHz and find the roll off of it.	43-52
17	Design a Circuit using IC741 to generate sine / square / triangular wave with period of 1 KHz and draw the output waveform.	53-61
18	Construct Mono-stable Multivibrator using IC555 and draw its output waveform.	62-66
19	Construct Astable Multivibrator using IC 555 and draw its output waveform and also find its duty cycle.	67-70
20	Design a Schmitt Trigger Circuit and find its LTP and UTP.	71-80
21	Design Voltage Regulator using IC723, IC 7805 / 7809 / 7912 and find its load regulation factor.	81-86
22	Design a 8x1 multiplexer using digital ICs.	87-91
23	Design a 4-bit Adder / Subtractor using digital ICs and Add / Sub the following bits.(i) 1010 (ii) 0101 (iii) 1011 (iv) 0100 (v) 0010 (vi) 1001.	92-96
24	Design a Decade counter and verify its truth table and draw respective waveforms.	97-100
25	Design a Up/downcounter using IC74163 and draw read/write waveforms.	101-105
26	Design a Universal shift register using IC74194 / 195 and verify its shifting operation.	106-110
27	Design a 16x4 RAM using 74189 and draw its read /write operation.	111-115

CERTIFICATE

This is to certify that this manual is a bonafide record of practical work in the **Linear And Digital Ic Applications** In IVth Semester of II -year B. Tech Sem II (ECE) Programme during the academic year 2023-2024. This book is prepared by Mrs. P.Lavanya (Assistant Professor), Mr. G.S.S.Varma (Assistant Professor), Department of Electronics and Communication Engineering.

LAB I/C

Head of the Department

PREFACE

Linear and Digital Integrated Circuits (ICs) are essential building blocks in the world of electronics, each contributing to the functionality of modern devices in unique ways. Linear ICs, which process continuous signals, are primarily used in applications that require precise amplification, regulation, and analog signal processing. These include audio equipment, sensors, power management systems, and other scenarios where signal fidelity and smooth operation are critical. By maintaining a direct, proportional relationship between input and output, Linear ICs are vital in ensuring that real-world analog signals, such as sound or temperature, are accurately captured and controlled in electronic systems.

Digital ICs, on the other hand, operate with discrete signals and are the foundation of digital processing, computation, and control. They power microprocessors, memory chips, and logic circuits, enabling devices like computers, smartphones, and automated systems to perform complex tasks. Digital ICs are built on binary systems, where signals exist in two distinct states, '0' and '1', allowing for rapid processing, data storage, and decision-making. Together, Linear and Digital ICs enable the seamless integration of analog and digital systems, driving innovations across a wide range of industries, from consumer electronics to industrial automation and communications.

By,

Mrs. P.Lavanya

ACKNOWLEDGEMENT

It was really a good experience, working with Linear And Digital IC Applications Laboratory. First, we would like to thank Dr. N. Srinivas, Assoc. Professor, HOD of Department of Electronics and Communication Engineering, Marri Laxman Reddy Institute of technology & Management for his concern and giving the technical support in preparing the document.

We are deeply indebted and gratefully acknowledge the constant support and valuable patronage of Dr. Ravi Prasad, Dean, Marri Laxman Reddy Institute of technology & Management for giving us this wonderful opportunity for preparing the Analog and Digital Communications Laboratory manual.

We express our hearty thanks to Dr.R.Murali Prasad, Principal, Marri Laxman Reddy Institute of technology & Management, for timely corrections and scholarly guidance.

At last, but not the least I would like to thanks the entire ECE Department faculty those who had inspired and helped us to achieve our goal.

By,

Mrs. P.Lavanya

GENERAL INSTRUCTIONS

1. Students should report to the concerned labs as per the timetable schedule.
2. Students who turn up late to the labs will in no case be permitted to perform the experiments scheduled for the day.
3. After completion of the experiment, certification of the concerned staff in-charge in the observation book is necessary.
4. Students should bring a notebook of about 100 pages and should enter the readings/observations into the notebook while performing the experiment.
5. The record of observations along with the detailed experimental procedure of the experiment.
6. Performed in the immediate last session should be submitted and certified by the staff member in-charge.
7. Not more than one student is permitted to perform the experiment on a setup.
8. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
9. Any damage of the equipment or burnout of components will be viewed seriously by putting penalty.
10. Students should be present in the labs for the total scheduled duration.
11. Students are required to prepare thoroughly to perform the experiment before coming to Laboratory.
12. Procedure sheets/data sheets provided to the student's should be maintained neatly and to be returned after the experiment.

SAFETY PRECAUTIONS

1. No horseplay or running is allowed in the labs.
2. No bare feet or open sandals are permitted.
3. Before energizing any equipment, check whether anyone is in a position to be injured by your actions.
4. Read the appropriate equipment instruction manual sections or consult with your instructor.
5. Before applying power or connecting unfamiliar equipment or instruments into any circuits.
6. Position all equipment on benches in a safe and stable manner.
7. Do not make circuit connections by hand while circuits are energized. This is especially.
8. Dangerous with high voltage and current circuits.

INSTITUTE VISION AND MISSION

Vision of the Institute

To be a globally recognized institution that fosters innovation, excellence, and leadership in education, research, and technology development, empowering students to create sustainable solutions for the advancement of society.

Mission of the Institute

To foster a transformative learning environment that empowers students to excel in engineering, innovation, and leadership.

To produce skilled, ethical, and socially responsible engineers who contribute to sustainable technological advancements and address global challenges.

To shape future leaders through cutting-edge research, industry collaboration, and community engagement.

Quality Policy

The management is committed in assuring quality service to all its stakeholders, students, parents, alumni, employees, employers, and the community. Our commitment and dedication are built into our policy of continual quality improvement by establishing and implementing mechanisms and modalities ensuring accountability at all levels, transparency in procedures, and access to information and actions.

DEPARTMENT VISION AND MISSION

Vision of the Department

To provide quality technical education in Electronics and Communication Engineering through research, innovation, striving for global recognition in specified domain, leadership, and sustainable societal solutions.

Mission of the Department

- **DM1:** To create a transformative learning environment that empowers students in electronics and communication engineering, fostering excellence in technical skills and leadership.
- **DM2:** To drive innovation through research, deliver a transformative education grounded in ethical principles, and nurture the development of professionals
- **DM3:** To cultivate strong industry partnerships, and engaging actively with the community for societal and technological progress.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Have successful careers in Industry

PEO2: Show Excellence in Higher Studies/ Research

PEO3: Show Good competency towards entrepreneurship.

PROGRAM OUTCOMES (PO):

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

PSO 1: Analyze and design analog & digital circuits or systems for a given specification and function.

PSO2: Implement functional blocks of hardware-software co-designs for signal processing and communication applications.

PSO 3: Gain the hands-on competency skills in computing tools for electronics and communication systems for the entry level position to meet the employer's requirements

COURSE STRUCTURE:

Level	Credits	Periods/Week	Prerequisites
UG	1	3	Entire subject of Analog and Digital Communications.

EVALUATION SCHEME:

MID (Internal Lab) Semester Test	20 Marks
Day to day evaluation	20 Marks
End Semester Lab external Examination	60 Marks

Evaluation Scheme:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for Continuous Internal Evaluation (CIE) and 60 marks for semester end lab examination. Out of 40 marks for internal evaluation:

- A write-up on day-to-day experiment(aim,components/procedure, expected outcome)
- 10 marks for viva-voce/ tutorial/ case study/ application/ poster presentation.
- Internal practical examination shall be evaluated for 10 marks.
- The remaining 10 marks are for Laboratory Project (Design/ Software / Hardware Model/ App Development/ Prototype).

Table 1: CIE marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIE marks	20	10	10	40

Continuous Internal Evaluation (CIE): Two CIE exams shall be conducted at the 8th week and 16th week of the semester; the average of the two CIEs will be taken into account. The CIE exam is conducted for 10 marks.

The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.

In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

- 10 marks for write-up
- 15 for experiment/program
- 15 for evaluation of results
- 10 marks for presentation on another experiment/program in the same laboratory course and
- 10 marks for viva-voce on concerned laboratory course.

COURSE OBJECTIVES:

1. Fundamental principles, characteristics, and applications of operational amplifiers, timers, and regulators.
2. Design and implementation of waveform generators, active filters, and signal processing circuits using ICs.
3. Architecture, working principles, and performance parameters of data converters such as DACs and ADCs.
4. Realization of combinational logic circuits using TTL and CMOS families for various digital applications.
5. Design and analysis of sequential logic circuits and memory devices for practical digital system development.

COURSE OUTCOMES:

At the end of the laboratory work, students will be able to

1. Assemble and test op-amp based amplifiers (inverting/noninverting), adders/subtractors, integrators/differentiators and measure their gains, bandwidth and linearity.
2. Construct and verify waveform generators, mono-stable/astable timers, PLL blocks, and characterize their frequency, duty cycle and stability.
3. Implement DACs and ADCs (R-2R, counter, SAR, dual slope, parallel comparator) and compute resolution, conversion time and efficiency.
4. Design and experimentally verify combinational and sequential logic circuits (multiplexers, encoders, decoders, adders, counters, shift registers) and memory read/write operations.
5. Analyze discrepancies between theoretical and measured results, compute error percentages, and propose methods to improve circuit performance (e.g., offset compensation, filtering, proper decoupling).

MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	PROGRAM OUTCOMES												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
CO2	✓	-	✓	✓	✓	-	-	-	-	-	-	-	✓	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
CO5	✓	-	✓	✓	✓	-	-	-	-	-	-	-	✓	✓

JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

Course Outcomes	PO'S/ PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO1	PO1	1. Application of scientific principles and methodologies.	1
	PO2	1. Recognizing and defining complex engineering problems or opportunities. 2. Structuring and abstracting the problem for systematic analysis. 3. Examining research literature 4. Investigating problems using data collection and relevant methodologies.	4
	PO3	1. Investigate and define a problem while identifying constraints, including environmental, sustainability, health, and safety considerations. 2. Understand customer and user needs while considering factors such as aesthetics. 3. Identify and manage cost drivers in engineering solutions. 4. Use creativity to develop innovative engineering solutions. 5. Ensure fitness for purpose across production, operation, maintenance, and disposal. 6. Manage the design process and evaluate outcomes for safety and risk assessment.	6
	PO5	1. Develop engineering solutions using modern tools across various disciplines.	1
	PSO1	1. Analyze response of a circuit or system	2

			2. Design of a circuit or system for a given specification		
		PSO2	1. Develop Operational block diagrams 2. Proficiency in the use of software tools for circuit design.	2	
	CO2	PO1	1. Utilization of mathematical concepts in problem-solving. 2. Integration of knowledge from various engineering disciplines.	2	
		PO3	1. Understand customer and user needs while considering factors such as aesthetics. 2. Identify and manage cost drivers in engineering solutions. 3. Use creativity to develop innovative engineering solutions. 4. Ensure fitness for purpose across production, operation, maintenance, and disposal.	4	
		PO4	1. Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data. 2. Address complex problems in various engineering contexts, including operations, management, and technology development. 3. Leverage technical literature and reliable information sources	3	
		PO5	Identify appropriate prediction and modeling tools for diverse engineering applications	1	
		PSO1	1. Analyze response of a circuit or system 2. Design of a circuit or system for a given specification 3. Understand and apply circuit or system specifications accurately. 4. Knowledge of analog and digital signal processing techniques.	4	
		PSO2	1. Develop Operational block diagrams 2. Proficiency in the use of software tools for circuit design.	2	
	CO3	PO1	1. . Integration of knowledge from various engineering disciplines.	1	
		PO2	1. Recognizing and defining complex engineering problems or opportunities. 2. Structuring and abstracting the problem for	8	

		<p>systematic analysis.</p> <ol style="list-style-type: none"> 3. Examining research literature 4. Investigating problems using data collection and relevant methodologies. 5. Applying mathematical, natural, and engineering sciences in problem-solving. 6. Ensuring accuracy and reliability through validation. 7. Planning and conducting experiments for problem analysis. 8. Implementing and testing solutions through experimentation. 	
	PO3	<ol style="list-style-type: none"> 1. Understand customer and user needs while considering factors such as aesthetics. 2. Identify and manage cost drivers in engineering solutions. 3. Use creativity to develop innovative engineering solutions. 4. Ensure fitness for purpose across production, operation, maintenance, and disposal. 5. Manage the design process and evaluate outcomes for safety and risk assessment. 6. Understand the commercial and economic context of engineering processes. 	6
	PO4	<ol style="list-style-type: none"> 1. Gain a deep understanding of materials, equipment, processes, and products through research to address engineering problems effectively. 2. Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data. 3. Address complex problems in various engineering contexts, including operations, management, and technology development. 4. Leverage technical literature and reliable information sources 5. Follow appropriate codes of practice and industry standards when analyzing and interpreting experimental data. 6. Ensure high-quality results by integrating various data sources and considering quality control during engineering investigations. 	6
	PO5	<ol style="list-style-type: none"> 1. Utilize IT tools in engineering analysis, design, and decision-making. 	1
	PSO1	<ol style="list-style-type: none"> 1. Analyze response of a circuit or system 2. Design of a circuit or system for a given 	2

		specification	
CO4	PO1	1. Integration of knowledge from various engineering disciplines.	1
	PO2	1. Structuring and abstracting the problem for systematic analysis. 2. Examining research literature 3. Investigating problems using data collection and relevant methodologies. 4. Applying mathematical, natural, and engineering sciences in problem-solving. 5. Ensuring accuracy and reliability through validation. 6. Planning and conducting experiments for problem analysis. 7. Implementing and testing solutions through experimentation. 8. Evaluating results to draw meaningful engineering conclusions.	8
	PO3	1. Understand customer and user needs while considering factors such as aesthetics. 2. Identify and manage cost drivers in engineering solutions. 3. Use creativity to develop innovative engineering solutions. 4. Ensure fitness for purpose across production, operation, maintenance, and disposal.	4
	PO4	1. Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data. 2. Address complex problems in various engineering contexts, including operations, management, and technology development. 3. Leverage technical literature and reliable information sources 4. Follow appropriate codes of practice and industry standards when analyzing and interpreting experimental data. 5. Ensure high-quality results by integrating various data sources and considering quality control during engineering investigations. 6. Draw valid conclusions by addressing technical uncertainties through sound reasoning and scientific principles.	6
	PO5	1. Implement simulation tools in different engineering fields.	1
	PSO1	1. Design of a circuit or system for a given specification	1
	PO1	1. Integration of knowledge from various engineering disciplines.	1

CO5	PO3	<ol style="list-style-type: none"> 1. Investigate and define a problem while identifying constraints, including environmental, sustainability, health, and safety considerations. 2. Understand customer and user needs while considering factors such as aesthetics. 3. Identify and manage cost drivers in engineering solutions. 4. Use creativity to develop innovative engineering solutions. 5. Ensure fitness for purpose across production, operation, maintenance, and disposal. 6. Manage the design process and evaluate outcomes for safety and risk assessment. 	6
	PO4	<ol style="list-style-type: none"> 1. Gain a deep understanding of materials, equipment, processes, and products through research to address engineering problems effectively. 2. Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data. 3. Address complex problems in various engineering contexts, including operations, management, and technology development. 4. Leverage technical literature and reliable information sources 5. Follow appropriate codes of practice and industry standards when analyzing and interpreting experimental data. 6. Ensure high-quality results by integrating various data sources and considering quality control during engineering investigations. 	6
	PO5	<ol style="list-style-type: none"> 1. Identify appropriate prediction and modelling tools for diverse engineering applications. 	1
	PSO1	<ol style="list-style-type: none"> 1. Analyze response of a circuit or system 2. Design of a circuit or system for a given specification 3. Understand and apply circuit or system specifications accurately. 4. Knowledge of analog and digital signal processing techniques. 	4
	PSO2	<ol style="list-style-type: none"> 1. Develop Operational block diagrams 2. Proficiency in the use of software tools for 	4

		<p>circuit design.</p> <p>3. Hardware-software integration in communication systems</p> <p>4. Understanding trade-offs in hardware and software design parameters.</p>	
--	--	--	--

TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

Course Outcomes	PROGRAM OUTCOMES												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2
	4	10	10	10	4	5	4	4	10	5	10	8	4	4
CO1	1	4	6	-	1	-	-	-	-	-	-	-	2	2
CO2	2	-	4	3	1	-	-	-	-	-	-	-	4	2
CO3	1	8	6	6	1	-	-	-	-	-	-	-	2	-
CO4	1	8	4	6	1	-	-	-	-	-	-	-	1	-
CO5	1	-	6	6	1	-	-	-	-	-	-	-	4	4

PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO/ PSO):

Course Outcomes	PROGRAM OUTCOMES												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2
CO1	25	40	50	-	75	-	-	-	-	-	-	-	50	50
CO2	50	-	40	30	100	-	-	-	-	-	-	-	100	50
CO3	25	80	50	50	100	-	-	-	-	-	-	-	50	-
CO4	25	80	40	50	100	-	-	-	-	-	-	-	25	-
CO5	25	-	50	50	75	-	-	-	-	-	-	-	100	100

COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S, CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation,

2 - $40\% < C < 60\%$ – Moderate

1-5 $< C \leq 40\%$ – Low/ Slight

3 - $60\% \leq C < 100\%$ – Substantial /High

Course Outcomes	PROGRAM OUTCOMES											PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2
CO1	1	1	2	-	3	-	-	-	-	-	-	-	2	2
CO2	2	-	1	1	3	-	-	-	-	-	-	-	3	2
CO3	1	3	2	2	3	-	-	-	-	-	-	-	2	-
CO4	1	3	1	2	3	-	-	-	-	-	-	-	1	-
CO5	1	-	2	2	3	-	-	-	-	-	-	-	3	3
Total	6	7	8	7	15	-	-	-	-	-	-	-	11	7
Average	1.2 0	2.3 3	1.6 0	1.75	3	-	-	-	-	-	-	-	2.2 0	2.3 3

LAB TIME TABLE

ROOM NO:
SR-110

NAME OF THE LAB: LDICA LAB

A.Y: 2026-2027

BRANCH: ECE

W.E. F:

SEMESTER: IV

PERIOD	1st	2nd	3rd		4th	5th	6th
TIME	09:40 -	10:35 -	11:30 -	12:25 -	01:15 -	02:10 -	03:05 -
DAY	10:35	11: 30	12:2 5	01:1 5	- 02:10	03: 05	04:0 0
MON				L U N C H			
TUE							
WED							
THU							
FRI							
SAT							

Time Table I/C

Time Tables C/D

HOD – ECE

COURSE CONTENT

LINEAR AND DIGITAL IC APPLICATIONS LAB										
IV Semester: ECE										
Course Code	Category	Hours/ Week			Credits	Maximum Marks				
		L	T	P		C	CI A	SEE	Total	
2540476	Core	0	0	2	1	40	60	100		
		Practical Classes: 32				Total Classes:32				
Contact Classes: Nil		Tutorial Classes: Nil								
Prerequisites: Nil										

Course Overview

This laboratory course provides hands-on experience in designing, implementing, and testing analog and digital circuits using operational amplifiers, timers, data converters, and logic ICs. Students learn to verify theoretical concepts through practical experiments and analyze circuit performance. The lab builds essential skills for applying IC-based circuit design in real-world applications of electronics and communication engineering.

Course Objectives

The students will try to learn

- Fundamental principles, characteristics, and applications of operational amplifiers, timers, and regulators.
- Design and implementation of waveform generators, active filters, and signal processing circuits using ICs.
- Architecture, working principles, and performance parameters of data converters such as DACs and ADCs.
- Realization of combinational logic circuits using TTL and CMOS families for various digital applications.
- Design and analysis of sequential logic circuits and memory devices for practical digital system development.

Course Outcomes

After successful completion of the course, students shall be able to

- Assemble and test op-amp based amplifiers (inverting/noninverting), adders/subtractors, integrators/differentiators and measure their gains, bandwidth and linearity.
- Construct and verify waveform generators, mono-stable/astable timers, PLL blocks, and characterize their frequency, duty cycle and stability.
- Implement DACs and ADCs (R-2R, counter, SAR, dual slope, parallel comparator) and compute resolution, conversion time and efficiency.

- Design and experimentally verify combinational and sequential logic circuits (multiplexers, encoders, decoders, adders, counters, shift registers) and memory read/write operations.
- Analyze discrepancies between theoretical and measured results, compute error percentages, and propose methods to improve circuit performance (e.g., offset compensation, filtering, proper decoupling).

LIST OF EXPERIMENTS

1. Design an Inverting and Non-inverting Amplifier using Op Amp and calculate gain.
2. Design Adder and Subtractor using Op Amp and verify addition and subtraction process.
3. Design a Comparator using Op-Amp and draw the comparison results of $A=B$, AB .
4. Design a Integrator and Differentiator Circuits using IC741 and derive the required condition practically.
5. Design a Active LPF, HPF cutoff frequency of 2 KHz and find the roll off of it.
6. Design a Circuit using IC741 to generate sine / square / triangular wave with period of 1 KHz and draw the output waveform.
7. Construct Mono-stable Multivibrator using IC555 and draw its output waveform.
8. Construct Astable Multivibrator using IC 555 and draw its output waveform and also find its duty cycle.
9. Design a Schmitt Trigger Circuit and find its LTP and UTP.
10. Design Voltage Regulator using IC723, IC 7805 / 7809 / 7912 and find its load regulation factor.
11. Design a 8x1 multiplexer using digital ICs.
12. Design a 4-bit Adder / Subtractor using digital ICs and Add / Sub the following bits.
(i) 1010 (ii) 0101 (iii) 1011 (iv) 0100 (v) 0010 (vi) 1001.
13. Design a Decade counter and verify its truth table and draw respective waveforms.
14. Design a Up/downcounter using IC74163 and draw read/write waveforms.
15. Design a Universal shift register using IC74194 / 195 and verify its shifting operation.
16. Design a 16x4 RAM using 74189 and draw its read /write operation.

Open Ended Experiments

1. Schmitt Trigger using Op-Amp – Noise elimination in digital circuits
2. Multiplexer (MUX) & Demultiplexer (DEMUX) Circuits – Data selection applications
3. Asynchronous & Synchronous Counters – Binary & Decade Counters

NOTE: Minimum 12 experiments to be conducted

Reference Link

1. https://onlinecourses.nptel.ac.in/noc25_ee103/preview
2. https://onlinecourses.nptel.ac.in/noc24_ee81/preview
3. https://onlinecourses.nptel.ac.in/noc20_ee27/preview
4. https://onlinecourses.nptel.ac.in/noc21_ee55/preview
5. https://onlinecourses.nptel.ac.in/noc21_ee31/preview

6. https://onlinecourses.nptel.ac.in/noc26_ee71/preview
7. https://onlinecourses.nptel.ac.in/noc25_ee125/preview **Materials**

Online:

1. Lab Manual
2. Open-ended experiments

LINEAR AND DIGITAL IC APPLICATIONS LABORATORY

LAB PLANNER

S.No	Experiment	CO	Virtual Lab Availability	Date planned	Date conducted
1	Design an Inverting and Non-inverting Amplifier using Op Amp and calculate gain.	1	No		
2	Design Adder and Subtractor using Op Amp and verify addition and subtraction process.	1	No		
3	Design a Comparator using Op-Amp and draw the comparison results of $A=B$, $A > B$.	2	No		
4	Design a Integrator and Differentiator Circuits using IC741 and derive the required condition practically.	1	No		
5	Design a Active LPF, HPF cutoff frequency of 2 KHz and find the roll off of it.	1	No		
6	Design a Circuit using IC741 to generate sine / square / triangular wave with period of 1 KHz and draw the output waveform.	1	No		
MID-I					
7	Design a 8x1 multiplexer using digital ICs.	5	No		
8	Design a 4-bit Adder / Subtractor using digital ICs and Add / Sub the following bits.	5	No		
9	(i) 1010 (ii) 0101 (iii) 1011 (iv) 0100 (v) 0010 (vi) 1001.	4	No		
10	Design a Decade counter and verify its truth table and draw respective waveforms.	4	No		
11	Design a Up/downcounter using IC74163 and draw read/write waveforms.	4	No		
12	Design a Universal shift register using IC74194 / 195 and verify its shifting operation.	4	No		

13	Design a 16x4 RAM using 74189 and draw its read /write operation.	4	No		
	MID-II				

LINEAR AND DIGITAL IC APPLICATIONS LABORATORY

LAB PLANNER

Date planed																			
Date conducted																			
Roll Number	Exp No	C O	VL	Ex P No	CO	VL	Exp No	C O	VL	Exp No	C O	VL	Exp No	C O	VL	Exp No	C O	VL	
	1	1	N	2	1	N	3	2	N	4	1	N	5	1	N	6	1	N	
	1	1	N	2	1	N	3	2	N	4	1	N	5	1	N	6	1	N	M
	1	1	N	2	1	N	3	2	N	4	1	N	5	1	N	6	1	N	I
	1	1	N	2	1	N	3	2	N	4	1	N	5	1	N	6	1	N	D
	1	1	N	2	1	N	3	2	N	4	1	N	5	1	N	6	1	N	-
	1	1	N	2	1	N	3	2	N	4	1	N	5	1	N	6	1	N	I

Note: VL*-Virtual Lab Availability

Date planed																			
Date conducted																			
Roll Number	Exp No	C O	VL	Exp No	CO	VL	Exp No	CO	VL	Exp No	CO	VL	Exp No	CO	VL	Exp No	CO	VL	
	7	4	Y	8	4	Y	9	4	Y	10	4	Y	11	4	Y	12	5	Y	
	7	4	Y	8	4	Y	9	4	Y	10	4	Y	11	4	Y	12	5	Y	M
	7	4	Y	8	4	Y	9	4	Y	10	4	Y	11	4	Y	12	5	Y	I
	7	4	Y	8	4	Y	9	4	Y	10	4	Y	11	4	Y	12	5	Y	D
	7	4	Y	8	4	Y	9	4	Y	10	4	Y	11	4	Y	12	5	Y	-
	7	4	Y	8	4	Y	9	4	Y	10	4	Y	11	4	Y	12	5	Y	II

Note: VL*-Virtual Lab Availability

LINEAR AND DIGITAL IC APPLICATIONS LABORATORY

RUBRICS USED TO ASSESS LEARNINGS IN LABORATORIES

1. RUBRICS FOR DAY TO DAY EVALUATION

Parameter	Max Marks	Level-1 (Very Poor)	Level-2 (Poor)	Level-3 (Average)	Level-4 (Good)	Level-5 (Excellent)
Observation Book	05	No observations or irrelevant data. (0-1)	Incomplete or incorrect data. (2)	Basic values with some errors. (3)	Mostly correct with good format. (4)	Fully correct, clear, and well-formatted. (5)
Record Writing	05	Not submitted. (0-1)	Submitted but mostly incomplete. (2)	Submitted with some missing/wrong parts. (3)	Submitted with minor issues. (4)	Fully complete, correct algorithm & flowchart. (5)
Result	05	No result or major errors. (0-1)	Result partially obtained. (2)	Acceptable result with limited error. (3)	Near-correct result and reasonable error. (4)	Accurate result. (5)
Viva-Voce	05	Did not answer any questions. (1)	Answered very few questions. (2)	Answered some questions with help. (3)	Answered most questions correctly. (4)	Answered all questions accurately. (5)

LINEAR AND DIGITAL IC APPLICATIONS LABORATORY

2. RUBRICS FOR INTERNAL EVALUATION

Criterion	Max Marks	Level-1 (Very Poor)	Level-2 (Poor)	Level-3 (Average)	Level-4 (Good)	Level-5 (Excellent)
Design/Tool/Apparatus Selection	2 Marks	Incorrect tool/design and no reasoning. (0)	Tool/design selection attempted with unclear logic. (0.5)	Satisfactory selection with partial justification. (1)	Correct selection and proper analysis with few errors. (1.5)	Smart selection with accurate, relevant analysis. (2)
Execution (Code/Debug/Run) /Analysis/Method Used	4 Marks	Did not attempt or completely failed to execute. (0)	Attempted but unable to proceed or with major errors. (1)	Partial execution with some logic/syntax errors. (2)	Mostly correct execution with minimal help. (3)	Fully correct and independently executed program. (4)
Results & Documentation	2 Marks	Incomplete or poorly presented. (0)	Basic structure but lacks clarity or formatting. (0.5)	Complete but generic or with formatting issues. (1)	Well-structured and mostly clear. (1.5)	Well-organized, professional, and engaging documentation. (2)
Viva-Voce (Understanding of Concepts)	2 Marks	No understanding; could not answer questions. (0)	Answered a few with difficulty. (0.5)	Answered half the questions with basic clarity. (1)	Good understanding with confident answers. (1.5)	Answered all questions with clarity and depth. (2)

LINEAR AND DIGITAL IC APPLICATIONS LABORATORY

3.RUBRICS FOR SEMESTER END EXAMINATIONS

Criterion	Max Marks	Level-1 (Very Poor) (0–2 marks)	Level-2 (Poor)(3–4 marks)	Level-3 (Average)(5–6 marks)	Level-4 (Good)(7–9 marks)	Level-5 (Excellent)(10–12 marks)
Preparedness for the Experiment	12 marks	No clarity on objective or procedure. Unable to explain basics.	Limited idea of the objective/procedure. Needed prompting.	Has basic understanding; minor gaps in concept or preparation.	Well-prepared, with clear understanding of steps and background.	Fully prepared with strong conceptual clarity and confident explanation.
Performance in the Laboratory	12 marks	Unable to perform experiment. Relied entirely on examiner's help.	Performed with multiple errors and constant support.	Performed with some errors; required occasional help.	Performed mostly independently with minimal support.	Performed independently, efficiently, and with precision.
Calculations & Graphs	12 marks	No or incorrect calculations. Graphs missing or irrelevant.	Multiple calculation errors. Graphs/plots inaccurate or poorly labelled.	Calculations partially correct. Graphs present but with some flaws.	Correct calculations and graphs with minor errors.	Accurate calculations and well-labelled graphs with proper interpretation.
Results & Error Analysis	12 marks	No result or invalid result. No error analysis attempted.	Incorrect result with vague or no error discussion.	Acceptable result. Error analysis attempted but limited.	Correct result with sound error discussion.	Accurate result with detailed and relevant error analysis.

Viva-Voce (Subject Knowledge)	12 marks	Unable to answer any questions. No conceptual understanding.	Answered few questions with poor logic.	Answered half of the questions with average understanding.	Answered most questions with clarity and confidence.	Answered all questions with depth, clarity, and reasoning.
--------------------------------------	----------	--	---	--	--	--

INDEX

Department of Electronics & Communication Engineering

B.Tech. ECE-II -II Sem

LDICA LAB

Note: Minimum of 12 experiments

Verify the functionality of the IC in the application

Part-I: Linear IC Experiments

1. Design an Inverting and Non-inverting Amplifier using Op Amp and calculate gain.
2. Design Adder and Subtractor using Op Amp and verify addition and subtraction process.
3. Design a Comparator using Op-Amp and draw the comparison results of $A=B$, $A > B$.
4. Design an Integrator and Differentiator Circuits using IC741 and derive the required condition practically.
5. Design a Active LPF, HPF cutoff frequency of 2 KHz and find the roll off of it.
6. Design a Circuit using IC741 to generate sine / square / triangular wave with period of 1 KHz and draw the output waveform.
7. Construct Mono-stable Multivibrator using IC555 and draw its output waveform.
8. Construct Astable Multivibrator using IC 555 and draw its output waveform and also find its duty cycle.
9. Design a Schmitt Trigger Circuit and find its LTP and UTP.
10. Design Voltage Regulator using IC723, IC 7805 / 7809 / 7912 and find its load regulation factor.

11. Design a 8x1 multiplexer using digital ICs.
12. Design a 4-bit Adder / Subtractor using digital ICs and Add / Sub the following bits.
(i) 1010 (ii) 0101 (iii) 1011 (iv) 0100 (v) 0010 (vi) 1001.
13. Design a Decade counter and verify its truth table and draw respective waveforms.
14. Design a Up/downcounter using IC74163 and draw read/write waveforms.
15. Design a Universal shift register using IC74194 / 195 and verify its shifting operation.
16. Design a 16x4 RAM using 74189 and draw its read /write operation.

EQUIPMENT REQUIRED:

1. 20MHz/40MHz/60MHz Oscilloscopes.
2. 1MHz Function Generator (Sine, Square, Triangular and TTL).
3. Regulated Power Supply.
4. Multimeter/Volt-Meter.

EXPERIMENT:1

DESIGN OF INVERTING AND NON-INVERTING AMPLIFIER USING OP-AMP

AIM:

To design and analyze inverting and non-inverting amplifiers using an operational amplifier and calculate their voltage gain.

PRELAB:

1. Study the purpose of using Operational amplifiers.
2. Learn the different Configuration of Operational amplifiers.
3. Identify all the formulae you will need in this Lab.

APPARATUS REQUIRED:

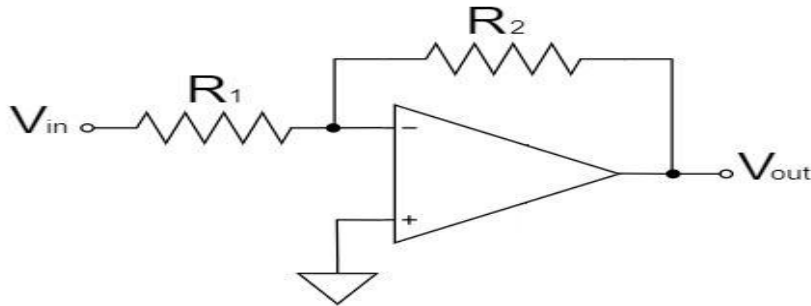
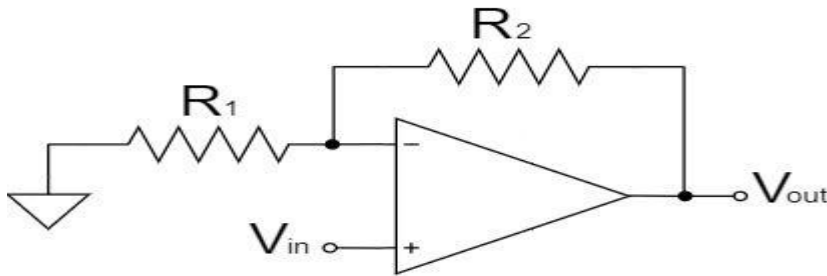
1. Op-Amp IC (741),
2. Resistors (10 k Ω , 100 k Ω),
3. Breadboard
4. Dual power supply ($\pm 12V$ or $\pm 15V$)
5. Function generator
6. CRO
7. Connecting wires

THEORY:

An operational amplifier can be configured as either an inverting or non-inverting amplifier based on the method of input application and feedback connection. In an inverting amplifier, the input signal is applied to the inverting terminal through a resistor while the non-inverting terminal is grounded, creating a virtual ground condition; the output is inverted (180° phase shift) and the voltage gain is determined by the ratio of feedback resistor to input resistor. This configuration provides precise gain control and is widely used in summing and signal processing circuits. In a non-inverting amplifier, the input signal is applied directly to the non-inverting terminal, and the inverting terminal is connected to a voltage divider feedback network, resulting in an output that is in phase with the input and always having a gain greater than or equal to one. Both configurations rely on negative feedback to improve stability, bandwidth, and linearity, making them essential building blocks in analog electronic circuits.

CIRCUITDIAGRAM:

INVERTING OP-AMP:

**NON-INVERTING OP-AMP:****PROCEDURE:**

1. Connect the inverting amplifier circuit as per design.
2. Apply sinusoidal input of 1V peak and 1 kHz frequency.
3. Observe input and output waveforms on CRO.
4. Measure output voltage and calculate gain.
5. Repeat the same procedure for non-inverting amplifier.

OBSERVATIONS:

Parameter	Inverting Amplifier	Non-Inverting Amplifier
R_1		
R_2		
V_{in}		
V_{out}		
Gain		

CALCULATIONS:

For inverting amplifier,

$$V_{out} = -\frac{R_2}{R_1} V_{in}$$

For non-inverting amplifier,

$$V_{out} = \left(1 + \frac{R_2}{R_1}\right) V_{in}$$

RESULT:

The inverting amplifier gain is found to be -10 and non-inverting amplifier gain is found to be 11. The output of inverting amplifier is phase inverted while non-inverting amplifier output is in phase with input.

APPLICATIONS:

Inverting amplifier is used for signal inversion and amplification in audio and communication circuits. non-inverting amplifier is used where signal amplification is required without phase change. They are widely used in signal conditioning, filtering, and instrumentation systems. Both provide controlled gain and are essential in analog electronic circuit design.

VIVA QUESTIONS:

1. What is an operational amplifier?
2. What are the basic terminals of an op-amp?
3. What is meant by open-loop gain?
4. What is closed-loop gain?
5. Define inverting amplifier
6. Define non-inverting amplifier
7. Why is it called an inverting amplifier?
8. Why is it called a non-inverting amplifier?
9. What is the gain formula of an inverting amplifier?
10. What is the gain formula of a non-inverting amplifier?
11. What is virtual ground?
12. Why is the inverting terminal at virtual ground?
13. What is the phase difference in inverting amplifier?
14. What is the phase difference in non-inverting amplifier?
15. Why is gain negative in inverting amplifier?

16. Why is gain always positive in non-inverting amplifier?
17. What is the function of feedback resistor?
18. What is negative feedback?
19. What happens if feedback is removed?
20. What is the input impedance of inverting amplifier?
21. What is the input impedance of non-inverting amplifier?
22. Which amplifier has higher input impedance?
23. What is output impedance of op-amp?
24. What is ideal op-amp?
25. State characteristics of ideal op-amp
26. What is slew rate?
27. Define bandwidth of op-amp
28. What is gain-bandwidth product?
29. What is offset voltage?
30. What is bias current?
31. What is CMRR?
32. What is PSRR?
33. What is saturation in op-amp?
34. What are power supply requirements for op-amp?
35. Why is 741 op-amp commonly used?
36. What are limitations of 741 op-amp?
37. What is the purpose of coupling capacitor?
38. What is frequency response of amplifier?
39. What is unity gain?
40. Can non-inverting amplifier have gain less than 1?
41. Can inverting amplifier have gain less than 1?
42. What is difference between open-loop and closed-loop operation?
43. What is linear operation of op-amp?
44. What is clipping in amplifier?
45. What is distortion?
46. What is the effect of temperature on op-amp?
47. What is noise in amplifier?
48. What are applications of inverting amplifier?
49. What are applications of non-inverting amplifier?

EXPERIMENTNO:2

DESIGN ADDER AND SUBTRACTOR USING OP-AMP

AIM: To study Adder & Subtractor circuits using OP-AMP IC741and verify their theoretical and practical output.

PRELAB:

1. Study the purpose of using Operational amplifiers.
2. Learn the different Configuration of Operational amplifiers.
3. Identify all the formulae you will need in this Lab.

OBJECTIVE:

After completion of this experiment student will be able to

- To Design and setup a Summing amplifier using op-amp
- To Ddetermine the output voltages by providing different dc input voltages

APPARATUS:

1. Breadboard
2. IC741
3. Resistors
4. DC Supply
5. Function Generator
6. Multimeter
7. CRO
8. Probes
9. Connecting Wires

THEORY:

Adder: Op-amp can be used to design a circuit whose output is the sum of several input signals. Such a circuit is called a summing amplifier or an adder. Summing amplifier can be classified as inverting & non-inverting summer depending on the input applied to inverting & non-inverting terminals respectively .Here the output will be the linear summation of input voltages.

The circuit can be used either as summing amplifier, scaling amplifier, Or as averaging amplifier.

$$V_o=V_1+V_2+V_3+...+V_n$$

This means that the output voltage is equal to the sum of all the input voltages.

Subtractor: A Subtractor is a circuit that gives the difference of the two inputs, $V_o =V_2-V_1$,Where V_1 and V_2 are the inputs. By connecting one input voltage V_1 to inverting terminal and Another input voltage V_2 to the non-inverting terminal, we get the resulting circuit as the Subtractor. This is also called as differential or difference amplifier using op-amps.

Output of a differential amplifier (subtractor) is given as

$$V_o = \frac{R_f}{R_1} [V_2 - V_1] \longrightarrow \textcircled{1}$$

If all external resistors are equal in value, then the gain of the amplifier is equal to -1. The output voltage of the differential amplifier with a gain of -1 is

$$V_o = (V_2 - V_1) \longrightarrow \textcircled{2}$$

Thus, the output voltage V_o is equal to the voltage V_2 applied to the non-inverting terminal minus the voltage V_1 applied to the inverting terminal. Hence the circuit is called a Subtractor.

CIRCUIT DIAGRAM:

ADDER:

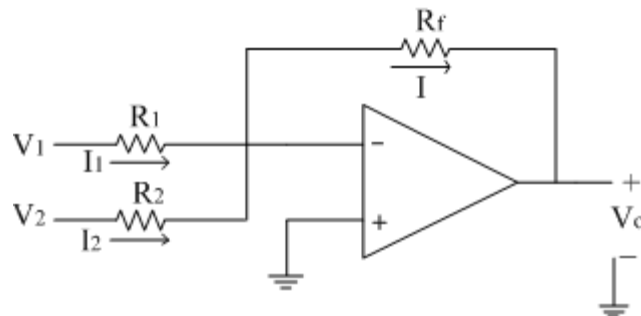


Fig :2.1 circuit diagram of adder

SUBTRACTOR:

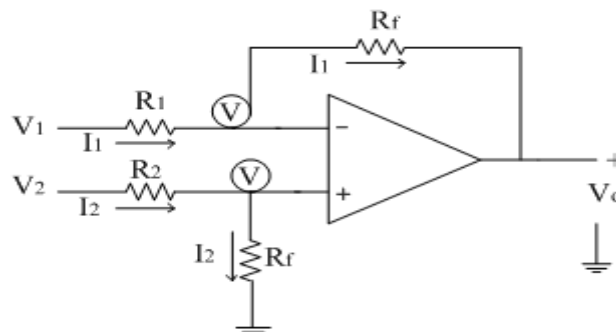


Fig :2.2 circuit diagram of subtractor

PROCEDURE:

Adder:

1. Connect the components/equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Apply dc voltages at each input terminal for V_1 and V_2 from the dc supply and check the output voltage V_o at the output terminal.
4. Tabulate 3 different sets of readings by repeating the above step.
5. Compare practical V_o with the theoretical output voltage $V_o = V_1 + V_2$.

Subtractor:

1. Connect the components / equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Apply dc voltages at each input terminal for V1 and V2 from the dc supply and check the output voltage V_o at the output terminal.
4. Tabulate 3 different sets of readings by repeating the above step.
5. Compare practical V_o with the theoretical output voltage $V_o=V_2-V_1$.

TABULAR COLUMN:

Adder:

S.No.	V1 Volts	V2 Volts	Theoretical $V_o=V_1+V_2$	Practical V_o Volts

Subtractor:

S.No.	V1 Volts	V2 Volts	Theoretical $V_o=V_2-V_1$	Practical V_o Volts

RESULT: Adder & Subtractor circuits using OpAMP IC741 and verify their theoretical and practical output.

APPLICATIONS:

Op-amp adder is used to combine multiple input signals in applications like audio mixing and DACs.

Op-amp subtractor is used to find the difference between two signals in instrumentation systems.

They are widely used in signal conditioning, noise cancellation, and control systems.

These circuits perform basic mathematical operations in analog electronics and communication systems.

VIVA QUESTION'S:

1. Draw the circuit diagram of 3 input adder.
2. What is the other name for adder?
3. Draw the circuit diagram of a Subtractor.
4. Which amplifier acts as a Subtractor?

5. Draw an op-amp circuit whose output V_o is $V_1+V_2 -V_3-V_4$.
6. What is operational amplifier?
7. Define Adder?
8. Define Subtractor?
9. What is the output of subtractor ?
10. What are the applications of op-amp?
11. What is the input impedance of ideal op-amp?
12. What is the output impedance of ideal op-amp?
13. What is the slew rate of ideal op-amp?
14. What is the bandwidth of idea lop-amp?
15. Op-amp was introduced in which year?
16. By using what the OP-amp was designed?
17. Why it is called as op-amp?
18. Who was invented IC741 op-amp?
19. Advantages of op-amp?
20. Dis-advantages of op-amp?
21. Op-amp is also called as?
22. What is the gain of inverting op-amp if $R_f=10k$ & $R_1=1k$?
23. What is the gain of non-inverting op-amp if $R_f=10k$ & $R_2=1k$?
24. What is the output of subtractor if $V_1=1v$ & $V_2=3v$?
25. What is negative feedback in op-amp?
26. What is positive feedback in op-amp?
27. What is open loop configuration of op-amp?
28. What is closed loop configuration of op-amp?
29. What are the DC characteristics of op-amp?
30. What are the liner applications of op-amp?
31. What are the non-linear applications of op-amp?
32. What is the non-inverting op-amp?
33. What is inverting op-amp?
34. What is frequency response?
35. Why we cannot fabricate inductors on IC?
36. What is the range of capacitors, we cannot fabricate on IC?
37. Can we replace new components on IC?
38. Which material is used to fabricate IC?
39. Formula to calculate voltage across capacitor?
40. Difference between non-inverting & inverting op-amp?
41. What is formula to calculate voltage across resistor?
42. What is formula to calculate voltage across the capacitor?
43. Classifications of IC's?
44. Based on level of integration IC is classified as?
45. Based on mode of operation IC is classified as?
46. Based on fabrication IC is classified as?
47. Range of components fabricated on large Scale IC?

48. Range of components fabricated on very large-scale IC?

49. Range of components fabricated on ultra-large-scale IC?

50. What is the output of inverting adder if these are V_1 , V_2 , V_3

EXPERIMENT NO:3

DESIGN A COMPARATOR USING OP-AMP

AIM: To study comparators using OP-AMP IC741 and verify their theoretical and practical output.

PRE LAB:

1. Study the purpose of using Operational amplifiers.
2. Learn about Differential Operational amplifiers
3. Identify all the formulae you will need in this Lab.

OBJECTIVE:

After completion of this experiment student will be able to

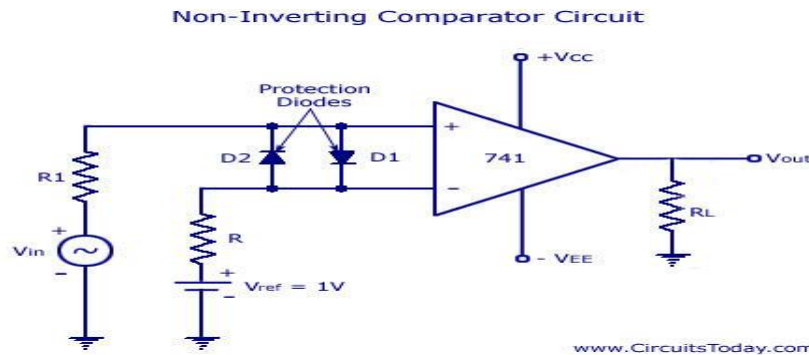
- To Design and setup a Comparator using op-amp
- To Determine the output voltages by providing different reference voltages and input voltages

APPARATUS:

1. Bread Board
2. IC741
3. Resistors
4. DC Supply
5. Function Generator
6. Multimeter
7. CRO Probes
8. Connecting Wires

THEORY:

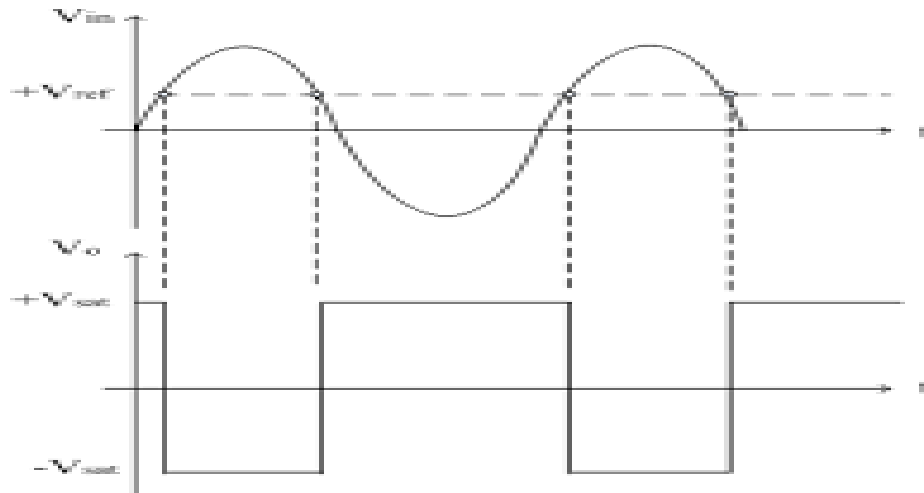
A Comparator is a non-linear signal processor. It is an open loop mode application of Op-amp operated in saturation mode. Comparator compares a signal voltage at one input with a reference voltage at the other input. Here the Op-amp is operated in open loop mode and hence the output is $\pm V_{sat}$. It is basically classified as inverting and non-inverting comparator. In a non-inverting comparator V_{in} is given to +ve terminal and V_{ref} to -ve terminal. When $V_{in} < V_{ref}$, the output is $-V_{sat}$ and when $V_{in} > V_{ref}$, the output is $+V_{sat}$ (see expected waveforms). In an inverting comparator input is given to the inverting terminal and reference voltage is given to the non-inverting terminal. The output of the inverting comparator is the inverse of the output of non-inverting comparator. The comparator can be used as a zero-crossing detector, window detector, time marker generator and phasemeter.

CIRCUITDIAGRAM:**Fig: Circuit diagram of comparator****PROCEDURE:**

1. Connect the components / equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Apply 1KHz sinewave with $5V_{pp}$ at the non-inverting input terminal of IC741 using a function generator.
4. Apply 1Vdc voltage as reference voltage at the inverting terminal of IC741.
5. Connect the channel-1 of CRO at the input terminals and channel-2 of CRO at the output terminals.
6. Observe the input sinusoidal signal at channel-1 and the corresponding output square wave at channel-2 of CRO. Note down their amplitude and time period.
7. Overlap both the input and output waves and note down voltages at positions on sinewave where the output changes its state. These voltages denote the Reference voltage.
8. Plot the output square wave corresponding to the sine input with $V_{ref}=1V$.

COMPARATOR OBSERVATION TABLE:

Theoretical Reference voltage (from circuit)	
Practical Reference voltage (from output waveforms)	

EXPECTED WAVEFORMS:**Fig : Input and output waveforms of inverting comparator**

RESULT: comparators using OP-AMP IC741 and verify their theoretical and practical output.

APPLICATIONS:

Op-amp comparator is used to compare two input voltages and produce a high or low output. It is widely used in zero-crossing detectors and level detection circuits. Applications include analog-to-digital converters and waveform generation. It is also used in switching circuits and signal monitoring systems.

VIVA QUESTION'S:

1. How many basic input parameters are required for comparator?
2. Draw the circuit diagram of a non-inverting comparator and inverting comparator.
3. What is the output of a non-inverting comparator and inverting comparator if the input is sinusoidal?
4. What are the differences between the Inverting and Non-Inverting comparator?
5. What is the name of the comparator if the reference voltage is 0V?
6. Draw the circuit diagram and the output waveform of a Zero Crossing Detector if the input is sinusoidal?
7. What is the name of a regenerative comparator?
8. Draw an op-amp circuit whose output V_o is $V_1+V_2-V_3-V_4$.
9. Define comparator?
10. What are the types of comparators?
11. In which configuration of op-amp does a comparator works?
12. Define an operational amplifier?
13. Define integrated circuit?
14. What are applications of comparator?
15. What is another name of comparator?
16. What operational does a comparator perform?
17. What are the differences between open loop & closed loop Configuration?

18. What are applications of IC's?
19. What are applications of operational Amplifier?
20. What does comparator generate when $V_{in} < V_{ref}$?
21. What output does comparator generates when $V_{in} > V_{ref}$?
22. What are the real-time applications of comparator?
23. How many input parameters are required for comparator?
24. Draw the circuit of inverting & non-inverting comparator?
25. What are the differences between inverting & non-inverting Comparator?
26. What is the gain of non-inverting op-amp?
27. What is the gain of inverting op-amp?
28. What are linear applications of op-amp?
29. What are non-linear applications of op-amp?
30. What are applications of open loop configuration?
31. Define feedback?
32. Define positive feedback?
33. Define Negative feedback?
34. What are the differences between positive & negative feedback?
35. Who invented IC741?
36. Why it is named as op-amp?
37. Why it is named as comparator?
38. What are advantages of op-amp?
39. What are advantages of IC's?
40. Define amplifier?
41. Define differential amplifier?
42. Define CMRR?
43. Define slew rate?
44. Define thermal drift?
45. Define bandwidth?
46. What are the characteristics of differential amplifier?
47. Why comparator is called voltage level detector?
48. What is the name of comparator if reference voltage is 0V?
49. What is inverting comparator.
50. What is non inverting comparator.

REAL TIME APPLICATIONS

A comparator consists of a specialized high-gain differential amplifier. They are commonly used in devices that measure and digitize analog signals, such as analog-to-digital converters (ADCs) and relaxation oscillators.

Comparator circuits are used in designing electrical and electronics projects (like Temperature Humidity Monitoring System, Smoke Alarm Circuit).

EXPERIMENT NO:4

DESIGN AN INTEGRATOR AND DIFFERENTIATOR CIRCUITS USING IC741 OP-AMP.

EXPERIMENT:4A

INTEGRATOR CIRCUIT USING IC741 OP-AMP:

AIM: To study the operation of the Integrator circuit using op-amp and trace the output waveforms for sine and square wave inputs.

PRE LAB:

1. Study the purpose of using Operational amplifiers
2. Learn the different types of Op-amp Configuration methods.
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

- To design and setup an Integrator using op-amp
- To determine the output voltages by providing different R and C values
- To plot the frequency response of an integrator circuit

APPARATUS:

1. Breadboard
2. IC741
3. Resistors
4. Capacitors
5. Function Generator
6. CRO
7. CRO Probes
8. Connecting wires

THEORY:

INTEGRATOR:

A circuit in which the output voltage is the integration of the input voltage is called an integrator.

$$V_o = -\frac{1}{R_1 C_1} \int V_{in} dt \longrightarrow \textcircled{1}$$

In the practical integrator to reduce the error voltage at the output, a resistor R_f is connected across the feedback capacitor C_f . Thus, R_f limits the low-frequency gain and hence minimizes the variations in the output voltage.

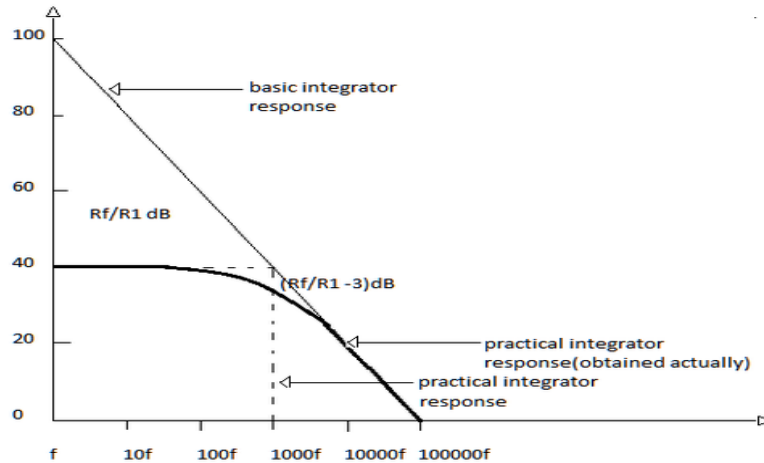


Fig: Frequency response of integrator.

The frequency response of the integrator is shown in the fig. 2.1. f_b is the frequency at which the gain is 0dB and is given by

$$f_b = \frac{1}{2\pi R_1 C_1} \longrightarrow \textcircled{2}$$

In this fig. there is some relative operating frequency, and for frequencies from f to f_a the gain $Rf/R1$ is constant. However, after f_a the gain decreases at a rate of 20 dB/decade. In other words, between f_a and f_b the circuit of fig. 2.1 acts as an integrator. The gain-limiting frequency f_a is given by

$$f_a = 1/2\pi R_f C_f \longrightarrow \textcircled{3}$$

Normally $f_a < f_b$. From the above equation, we can calculate R_f by assuming f_a & C_f . This is very important frequency. It tells us where the useful integration range starts.

- If $f_{in} < f_a$ -circuit acts like a simple inverting amplifier and no integration results,
- If $f_{in} = f_a$ -integration takes place with only 50% accuracy results,
- If $f_{in} = 10f_a$ -integration takes place with 99% accuracy results.
- In the circuit diagram of Integrator, the values are calculated by assuming f_a as 50Hz.

Hence the input frequency is to be taken as 500Hz to get 99% accuracy results.

CIRCUIT DIAGRAM:

INTEGRATOR:

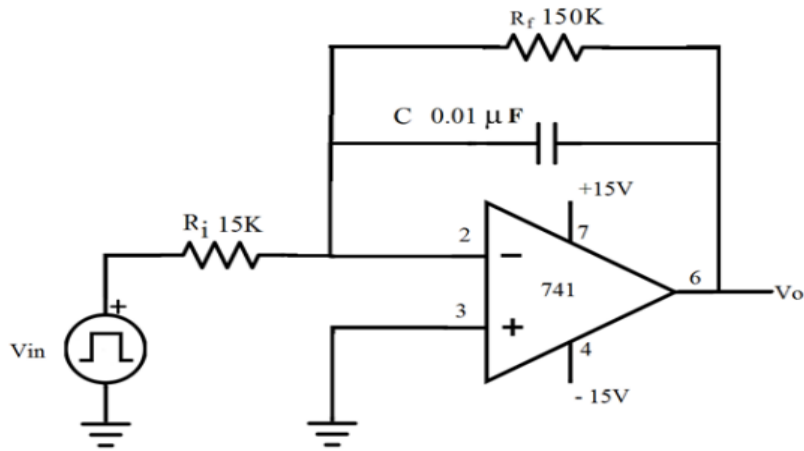


Fig: Circuit diagram of Integrator.

PROCEDURE:

INTEGRATOR:

1. Connect the components/equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Apply sine wave at the input terminals of the circuit using function Generator.
4. Connect channel-1 of CRO at the input terminals and channel-2 at the output terminals.
5. Observe the output of the circuit on the CRO which is a cosinewave (90° phase shifted from the sine wave input) and note down the position, the amplitude and the time period of V_{in} & V_o .
6. Now apply the square wave as input signal.
7. Observe the output of the circuit on the CRO which is a triangular wave and note down the position, the amplitude and the time period of V_{in} & V_o .
8. Plot the output voltages corresponding to sine and square wave inputs.

EXPECTED WAVEFORMS:

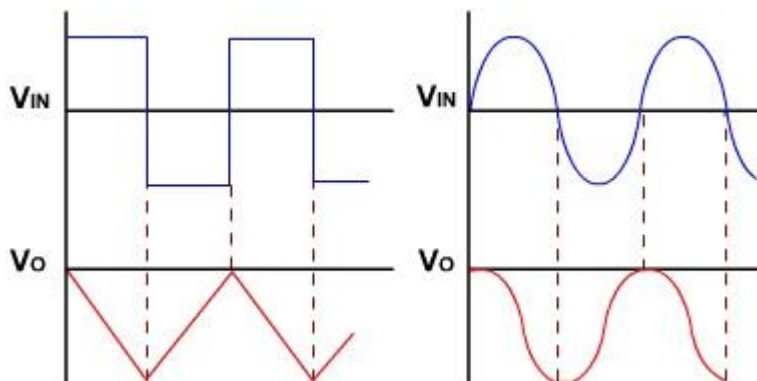


Fig: Output waveforms of Integrator

RESULT: Verify the operation of the Integrator circuit using op-amp and trace the output waveforms for sine and square wave inputs.

VIVA QUESTIONS:

1. What is an Integrator?
2. Draw the circuit of the Integrator using op-amp IC741.
3. Write down the expression for V_o of an Integrator.
4. Draw the frequency response of the Integrator and explain.
5. Draw the output waveform of the Integrator when the input is a square wave.
6. What is the purpose behind the connection of R_f in the feedback path of Integrator?
7. What are the applications of Integrator?
8. How does integrator acts?
9. Integrator converts square wave to wave? Bandwidth formula ?
10. At which frequency gain of integrator is constant?
11. Which feedback is used in integrator?
12. Applications of integrator?
13. Which IC is used in integrator circuit?
14. If frequency is integrator circuit?
15. If frequency is increased than the gain of integrator is increased(or) decreased?
16. What is formulas for FH?
17. What is the application of closed loop feedback?
18. What are advantages closed loop feedback?
19. Define bandwidth?
20. Define frequency response?
21. At which pin we are taking output?
22. At which pin we are giving input to the integrator?
23. Formula for the gain?
24. Define IC?
25. Advantage of IC's?
26. Disadvantage of ICs?
27. Integrator is amplifier?
28. Formula for the gain of inverting amplifier?
29. Formula for the gain of non-inverting amplifier?
30. Define op-amp?
31. Difference between closed loop and open loop feedback?
32. Difference between inverting amplifier op-amp and non-op-amp

33. Draw the circuit of the integrator using op-amp?
34. Draw the frequency response of the integrator?
35. Define slew rate?
36. Define CMRR?
37. Define low pass filter?
38. Define high pass filter?
39. Define filter?
40. Draw the output wave form for integrator?
41. What is passive filter?
42. What is active filter?
43. Application of the filter
44. Define the feedback
45. Define the roll off
46. What is the range for semi log graph?
47. Define the frequency response plot
48. At low frequency the output of integrator?
49. At high frequency the output of integrator
50. Define frequency?

EXPERIMENT NO:4B**DIFFERENTIATOR CIRCUIT USING IC 741 OP-AMP**

AIM: To study the operation of the differentiator circuit using op-amp and trace the output waveforms for sine and square wave inputs.

PRELAB:

1. Study the purpose of Differentiator using Operational amplifiers
2. Learn about inverting and Non inverting Configurations.
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

- To design and setup a Differentiator using op-amp
- To determine the output voltages by providing different R and C values
- To plot the frequency response of an integrator circuit

APPARATUS:

Bread board
IC 741
Resistors
Capacitors
Function Generator
CRO
Probes
Connecting wires

THEORY:**DIFFERENTIATOR:**

As the name suggests, the circuit performs the mathematical operation of differentiation, i.e. the output voltage is the derivative of the input voltage.

$$V_o = -R_f C_1 dV_{in}/dt \longrightarrow \textcircled{1}$$

~~Both the stability and the high-frequency noise problems can be corrected by the addition~~

Of two components: R_1 and C_f , as shown in the circuit diagram.

This circuit is a practical differentiator.

The input signal will be differentiated properly if the time period T of the input signal is larger than or equal to $R_f C_1$. That is, $T \geq R_f C_1$

Differentiator can be designed by implementing the following steps.

Select f_a equal to the highest frequency of the input signal to be differentiated. Then, assuming a value of $C_1 < 1 \mu\text{F}$,

Calculate the values of R_1 and C_f so that $R_1 C_1 = R_f C_f$.

CIRCUITDIAGRAM:

DIFFERENTIATOR:

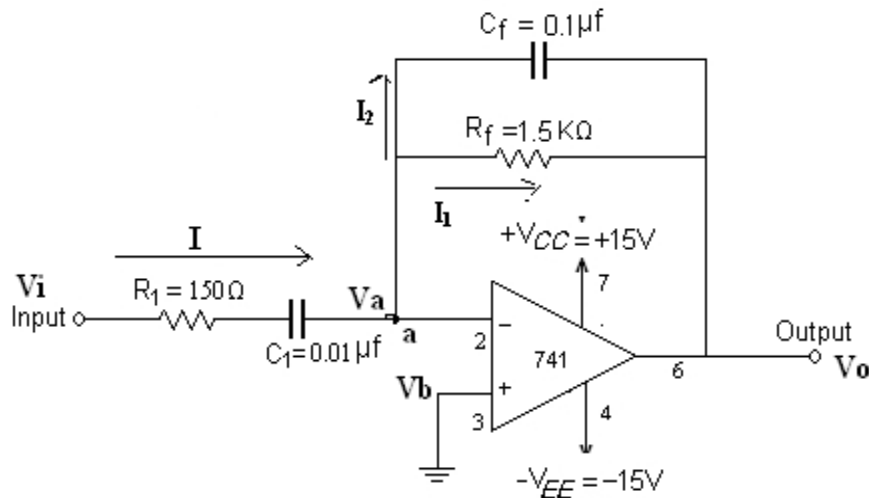
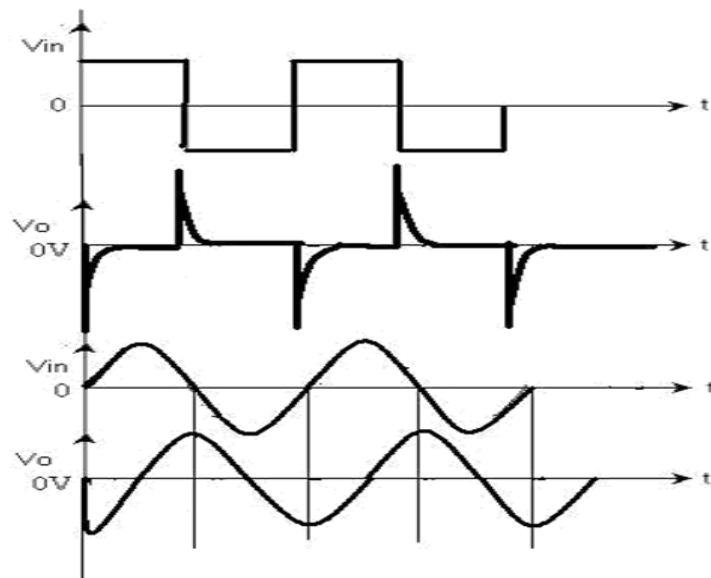


Fig: Circuit diagram of Differentiator

PROCEDURE:

DIFFERENTIATOR:

1. Connect the components/equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Apply sine wave at the input terminals of the circuit using function Generator.
4. Connect channel-1 of CRO at the input terminals and channel-2 at the output terminals.
5. Observe the output of the circuit on the CRO which is a cosine wave (90° phase shifted from the sine wave input) and note down the position, the amplitude and the time period of V_{in} & V_o .
6. Now apply the square wave as input signal.
7. Observe the output of the circuit on the CRO which is a spike wave and note down the position, the amplitude and the time period of V_{in} & V_o .
8. Plot the output voltages corresponding to sine and square wave inputs.

EXPECTED GRAPHS:**Fig: Output waveform of Differentiator**

RESULT: Verify the operation of the Differentiator circuit using op-amp and trace the output waveforms for sine and square wave inputs.

APPLICATIONS:

Integrator circuit using IC 741 is used to produce the integral of input signal and is applied in waveform generation and analog computers.

Differentiator circuit produces output proportional to rate of change of input and is used in edge detection and pulse shaping.

These circuits are widely used in signal processing and control systems.

They are essential for performing mathematical operations in analog electronics.

VIVA QUESTIONS:

1. Why R comp is used in both Integrator and Differentiator circuits?
2. What is a Differentiator?
3. Draw the circuit of the Differentiator using op-amp IC741.
4. Write down the expression for V_o of a Differentiator.
5. Draw the output waveform of the Differentiator when the input is a Sinewave.

6. Why R_1 and C_f are connected in the circuit of the Differentiator?
7. What are the applications of Differentiator?
8. Formula for the gain of inverting amplifier?
9. Formula for the gain of non-inverting amplifier?
10. Define op-amp?
11. Difference between closed loop and open loop feedback?
12. Difference between inverting amplifier op-amp and non-op-amp
13. Draw the circuit of the integrator using op-amp?
14. Draw the frequency response of the integrator?
15. Define slew rate?
16. Define CMRR?
17. Define lowpass filter?
18. Define high pass filter?
19. How does integrator acts?
20. Integrator converts square wave to wave?
21. Bandwidth formula ?
22. At which frequency gain of integrator is constant?
23. Which feedback is used in integrator?
24. Define amplifier?
25. Define differential amplifier?
26. Define CMRR?
27. Define slew rate?
28. Define thermal drift?
29. Define band width?
30. What are the characteristics of differential amplifier?
31. Why comparator is called voltage level detector?
32. What is the name of comparator if reference voltage is 0V?
 - a. What are formulae for gain of amplifier
 - b. Why R_1 and C_f are reconnected in the circuit of the Differentiator?
33. What are the applications of Differentiator?
34. Formula for the gain of inverting amplifier?
35. What is the gain of inverting op-amp if $R_f=10k$ & $R_1=1k$?
 - a. What is the gain of non-inverting op-amp if $R_f=10k$ & $R_2=1k$?
36. What is the output of subtractor if $V_1=1v$ & $V_2=3v$?
37. What is negative feedback in op-amp?

38. What is positive feedback in op-amp?
39. What is open loop configuration of op-amp?
40. What is closed loop configuration of op-amp?
41. What are the DC characteristics of op-amp?
42. Draw the circuit of the Differentiator using op-amp IC741.
43. Write down the expression for V_o of a Differentiator.
44. Draw the output wave form of the Differentiator when the input is a Sine wave.
45. Why R_1 and C_f are reconnected in the circuit of the Differentiator?
46. What are the applications of Differentiator?
47. What is the output of subtractor if $V_1=1\text{v}$ & $V_2=3\text{v}$?
48. What is formulae for gain of amplifier?
49. What are formulae for output voltage of differential amplifier?
50. Define low pass filter?

EXPERIMENTNO: 5

DESIGN AN ACTIVE LPF, HPF USING OP-AMP

EXPERIMENTNO:5A

1st Order LOW PASS FILTER:

AIM: To plot the frequency response of Butter worth LPF(First order)and find the high cut-off exp frequency.

PRELAB:

1. Study the purpose of using Operational amplifiers
2. Learn about Active Low Pass Filters
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

- To Design and setup a Differentiator using op-amp
- To Ddetermine the output voltages by providing different R and C values
- To plot the frequency response of an integrator circuit

APPARATUS:

1. Bread Board
2. Function Generator

3. CRO Probes
4. Connecting Wires
5. 741Op-amp
6. Resistors
7. Capacitors

THEORY:

Filters are classified based on components used and frequency range. Based on components, filters are of two types: active filters, which use active elements like transistors or op-amps along with passive elements and provide gain, and passive filters, which use only resistors, capacitors, and inductors. Based on frequency range, filters are categorized as low pass filters (LPF) that allow low frequencies, high pass filters (HPF) that allow high frequencies, band pass filters (BPF) that allow a specific band of frequencies, band reject filters (BRF) that reject a certain band of frequencies, and all pass filters that allow all frequencies but introduce a phase shift. An active filter is a frequency-selective circuit that passes a desired range of frequencies while attenuating others, and these filters are widely used in communication and signal processing systems, forming essential components in most modern electronic applications.

Active Filters employ transistors or Op- Amps in addition to that of resistors and capacitors. Active filters have the following advantages over passive filters. (1) Flexible gain and frequency adjustment. (2) No loading problem (because of high input impedance and low output impedance) and Active filters are more economical than passive filters.

A first – Order Low – Pass Butterworth filter uses RC network for filtering. Note that the op-amp is used in the non – inverting configuration; hence it does not load down the RC network resistors R_1 and R_F determine the gain of the filter.

CIRCUIT DIAGRAM:

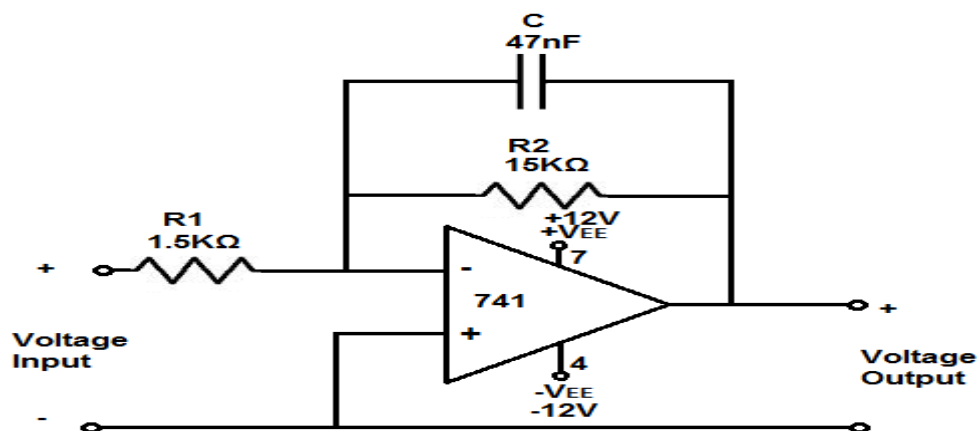


Fig: Active LowPass Filter

PROCEDURE:

1. Connect the components/equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Connect channel -1 of CRO to input terminals (V_{in}) and channel -2 to output terminals(V_o).
4. Set $V_{in}=1V$ & $f_{in}=10Hz$ using function generator.
5. By varying the input frequency in regular intervals, noted down the output voltage.
6. Calculate the gain(V_o/V_{in}) and Gain in $dB=20\log(V_o/V_{in})$ at every frequency.
7. Plot the frequency response curve(taking frequency on X-axis & Gain in dB on Y-axis)using Semi-log Graph.
8. Find out the high cut-off frequency, f_H (at Gain=Constant Gain, A_f-3dB)from the frequency response plotted.
9. Verify the practical(f_H from graph) and the calculated theoretical cut-off frequency ($f_H=1/2\pi RC$).

TABULAR COLUMN: $V_{in}=1V$

S .No.	Input Frequency f(Hz)	Output Voltage $V_o(V)$	Gain Magnitude $ V_o/V_{in} $	Gain in dB= $20\log V_o/V_{in} $

CALCULATIONS:

THEORETICAL Cut-off frequency:

$$f_H = 1 / (2\pi RC) = \text{high cut-off frequency of the Low pass filter.}$$

PRACTICAL Cut-off frequency(from Graph):

$$f_H = \text{high cut-off frequency of the Lowpass filter} = 3\text{dB cut-off frequency} =$$

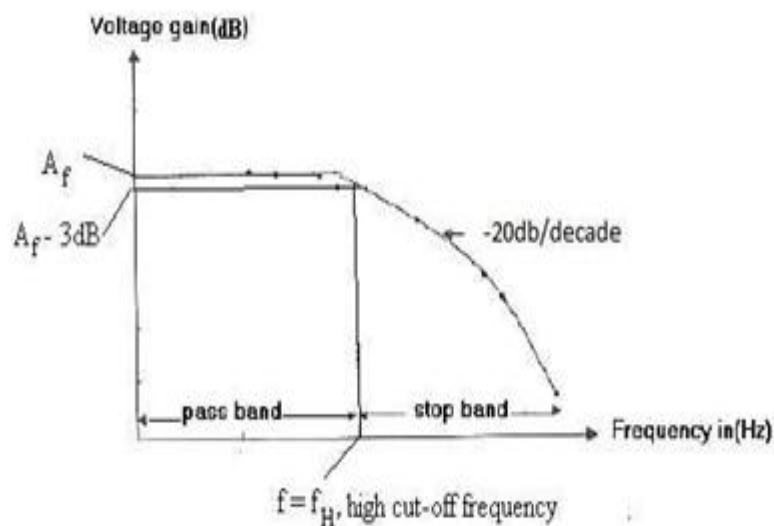
EXPECTED GRAPH:

Fig: Active LPF Frequency Response

EXPERIMENTNO:5B**1st Order HIGH PASS FILTER**

AIM: To plot the frequency response of Butterworth HPF (First order) and find the low cut-off frequency.

PRE LAB:

1. Study the purpose of using Operational amplifiers
2. Learn about Active Filters
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

- To Design and setup a Active High Pass Filter using op-amp
- To determine the output voltages by providing different R and C values
- To plot the frequency response of an integrator circuit

APPARATUS:

1. Bread Board
2. Function Generator CRO
3. Probes Connecting Wires
4. 741Op-amp
5. Resistors
6. Capacitors

THEORY: First Order High Pass Filter consists of RC network for filtering. First Order High Pass filter can be constructed from a First Order Low Pass filter simply by interchanging frequency determining components R & C. Op-Amp is used in the non-inverting configuration. Resistor R_1 and R_F determine the gain of the Filter.

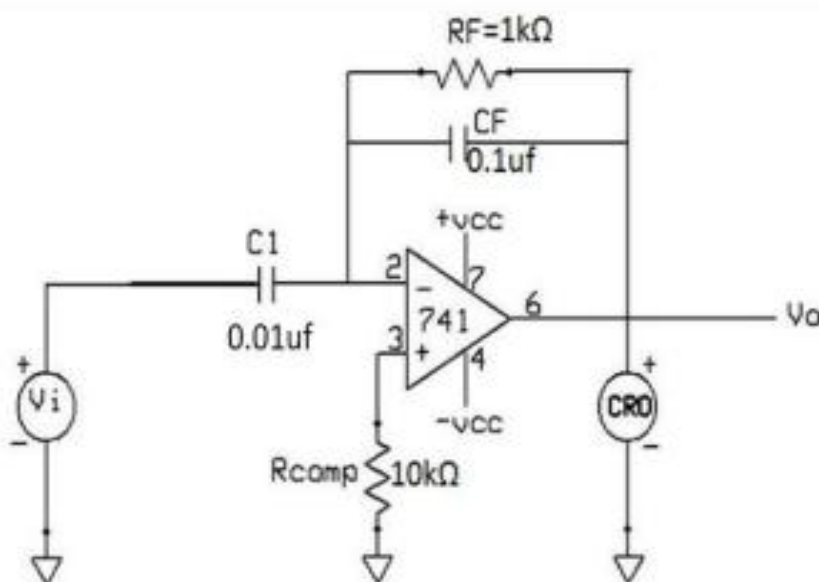
Where $A_F = 1 + R_F / R_1$

f = Operating (input) frequency.

f_L = Low cut-off frequency of the filter. $2\pi RC$

.Obviously, all frequencies higher than f_L are Pass Band frequencies, with the highest frequency determined by the closed-loop band width of the OP-Amp.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the components/ equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Connect channel -1 of CRO to input terminals (V_{in}) and channel -2 to output terminals(V_o).
4. Set $V_{in}=1V$ & $f_{in}=10Hz$ using function generator.
5. By varying the input frequency in regular intervals, note down the output voltage.
6. Calculate the gain (V_o/V_{in}) and Gain in $dB=20\log(V_o/V_{in})$ at every frequency.
7. Plot the frequency response curve (taking frequency on X – axis & Gain in dB on Y-axis) using Semi log Graph.
8. Find out the low cut-off frequency, f_L (at Gain=Constant Gain, A_f-3dB) from the frequency response plotted.
9. Verify the practical (f_L from graph) and the calculated theoretical cut-off frequency ($f_L = 1/2\pi RC$).

TABLUAR COLUMN: $V_{in}=1V$

S.No.	Input Frequency f(Hz)	Output Voltage $V_o(V)$	Gain Magnitude $ V_o/V_{in} $	Gain in dB= $20\log V_o/V_{in} $

CALCULATIONS:

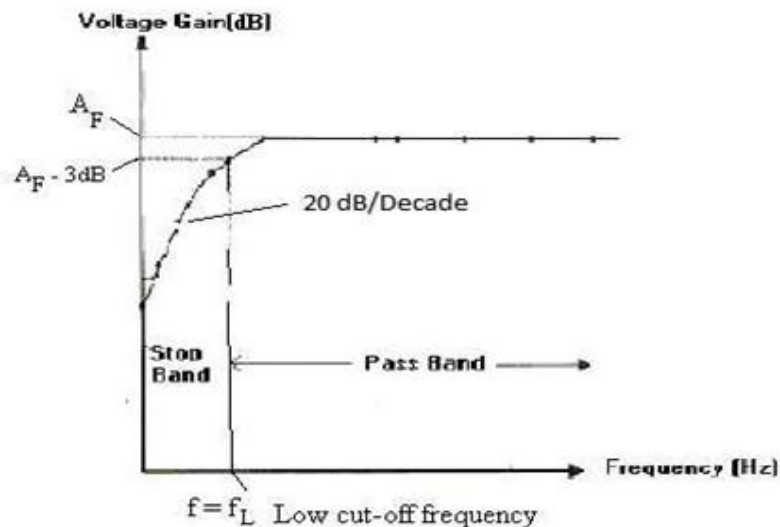
THEORETICAL Cut-off frequency:

$$f_L = 1/(2\pi RC) = \text{Low cut-off frequency of the HPF.}$$

PRACTICAL Cut-off frequency:

$$f_L = \text{Low cut-off frequency of the HPF.} = 3dB \text{ cut-off frequency}$$

EXPECTED GRAPH:



RESULT: The frequency response of LPF & HPF (1st order) had plotted.

APPLICATIONS:

Active LPF using op-amp allows low-frequency signals and is used in noise reduction and audio systems.

Active HPF allows high-frequency signals and blocks low-frequency components in communication circuits.

They are widely used in signal conditioning and filtering applications.

Op-amp based filters provide gain along with frequency selection

VIVA QUESTIONS:

1. How filters are classified ? Give one example for each classification.
2. What is an active filter and why it is called so?
3. How an active filter differs from a passive filter?
4. What are the advantages of active filters over passive filters?
5. Draw the circuit diagrams of active filters LPF and HPF.
6. Draw the frequency response of all filters(LPF, HPF, BPF, BRF and All-pass).
7. What is the gain roll off rate for a 1st order and 2nd order filter?
8. What is the formula for cut-off frequency?
9. What is a 3dB frequency and why it is called so?
10. What are the other names for 3db frequency?
11. Formula for the gain of inverting amplifier?
12. Formula for the gain of non-inverting amplifier?
13. Define op-amp?
14. Difference between closed loop and open loop feedback?
15. Difference between inverting amplifier op-amp and non-op-amp
16. Draw the circuit of the integrator using op-amp?
17. Draw the frequency response of the integrator?
18. Define slew rate?
19. Define CMRR?
20. Define low pass filter?
21. What output does comparator generates when $V_{in} > V_{ref}$?

22. What are the real time applications of comparator?
23. How many input parameters are required for comparator?
24. Draw the circuit of inverting & non-inverting comparator?
25. What are the differences between inverting & non - inverting?
26. Define Comparator?
27. What is the gain of non-inverting op-amp?
28. What is the gain of inverting op-amp?
29. What are linear applications of op-amp?
30. What are non-linear applications of op-amp?
31. What are applications of open loop configuration?
32. What are the characteristics of differential amplifier?
33. Why comparator is called voltage level detector?
34. What is the name of comparator if reference voltage is 0V?
35. What is formulae for gain of amplifier?
36. What is formulae for output voltage of differential amplifier?
37. Formula for the gain of inverting amplifier?
38. Formula for the gain of non-inverting amplifier?
39. Define op-amp?
40. Difference between closed loop and open loop feedback?
41. Difference between inverting amplifier op-amp and non-op-amp
42. Draw the circuit of the integrator using op-amp?
43. Draw the frequency response of the integrator?
44. What is the output of subtractor if $V_1=1\text{v}$ & $V_2=3\text{v}$?
45. What is negative feedback in op-amp?
46. What is positive feedback in op-amp?
47. What is open loop configuration of op-amp?
48. What is closed loop configuration of op-amp?
49. What are the DC characteristics of op-amp?
50. Define LPF and HPF.

EXPERIMENT NO:6

IC741 WAVEFORM GENERATORS – SINE, SQUARE WAVE AND TRIANGULAR WAVES

AIM: To design a Waveform Generator which generates Sine, Square and Triangular wave forms using IC741 and to verify it's various output waveforms.

PRELAB:

1. Study the purpose of using Operational amplifier IC 741
2. Learn about Waveform generators such as Oscillators, Multivibrators
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

- To Design and setup a Sine wave generator using op-amp
- To Determine the output voltages by providing different R and C values
- To plot the waveforms of different wave generators

APPARATUS:

1. Bread Board
2. CRO
3. Probes
4. 741Op-amp
5. Resistors
6. Capacitors

THEORY:

Waveform generator using IC741 is a circuit which generates Sine wave, square wave and Triangular wave. This circuit is a combination of Wien Bridge oscillator, zero crossing detector (Comparator with zero reference voltage) and Integrator. The Wien Bridge oscillator generates Sine wave which is fed to the input of Zero crossing detector. This detector gives the square wave output which's connected to the input of the Integrator which in turn produces the Triangular wave output. The frequency of oscillations of the Sine wave output of Wien Bridge oscillator is given by $f_0=1/2\pi RC$

The frequency of oscillations of Square and Triangular wave outputs will also be the same frequency as that of the Sine wave output. For theory of individual circuits i.e. Wien Bridge oscillator, Zero Crossing Detector and Integrator, please refer to the THEORY section of respective experiments mentioned earlier in this manual.

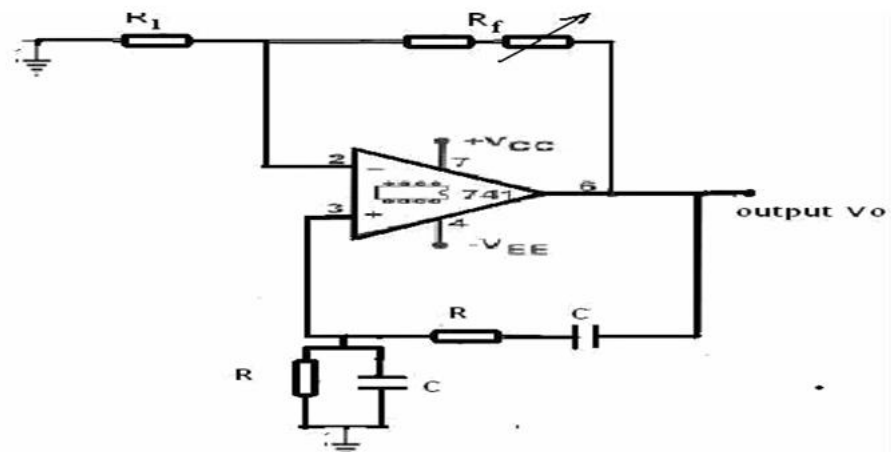
DESIGN for Wien Bridge Oscillator:

1. Choose a desired frequency of oscillation, say $f_0=500\text{Hz}$.
2. Choose a value for capacitor C(0.1 μF) and then calculate the value of R by using the equation for $f_0(f_0=1/2\pi RC)$.

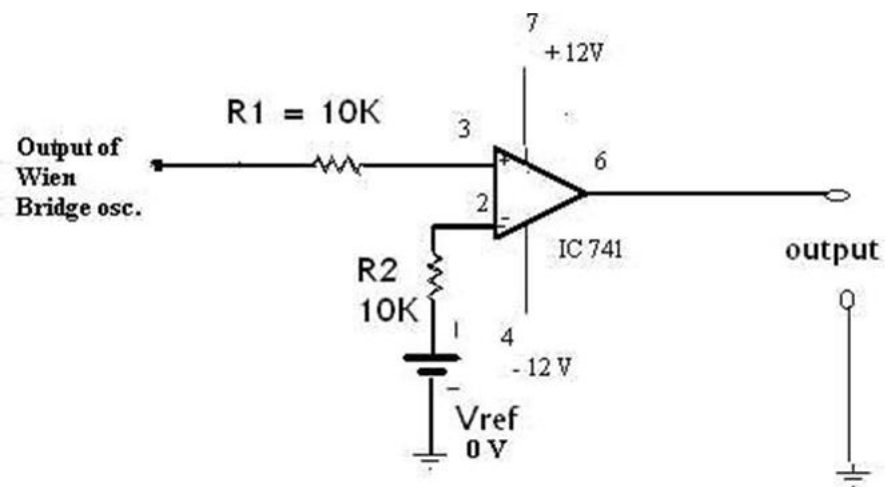
Choose a value for R_1 (10 $\text{K}\Omega$) and calculate the value of R_f from the gain equation($A_v = 1+R_f/R_1 = 3$). (Note: In practical, the value of R_f may need to be varied to be more than the calculated value.

CIRCUIT DIAGRAMS:

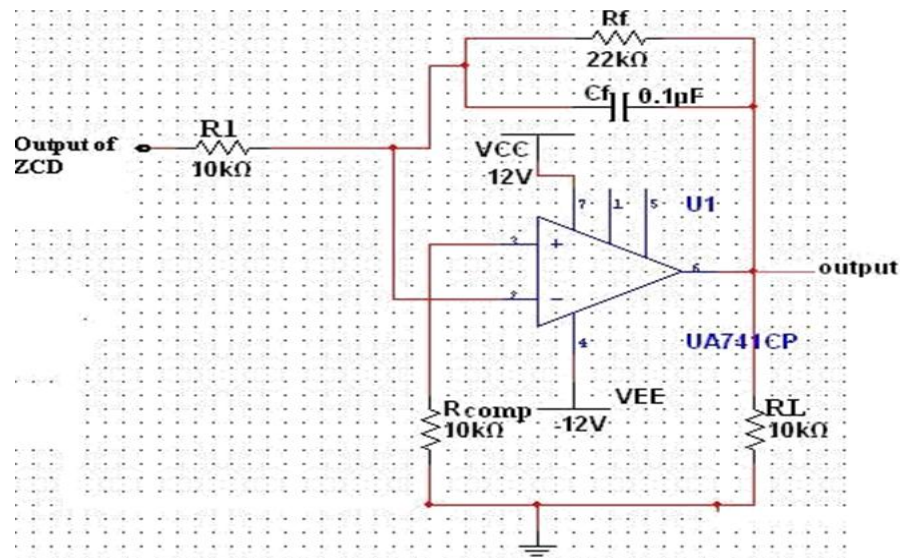
SINE WAVE GENERATOR (WIEN BRIDGE OSCILLATOR):



SQUARE WAVE GENERATOR (ZERO CROSSING DETECTOR):



TRIANGULAR WAVE GENERATOR (INTEGRATOR):



PROCEDURE:

Sine wave Generator:

1. Connect the components/equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Connect output to the CRO.
4. Adjust the potentiometer to get an undistorted waveform.
5. Note down the amplitude and the time period, T of the sine wave and calculate the frequency of oscillation, $f_o=1/T$.
6. Verify the practical frequency of oscillation calculated in the preceding step with the theoretical value, $f_o=1/2\pi RC$.
7. Plot the waveform.

Square wave Generator:

1. Switch OFF the power supply.
2. Connect the components/equipment as shown in the circuit diagram.
3. Switch ON the power supply.
4. Connect the input to the channel-1 of CRO and output to the channel-2 of CRO.
5. Observe the square wave output at channel-2 and note down the amplitude and time period, T of the waveform. Time period, T of the waveform.
6. Verify that the frequency of oscillation of both the input and the output wave is same. Also verify that both the input and the output waves are in same phase. Plot the output wave form in accordance with the

Triangular wave Generator:

1. Switch OFF the power supply.
2. Connect the components/equipment as shown in the circuit diagram.
3. Switch ON the power supply.
4. Connect the input to the channel-1 of CRO and output to the channel-2 of CRO.
5. Observe the triangular wave output at channel-2 and note down the amplitude and time period, T of the waveform.
6. Verify that the frequency of oscillation of both the input and the output waves is same. Also

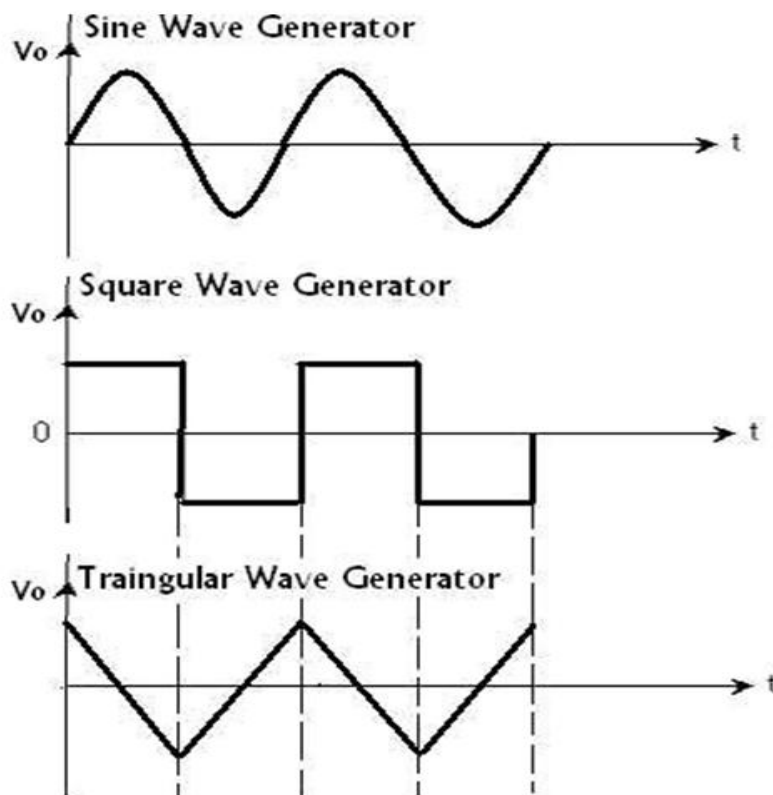
- verify that the output wave is inverted i.e. 180° phase shift from the input wave.
7. Plot the output waveform in accordance with the input waveform.

CALCULATIONS:

THEORETICAL Frequency of Oscillation $f_o = 1/2\pi RC$

PRACTICAL Frequency of Oscillation $f_o = 1/T$

EXPECTED GRAPHS:



RESULT: The Waveform Generator which generates Sine, Square and Triangular wave forms using IC741 and to verify it's various output waveforms.

APPLICATIONS:

Waveform generators are used to produce signals like sine, square, and triangular waves.

They are widely used in testing and analysis of electronic circuits.

Applications include communication systems and signal processing.

They are essential in laboratories for designing and troubleshooting circuits

VIVA QUESTIONS:

1. What is a Function Generator?
2. What are the different stages in a Function Generator and how they are connected?
3. Draw the output wave forms at different stages of Function Generator.
4. What is the relationship among the frequencies of output waveforms at different stages of Function Generator?
5. Will there be any phase shift between the input and the output of any stage in the Function Generator and what factor it depends on?
6. Why is R comp used in the circuit of Triangular wave generator?
7. Why is potentiometer used in the circuit of Wien Bridge Oscillator?
8. Formula for the gain of inverting amplifier?
9. Formula for the gain of non-inverting amplifier?
10. Define op-amp?
11. Difference between closed loop and open loop feed back?
12. Difference between inverting amplifier op-amp and non-op-amp
13. Draw the circuit of the integrator using op-amp?
14. Draw the frequency response of the integrator?
15. Define slew rate?
16. Define CMRR?
17. What output does comparator generates when $V_{in} > V_{ref}$?
18. What is meant by clipper circuit?
19. What is the 'tilt' applicable to RC circuits ? Give an expression for tilt?
20. What type of distortion is observed in monostable multivibrator?
21. What is meant by clamper circuit?
22. Give two applications of Schmitt Trigger circuit...?
23. Why do we call monostable multivibrator as free running multivibrator?
24. Define the threshold points in a Schmitt trigger circuit.?
25. What is are generative comparator?
26. Distinguish between symmetrical and unsymmetrical triggering methods
27. A monostable 555 timer has the following number of stable states?
28. The mono stable multivibrator circuit is not an oscillator because_?.
29. To obtain a 50% duty cycle in an monostable 555 timer circuit?
30. How many stable states are present in monostable 555 timer?
31. Which of the following is NOT a characteristic of a re triggerable monostable multivibrator?

32. What does the monostable do?
33. What is the main purpose of monostable multivibrator?
34. What is the other name of monostable multivibrator?
35. Disadvantages of monostable multivibrator?
36. Monostable multivibrator is used as
37. What type of transistors are used in monostable multivibrator?
38. Monostable multivibrator has a?
39. Characteristics of retriggerable monostable multivibrator?
40. Block diagram of monostable multivibrator?
41. Draw the circuit of the Differentiator using op-amp IC741.
42. Write down the expression for V_O of a Differentiator.
43. Difference between closed loop and open loop feedback?
44. Difference between inverting amplifier op-amp and non-op-amp
45. Draw the circuit of the integrator using op-amp?
46. Draw the frequency response of the integrator?
47. What is the function of an integrator circuit using IC 741?
48. Why is a capacitor used in the feedback path of an integrator circuit?
49. What is the main difference between an integrator and a differentiator circuit?
50. How does a differentiator circuit using IC 741 respond to high-frequency signals?

EXPERIMENTNO:7

MONOSTABLE MULTIVIBRATOR USING IC555

AIM: To design a Monostable Multivibrator using IC555 and compare it's theoretical and practical pulse width.

PRELAB:

1. Study the purpose of using IC 555 Timer
2. Learn about different Multivibrators
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

- To Design and setup a Monostable Multivibrator using IC 555
- To determine the Time period
- To plot waveforms of Monostable Multivibrator

APPARATUS:

1. Bread Board.
2. CRO
3. Probes
4. Connecting wires
5. Resistors, Capacitors
6. IC 555 Timer

THEORY:

Monostable multivibrator is also called as one-shot Multivibrator. When the output is low, the circuit is in stable state, transistor T1 is ON and Capacitor C is shorted to the ground. However, upon application of a negative trigger pulse to Pin-2, transistor T1 is turned OFF, which releases short circuit across the external capacitor and drives the output High. The capacitor C now starts charging up toward VCC through R. However when the voltage across the external capacitor equals $\frac{2}{3} VCC$, upper comparator's output switches from low to high which inturn derives the output to its low state. And the output of the flip flop turns transistor T1 ON, and hence the capacitor C rapidly discharges through the transistor. The output of the Monostable remains low until a trigger pulse is a gain applied. Then the cycle repeats. The time during which the output remains high is given by

$$t_p = 1.1RC$$

Once triggered, the circuit 's output will remain in the high state until the set time t_p elapses. The output will not change its state even if an input trigger is applied again during this time interval t_p

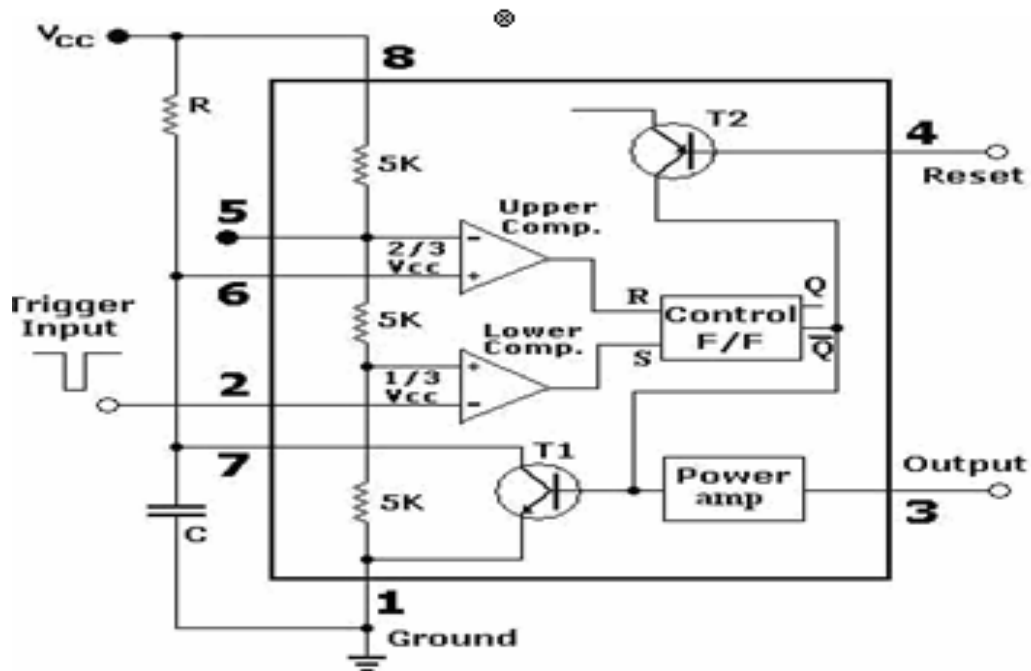


Fig: Internal Circuit Diagram of IC555 Monostable Multivibrator

CIRCUIT DIAGRAM:

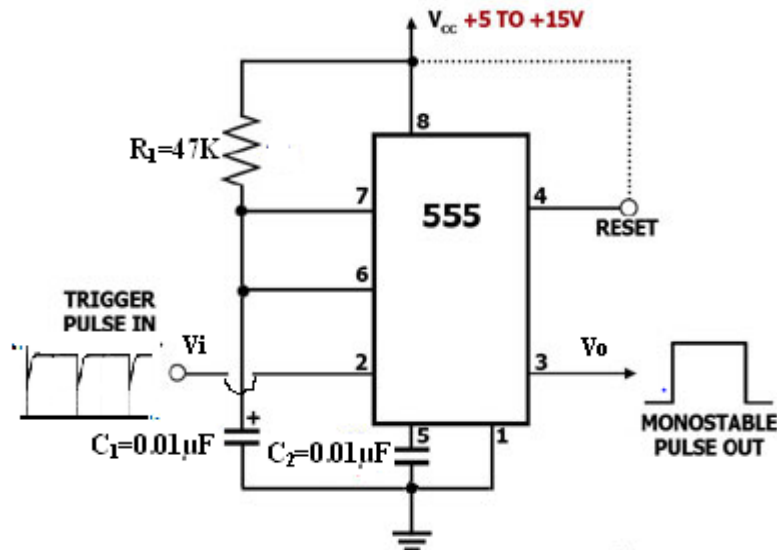
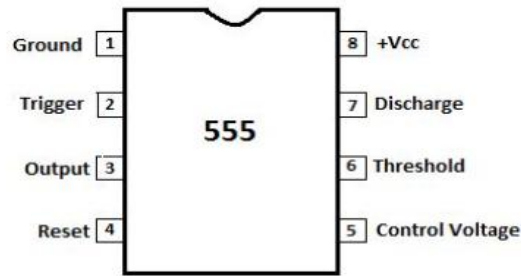


Fig: IC555 Monostable Multivibrator

PIN DIAGRAM:



PROCEDURE:

1. Connect the components/equipment as shown in the circuit diagram.
2. Switch ON the power supply.
3. Connect function generator at the trigger input.
4. Connect channel-1 of CRO to the trigger input and channel-2 of CRO to the output(Pin3).
5. Using Function Generator, apply 1KHz square wave with amplitude of approx. equal to $9V_{pp}$ at the trigger input.
6. Observe the output voltage with respect to input and note down the pulse width and amplitude.
7. Now connect channel-2 of CRO across capacitor and observe the voltage across the capacitor and note it down.

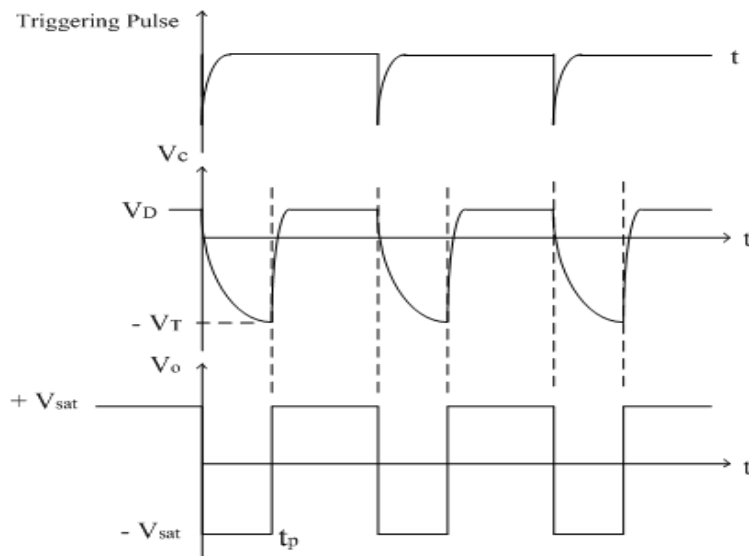
Compare the practical pulse width noted in the step above with its theoretical value

CALCULATIONS:

THEORETICAL

$$\text{Pulse width} = t_p = 1.1RC = \text{PRACTICAL}$$

EXPECTED GRAPH:



RESULT: Monostable Multivibrator using IC555 and compare it's theoretical and practical pulse width

APPLICATIONS:

Monostable multivibrator using IC 555 produces a single pulse for each trigger input. It is used in timing circuits and pulse generation applications. Common applications include delay circuits, switch debouncing, and pulse stretching. It is widely used in digital electronics and control systems.

VIVA QUESTIONS:

1. What is a monostable multivibrator?
2. Why is it called a one-shot multivibrator?
3. What are the main components required to design a monostable circuit using IC 555?
4. What is the function of the trigger input in IC 555?
5. What type of pulse triggers the monostable circuit?
6. What happens when the trigger input goes below $1/3 V_{cc}$?
7. What is the role of the threshold pin in IC 555?
8. What is the output state before triggering the monostable circuit?
9. What is the output state after triggering?
10. What determines the pulse width in a monostable multivibrator?
11. Write the expression for pulse width of IC 555 monostable.
12. How does changing resistance affect the output pulse duration?
13. How does changing capacitance affect the timing interval?
14. What is the function of the discharge pin?
15. Why is a capacitor used in the timing circuit?
16. What is the typical range of timing that can be achieved using IC 555?
17. What is the purpose of the control voltage pin?
18. What happens if the reset pin is grounded?
19. Why is the reset pin usually connected to V_{cc} ?
20. What is the internal structure of IC 555?
21. What are the two comparators used in IC 555?
22. What is the function of the flip-flop inside IC 555?
23. What role does the discharge transistor play?
24. What is meant by stable and quasi-stable states?
25. How many stable states does a monostable multivibrator have?
26. What is the initial condition of the capacitor in monostable mode?

27. What happens to the capacitor voltage during the timing period?
28. At what voltage does the capacitor stop charging?
29. What happens when the capacitor voltage reaches $2/3 V_{cc}$?
30. How does the output return to its original state?
31. What is retriggering in monostable multivibrator?
32. Can IC 555 monostable be retriggered? Explain.
33. What is the difference between astable and monostable multivibrator?
34. What are the applications of monostable multivibrator?
35. How is IC 555 used as a timer?
36. What is the importance of decoupling capacitor in IC 555 circuits?
37. Why is noise immunity important in triggering?
38. What is the minimum trigger pulse width required?
39. What is the effect of supply voltage variation on timing?
40. How can you increase accuracy of timing circuit?
41. What are the limitations of IC 555 monostable?
42. What is the maximum output current of IC 555?
43. What type of output does IC 555 provide (TTL/CMOS compatible)?
44. What is the significance of pin configuration of IC 555?
45. What happens if trigger pin is left floating?
46. What is the function of external resistor in monostable circuit?
47. What is the effect of leakage current of capacitor?
48. How can monostable multivibrator be used as a delay circuit?
49. How can you generate long time delays using IC 555?
50. What are practical applications of IC 555 monostable in real-world circuits?

EXPERIMENT NO:8**ASTABLE MULTIVIBRATOR**

AIM: To design a Astable Multivibrator using IC555 and compare it's theoretical and practical pulse width.

PRELAB:

1. Study the purpose of using IC 555 Timer
2. Learn about different Multivibrators
3. Identify all the formulae you will need in this Lab.

OBJECTIVES:

After completion of this experiment student will be able to

1. To Design and setup a Monostable Multivibrator using IC 555
2. To determine the Time period
3. To plot waveforms of Astable Multivibrator

APPARATUS:

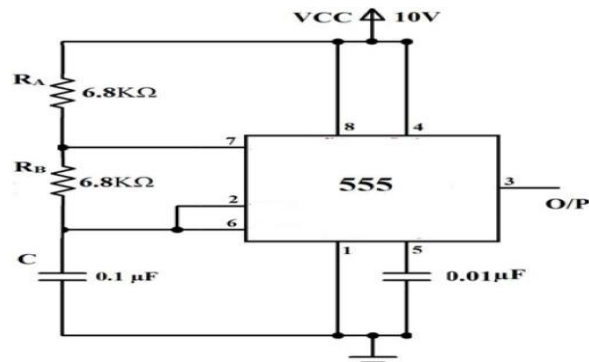
1. Bread Board.
2. CRO
3. CRO Probes
4. Connecting wires
5. Resistors, Capacitors
6. IC 555 Timer

THOERY:

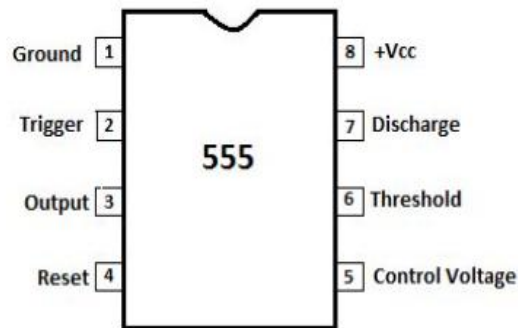
An astable multivibrator using the IC 555 timer operates as a continuous pulse generator with no stable state, meaning it does not require any external triggering to produce output. The circuit consists of two resistors and a capacitor that control the timing of oscillations. Initially, the capacitor charges through both resistors until its voltage reaches $2/3$ of the supply voltage, at which point the upper comparator resets the internal flip-flop, causing the output to switch low and the discharge transistor to turn on. This allows the capacitor to discharge through one resistor until its voltage drops to $1/3 V_{cc}$, triggering the lower comparator.

to set the flip-flop again and make the output high. This repetitive charging and discharging process creates a rectangular waveform at the output. The time period, frequency, and duty cycle of the waveform depend on the resistor and capacitor values, making the circuit highly useful in applications such as clock pulse

CIRCUIT DIAGRAM:

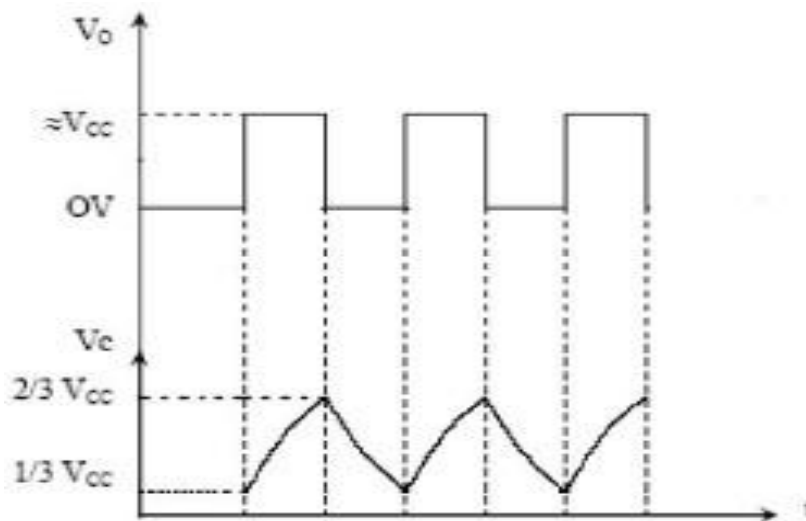


PIN DIAGRAM:



PROCEDURE:

1. Check the components.
2. Setup the symmetric astable multivibrator circuit on the breadboard and check the connections.
3. Switch on the power supply.
4. Observe output and capacitor voltage on different channels of the oscilloscope simultaneously.
5. Draw the waveforms on the graph.
6. Measure the frequency of oscillation and duty cycle .
7. Repeat the procedures for asymmetric astable multivibrator.

EXPECTED GRAPH:

RESULT: Astable Multivibrator using IC555 and compare it's theoretical and practical pulse width.

APPLICATIONS:

Astable multivibrator produces a continuous square wave without any external trigger. It is used as a clock generator and pulse generator in digital circuits. Applications include LED flashing and waveform generation. It is widely used in timing and oscillator circuits.

VIVA QUESTIONS:

1. What is an astable multivibrator?
2. Why is it called a free-running multivibrator?
3. How many stable states are present in an astable multivibrator?
4. What is the basic function of IC 555 in astable mode?
5. What type of waveform is generated in astable mode?
6. What components are required to design an astable multivibrator using IC 555?
7. What is the role of resistors in astable circuit?
8. What is the function of capacitor in astable mode?
9. What is the purpose of trigger pin in astable configuration?
10. What is the function of threshold pin?
11. What happens when capacitor voltage reaches $2/3 V_{CC}$?
12. What happens when capacitor voltage drops to $1/3 V_{CC}$?
13. What is the role of discharge pin in astable multivibrator?
14. What is the function of control voltage pin?

15. Why is reset pin connected to Vcc?
16. What is the expression for time period of astable multivibrator?
17. What is the formula for frequency of oscillation?
18. What is duty cycle in astable multivibrator?
19. How is duty cycle calculated in IC 555 astable circuit?
20. Can duty cycle be made exactly 50%? How?
21. What is the charging path of capacitor in astable circuit?
22. What is the discharging path of capacitor?
23. Why does the output continuously oscillate?
24. What is the role of internal comparators in IC 555?
25. What is the function of flip-flop inside IC 555?
26. What is the significance of voltage levels $1/3 V_{cc}$ and $2/3 V_{cc}$?
27. What type of output is obtained from IC 555 (analog/digital)?
28. What is the maximum output current of IC 555?
29. What is the effect of changing R1 on frequency?
30. What is the effect of changing R2 on duty cycle?
31. What happens if capacitor value increases?
32. What happens if supply voltage increases?
33. What is the importance of decoupling capacitor?
34. What is the typical frequency range of IC 555 astable circuit?
35. What are the limitations of IC 555 astable multivibrator?
36. What is the effect of leakage current of capacitor?
37. What is meant by mark time and space time?
38. What is the difference between astable and monostable multivibrator?
39. What are the applications of astable multivibrator?
40. How is IC 555 used as a square wave generator?
41. How can astable multivibrator be used as a clock generator?
42. What is the role of diode in modified astable circuit?
43. How can duty cycle be reduced below 50%?
44. What happens if trigger and threshold pins are shorted?
45. What precautions should be taken while designing astable circuit?
46. What is the effect of noise on astable operation?
47. Why is IC 555 widely used in timing circuits?
48. How can frequency stability be improved?
49. What are real-time applications of astable multivibrator?

50. How does IC 555 compare with other oscillator circuits?

EXPERIMENT NO:9

SCHMITT TRIGGER

AIM: To construct and study the Schmitt Trigger using IC741 and IC 555 Operational Amplifiers

OBJECTIVES:

After completion of this experiment student will be able to

1. To Design and setup a Monostable Schmitt trigger using IC 555
2. To Design and setup a Monostable Schmitt trigger using IC 741
3. To determine the Time period

APPARATUS:

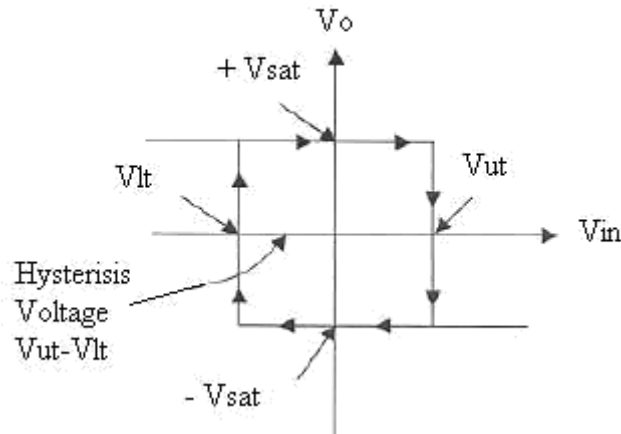
1. Bread Board.
2. CRO
3. Probes
4. Connecting wires
5. Resistors, Capacitors
6. IC 555 Timer

PROCEDURE:

1. Connect the circuit as shown Fig.
2. Set Function Generator output for sine wave signal of Amplitude at 1V(p-p) & frequency 1KHz.
3. Set R1 and R2 values at fixed positions and note down the values in tabular column. Calculate theoretical values of V_{ut} and V_{lt} and note down the values in tabular column. ($+V_{sat} = 14V, -V_{sat} = -14V$).
4. Apply Function Generator output at input terminals V_i , connect C.R.O- CH2 at output terminals V_o , C.R.O-CH1 at input terminals V_i .
5. Observe square wave output on C.R.O for the given input sine wave & compare them with the sample waveform as shown in fig.2.
6. Note down the practical V_{ut} , V_{lt} and V_H values in tabular column.
7. Compare the theoretical and practical values of V_{ut}, V_{lt} and V_H

HYSTERESIS GRAPH:

Vo versus Vin plot of Hysteresis Voltage



TABULAR COLUMN:

S.No	Theoretical Values				Practical value	
	R ₁	R ₂	$V_{ut} = \frac{R_1}{R_1 + R_2} (+V_{sat})$	$V_{lt} = \frac{R_1}{R_1 + R_2} (-V_{sat})$	V _{ut}	V _{lt}
1						
2						
3						

OBSERVATIONS FOR SCHMITT TRIGGER USING IC 741:

Input signal

Amplitude =

Time period =

Output signal

Amplitude =

Time period =

RESULT: Constructed and studied the Schmitt Trigger using IC741 and IC 555 Operational Amplifiers.

APPLICATIONS:

Schmitt Trigger is a comparator circuit with hysteresis used to convert noisy signals into clean digital output.

It is used for wave shaping and noise removal in electronic circuits.
Applications include switch debouncing and signal conditioning.
It is widely used in digital and communication systems.

VIVA QUESTIONS:

1. What is an operational amplifier?
2. What is the function of an inverting amplifier?
3. What is the gain formula of an inverting amplifier?
4. What is a non-inverting amplifier?
5. What is the gain of a non-inverting amplifier?
6. What is a summing amplifier?
7. What is the purpose of an op-amp subtractor?
8. What is a comparator?
9. What is the difference between open-loop and closed-loop op-amp?
10. What is virtual ground in op-amp?
11. What is an integrator circuit?
12. What is a differentiator circuit?
13. What is the application of an integrator?
14. What is the drawback of an ideal differentiator?
15. What is IC 741?
16. What are the characteristics of IC 741?
17. What is slew rate?
18. What is input offset voltage?
19. What is bandwidth of an op-amp?
20. What is CMRR?
21. What is an active filter?
22. What is a low pass filter?
23. What is a high pass filter?
24. What is cutoff frequency?
25. What is the advantage of active filters over passive filters?
26. What is a waveform generator?
27. What are types of waveforms generated?
28. What is the function of a function generator?
29. What is an oscillator?

30. What is the difference between oscillator and amplifier?
31. What is IC 555 timer?
32. What is monostable multivibrator?
33. What is astable multivibrator?
34. What is bistable multivibrator?
35. What is duty cycle?
36. What is the role of capacitor in 555 timer?
37. What is trigger pulse?
38. What is threshold voltage in 555?
39. What is control voltage pin?
40. What is reset pin function?
41. What is a Schmitt trigger?
42. What is hysteresis?
43. What are upper and lower threshold voltages?
44. What is noise immunity?
45. What is zero crossing detector?
46. What is clipping circuit?
47. What is clamping circuit?
48. What is phase shift in op-amp?
49. What is feedback in op-amp circuits?
50. What are practical applications of op-amps?

EXPERIMENT NO:10**THREETERMINALVOLTAGE REGULATORS–7805,7809,7912****AIM:**

To study the Fixed Voltage Regulators(1)7805
(2)7809
(3)7812

OBJECTIVES:

1. Study the purpose of using Voltage Regulators
2. Learn about different IC Voltage Regulators
3. Identify **7805,7809,7912** Voltage Regulators

APPARATUS:

1. Bread Board.
2. Connecting wires
3. **7805,7809,7912** ICs
4. Multi meter

THEORY:

DC power for electronic circuits is most conveniently obtained from commercial ac lines by using rectifier - filter system, called a dc power supply. The rectifier-filter combination constitutes an ordinary dc power supply . The dc voltage from an ordinary power supply remains constant so long as ac mains voltage or load is unaltered. However, in many electronic applications, it is desired that Constant Dc voltage should remain irrespective of changes in ac mains or load. Under such situations, voltage regulating devices are used with ordinary power supply. This constitutes regulated dc power supply and keeps the dc voltage at fairly constant value.

ORDINARY DC POWER SUPPLY:

An ordinary or regulated dc power supply contains a rectifier and a filter circuit as shown in Fig-1. The output from the rectifier is pulsating dc. These pulsations are due to the presence of ac component in the rectifier output. The filter circuit removes the ac component so that steady dc voltage is obtained across the load.

Limitations : An ordinary dc power supply has two following drawbacks:

- 1.The dc output voltage changes directly with input ac voltage.
2. The dc output voltage decreases as the load current increases. This is due to voltage drop in(a)Transformer windings(b)Rectifier(c)Filter circuit

These variations in dc output voltage may cause in accurate or erratic operation or even malfunctioning of many electronic circuits.

REGULATED POWER SUPPLY:

A dc power supply which maintains the output voltage constant irrespective of ac mains fluctuations or load variations is known as regulated dc power supply. A regulated power supply consists of an ordinary power supply and voltage regulating device as in fig-4. The output of ordinary power supply is fed to the voltage regulator which produces the final output. The output voltage (V_{dc}) remains constant whether the load current changes or there are fluctuations in the

LDICA LAB MANNUAL ECE , MLRITM
input ac voltage.

HARDWARE SPECIFICATIONS

1. Built-in 16V -0-16V/350mA
12V -0-12V/350mA
8V-0-8V/350mA AC sources
2. Bridge rectifier using IN4007 diodes-1No.
3. Filter capacitors(470 μ F/ 35V) -2Nos.
4. Fixed Voltage Regulator 7805-1No.
7809-1No.
7812-1No.
7912-1No.
5. Variable Voltage Regulator using 723IC

PROCEDURE:

1. Connect the circuit as shown in fig-4.
2. Connect different load resistors available in the front panel, note down the output current and voltage.
3. Also test the circuit with 12V-0-12V, 16V -0-16V AC sources also.
4. Remove 7805 and connect 7809, 7812 also repeat 2 and 3 steps.
5. Connect the circuit shown in fig-5.

RESULT: Studied and verified the Fixed Voltage Regulators

(1)7805

(2)7809

(3)7812

APPLICATIONS:

Three-terminal voltage regulators like 7805, 7809 provide fixed positive voltages of +5V and +9V respectively.

IC 7912 provides a fixed negative output of -12V.

They have three terminals: input, ground, and output.

These regulators are widely used for providing stable and regulated power supply in electronic circuits.

VIVA QUESTIONS:

1. What is a three-terminal voltage regulator?
2. What is IC 7805?
3. What output voltage does 7805 provide?
4. What is IC 7809?
5. What output voltage does 7809 provide?
6. What is IC 7912?
7. What output voltage does 7912 provide?
8. Which series does 7805 belong to?
9. Which series does 7912 belong to?
10. What are the three terminals of a regulator?

11. What is the function of input terminal?
12. What is the function of ground terminal?
13. What is the function of output terminal?
14. What is line regulation?
15. What is load regulation?
16. What is dropout voltage?
17. What is ripple rejection?
18. What is maximum current rating of 78xx series?
19. What is the difference between 78xx and 79xx series?
20. Why are capacitors used in regulator circuits?
21. What is the role of input capacitor?
22. What is the role of output capacitor?
23. What is heat sink?
24. Why is heat sink required?
25. What is thermal shutdown?
26. What is short circuit protection?
27. What is power dissipation?
28. What is efficiency of linear regulators?
29. What is quiescent current?
30. What is voltage regulation?
31. What is regulated power supply?
32. What is unregulated power supply?
33. What is filtering in power supply?
34. What is the polarity of 79xx regulators?
35. What happens if input polarity is reversed?
36. What is safe operating area?
37. What is transient response?
38. What is output impedance?
39. What is input voltage range for 7805?
40. What is input voltage range for 7809?
41. What are applications of 7805?
42. What are applications of 7809?
43. What are applications of 7912?
44. What is voltage reference?
45. What is noise in power supply?
46. What is bypass capacitor?
47. What is stability in regulators?
48. What are advantages of three-terminal regulators?
49. What are disadvantages of linear regulators?
50. Why are 7805 regulators widely used?

EXPERIMENT NO:11

DESIGN A 8X1 MULTIPLEXER USING DIGITAL ICs.

AIM: To construct multiplexer and de-multiplexer circuits using IC-74X151 and IC-74X155 respectively.

APPARATUS REQUIRED:

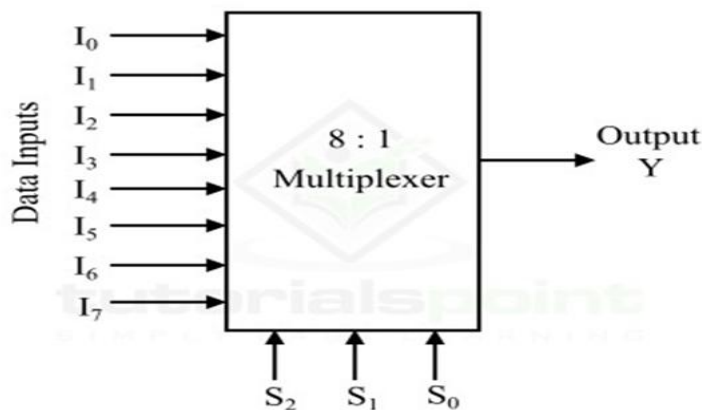
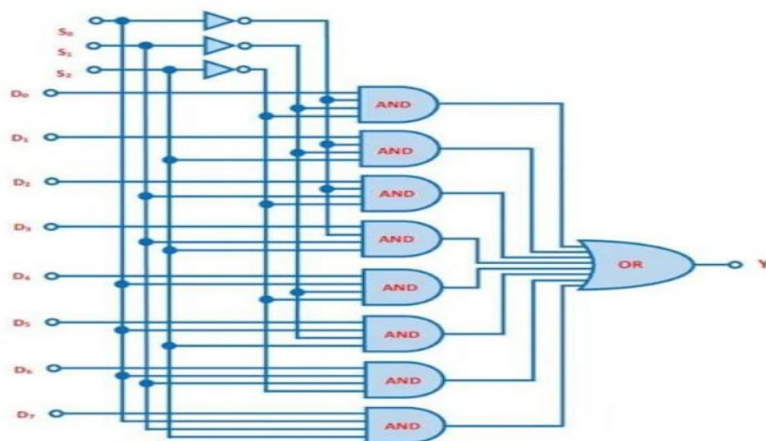
1. IC
2. Digital IC Trainer Kit
3. Patch cards
4. Fixed Power Supply

THEORY:

The multiplexers contains full on-chip decoding unit to select desired data source. The 74151 selects one-of-eight data sources. It has a enable input which must be at a LOW logic level to enable these devices. These perform parallel-to-serial conversion. The 74150 selects one-of sixteen data sources.

The 74155 sends the data source to one of four data destinations. It has a enable input which must be at a LOW logic level to enable these devices.

The binary decoder with enable input connected to data line known as De multiplexer.

PIN DIAGRAM:

8:1 MULTIPLEXER LOGIC DIAGRAM:


PROCEDURE:

1. Connections are made as per the logic diagram.
2. Apply +5V for Vcc & 0V for GND
3. Outputs will be verified for different combinations of inputs.

RESULT:

Designed and verified multiplexer and de-multiplexer circuits using digital ICs.

APPLICATIONS:

An 8×1 multiplexer selects one of eight input signals and routes it to a single output.

It uses three select lines to choose the desired input.

Digital ICs like 74151 are commonly used to implement 8×1 multiplexers.

It is widely used in data selection, communication systems, and digital circuits.

VIVA QUESTIONS:

1. What is a multiplexer?
2. What is the function of an 8×1 multiplexer?
3. How many inputs does an 8×1 MUX have?
4. How many select lines are required for 8×1 MUX?
5. What is the output of a multiplexer?
6. Which IC is commonly used for 8×1 MUX?
7. What is IC 74151?
8. What are the select lines in MUX?
9. What is the role of enable pin?
10. What happens when enable is disabled?
11. What is the truth table of 8×1 MUX?
12. What is the difference between MUX and DEMUX?
13. What is data selection?
14. What is the Boolean expression of 8×1 MUX?
15. What are data inputs in MUX?
16. What is strobe input?
17. What is active low enable?
18. What is propagation delay in MUX?
19. What is fan-in?
20. What is fan-out?
21. What is the use of multiplexer in communication systems?

22. Can MUX be used as a data selector?

23. How is MUX used in digital systems?
24. What is logic implementation using MUX?
25. What is combinational circuit?
26. What is switching circuit?
27. What is binary selection?
28. What is channel selection?
29. What is address line?
30. What is control signal?
31. What is digital IC?
32. What is TTL logic?
33. What is logic level?
34. What is HIGH and LOW in digital circuits?
35. What is power supply for 74151?
36. What is ground pin?
37. What is output inversion in MUX?
38. What is difference between active high and active low?
39. What is data routing?
40. What is signal selection?
41. What is advantage of using MUX?
42. What is limitation of MUX?
43. What is cascading of MUX?
44. How to implement larger MUX using smaller ones?
45. What is digital switching?
46. What is synchronous selection?
47. What is asynchronous selection?
48. What is noise margin?
49. What is logic family?
50. What are applications of 8×1 MUX?

EXPERIMENT: 12**DESIGN OF 4-BIT ADDER / SUBTRACTOR USING DIGITAL ICs**

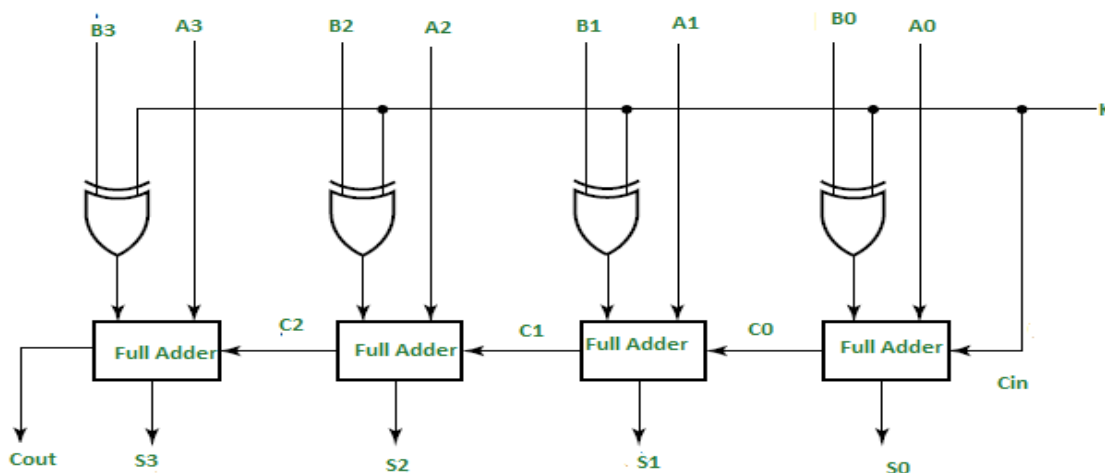
AIM: To design and implement a 4-bit Adder/Subtractor circuit using digital ICs and perform addition and subtraction for given binary numbers.

APPARATUS REQUIRED:

- IC 7483 (4-bit binary adder)
- IC 7486 (XOR gates)
- Breadboard
- Connecting wires
- Power supply (+5V)
- Toggle switches / input logic trainer
- LEDs for output display

THEORY: A 4-bit Adder/Subtractor performs both addition and subtraction using the same circuit. Subtraction is achieved using 2's complement method, where:

- Subtraction: $A - B = A + (2\text{'s complement of } B)$
- XOR gates are used to complement B inputs when subtraction mode is selected.
- A control input **M** is used:
 - $M = 0 \rightarrow$ Addition
 - $M = 1 \rightarrow$ Subtraction

CIRCUIT DIAGRAM:**TABULAR COLUMN:****ADDITION (M = 0)**

S.No	A	B	Result (Sum)	Carry
1	1010	1010	10100	1
2	0101	0101	01010	0
3	1011	1011	10110	1

S.No	A	B	Result (Sum)	Carry
4	0100	0100	01000	0
5	0010	0010	00100	0
6	1001	1001	10010	1

SUBTRACTION (M = 1)

(Assuming $A - B$ where $A =$ given number, $B =$ same number \rightarrow Result = 0000)

S.No	A	B	Result (Difference)	Borrow
1	1010	1010	0000	0
2	0101	0101	0000	0
3	1011	1011	0000	0
4	0100	0100	0000	0
5	0010	0010	0000	0
6	1001	1001	0000	0

PROCEDURE

1. Place IC 7483 and IC 7486 on the breadboard.
2. Connect power supply (+5V and GND).
3. Connect A inputs directly to the adder.
4. Connect B inputs through XOR gates.
5. Connect control input M to XOR gates and Carry-in.
6. Apply input combinations using switches.
7. Observe outputs on LEDs.
8. Verify results for both addition and subtraction modes.

RESULT:

The 4-bit Adder/Subtractor circuit was successfully designed and implemented using digital ICs. The circuit correctly performed both addition and subtraction operations for the given binary inputs.

VIVA QUESTIONS:

1. What is a binary adder?
2. What is a binary subtractor?
3. What is the function of a 4-bit adder?
4. Which IC is used for a 4-bit adder?
5. What is the function of IC 7483?
6. What is the function of IC 7486?
7. What is an XOR gate?
8. Why are XOR gates used in this circuit?
9. What is the role of control input M?
10. What happens when $M = 0$?
11. What happens when $M = 1$?
12. What is 2's complement?
13. Why is 2's complement used in subtraction?

14. How do you find 2's complement of a binary number?
15. What is the function of carry input (Cin)?
16. Why is Cin connected to control input?
17. What is the difference between half adder and full adder?
18. What are the inputs and outputs of a full adder?
19. How many full adders are present in IC 7483?
20. What is ripple carry adder?
21. What is propagation delay?
22. What is carry output (Cout)?
23. What is borrow in subtraction?
24. How is borrow represented in this circuit?
25. What is the truth table of XOR gate?
26. What is the advantage of using ICs over discrete components?
27. What is the power supply required for TTL ICs?
28. What happens if power supply is not proper?
29. What are logic levels in TTL?
30. What is meant by combinational circuit?
31. Is adder a combinational or sequential circuit?
32. What is the difference between addition and subtraction in binary?
33. What is overflow in binary addition?
34. When does overflow occur?
35. What is the maximum number that can be added using 4 bits?
36. How many bits are required to represent the result?
37. What is the function of LEDs in this experiment?
38. What is breadboard?
39. Why are switches used in the circuit?
40. What are the limitations of ripple carry adder?
41. How can speed of addition be improved?
42. What is carry look-ahead adder?
43. What is the importance of this experiment?
44. What are practical applications of adder circuits?
45. What are practical applications of subtractor circuits?
46. What happens if XOR gates are removed?
47. Can subtraction be done without XOR gates?
48. What is meant by digital IC?
49. What is fan-in and fan-out?
50. What precautions should be taken while performing the experiment?

EXPERIMENT:13**DESIGN OF DECADE COUNTER AND VERIFICATION OF TRUTH TABLE & WAVEFORMS**

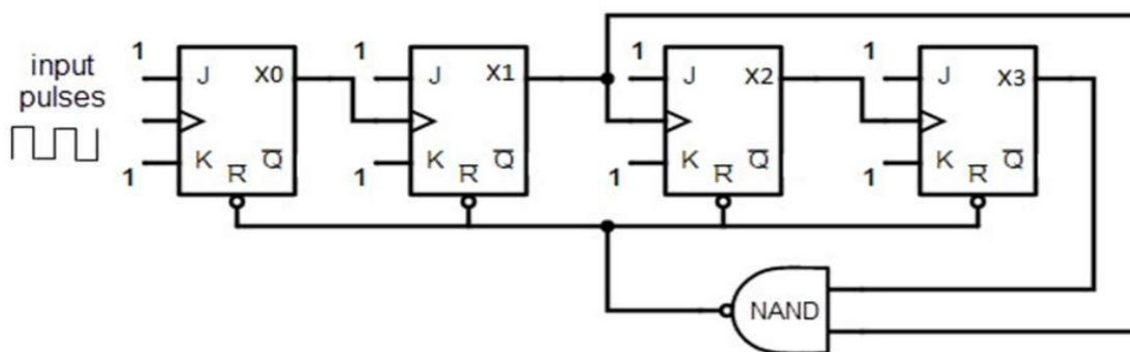
AIM: To design a Decade (MOD-10) counter using digital ICs, verify its truth table and observe the output waveforms.

APPARATUS REQUIRED:

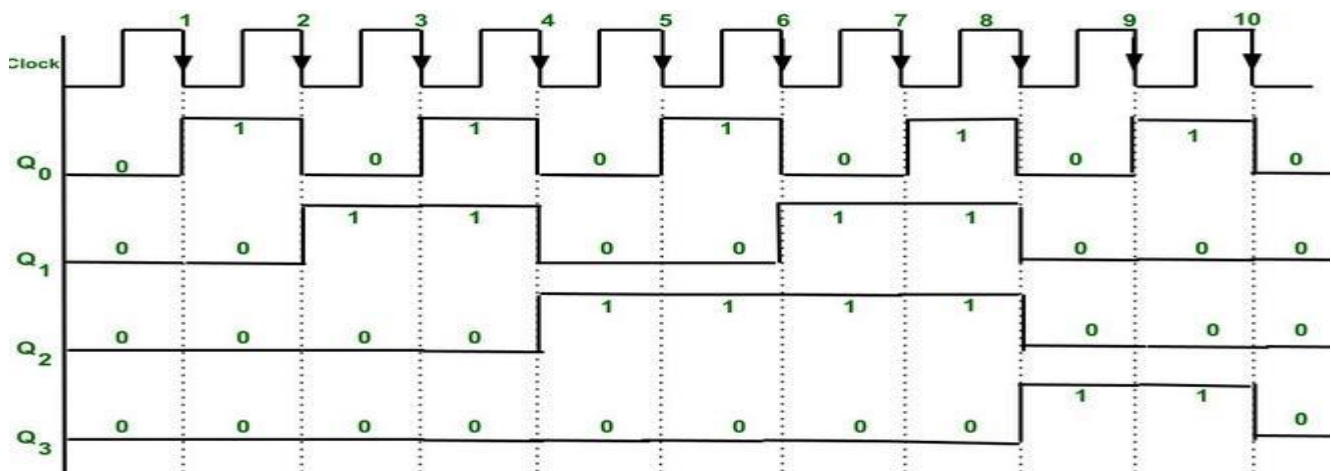
IC 7490 (Decade counter), breadboard, connecting wires, +5V power supply, function generator/clock pulse source, LEDs, CRO/DSO.

THEORY:

A Decade counter is a MOD-10 counter that counts from 0 to 9 (0000 to 1001) and then resets to 0000. It requires 4 flip-flops since $2^4 = 16$ states, but only 10 states are used. IC 7490 is commonly used, which internally consists of flip-flops configured to count in binary and reset after count 9. The outputs are QA, QB, QC, QD.

CIRCUIT DIAGRAM:**TRUTH TABLE:**

Input Pulses	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
0	0	0	0	0 (resets)

WAVEFORMS:**PROCEDURE:**

1. Place IC 7490 on the breadboard.
2. Connect power supply (+5V and GND).
3. Apply clock pulses to the counter.
4. Connect reset pins for MOD-10 operation.
5. Observe outputs using LEDs.
6. Verify the counting sequence from 0 to 9.
7. Use CRO/DSO to observe waveforms of QA, QB, QC, QD.

RESULT:

The Decade counter was successfully designed using IC 7490. The output sequence from 0000 to 1001 was verified, and the waveforms were observed as expected.

VIVA QUESTIONS:

1. What is a counter?
2. What is a decade counter?
3. Why is it called a MOD-10 counter?
4. Which IC is used to design a decade counter?
5. What is the function of IC 7490?
6. How many flip-flops are required for a MOD-10 counter?
7. Why are 4 flip-flops used in decade counter?
8. What is the counting sequence of a decade counter?
9. What happens after count 9?

10. What is the binary equivalent of decimal 9?
- ~~11. What is meant by modulus of a counter?~~
12. What is MOD number?
13. What is an asynchronous counter?
14. Is IC 7490 synchronous or asynchronous?
15. What is ripple effect in counters?
16. What is propagation delay?
17. What is the function of clock input?
18. What type of triggering is used in IC 7490?
19. What are the output pins of IC 7490?
20. What are QA, QB, QC, QD?
21. Which output has highest frequency?
22. Which output has lowest frequency?
23. How is frequency division achieved in counters?
24. What is reset in counter?
25. Why is reset required in decade counter?
26. What is the role of reset pins in IC 7490?
27. What happens if reset is not connected properly?
28. What is the power supply requirement for IC 7490?
29. What are logic levels in TTL circuits?
30. What is meant by counting up?
31. Can IC 7490 be used as frequency divider?
32. What is the divide-by-2 section in IC 7490?
33. What is the divide-by-5 section in IC 7490?
34. How is MOD-10 achieved using IC 7490?
35. What is the difference between synchronous and asynchronous counter?
36. What is a ring counter?
37. What is a Johnson counter?
38. What is the use of LEDs in this experiment?
39. What is a clock pulse?
40. What is duty cycle of a clock signal?
41. What is the importance of timing diagram?
42. What is waveform observation?
43. Why CRO/DSO is used in this experiment?
44. What is the frequency relation between QA, QB, QC, QD?
45. What are applications of decade counter?
46. Where are counters used in real life?
47. What is digital IC?
48. What precautions should be taken during the experiment?
49. What is the advantage of using IC 7490?
50. Can decade counter be designed using flip-flops separately?

EXPERIMENT:14**DESIGN OF UP/DOWN COUNTER USING IC 74163 AND VERIFICATION OF WAVEFORMS**

AIM: To design and implement an Up/Down counter using IC 74163 and observe the corresponding output waveforms.

APPARATUS REQUIRED:

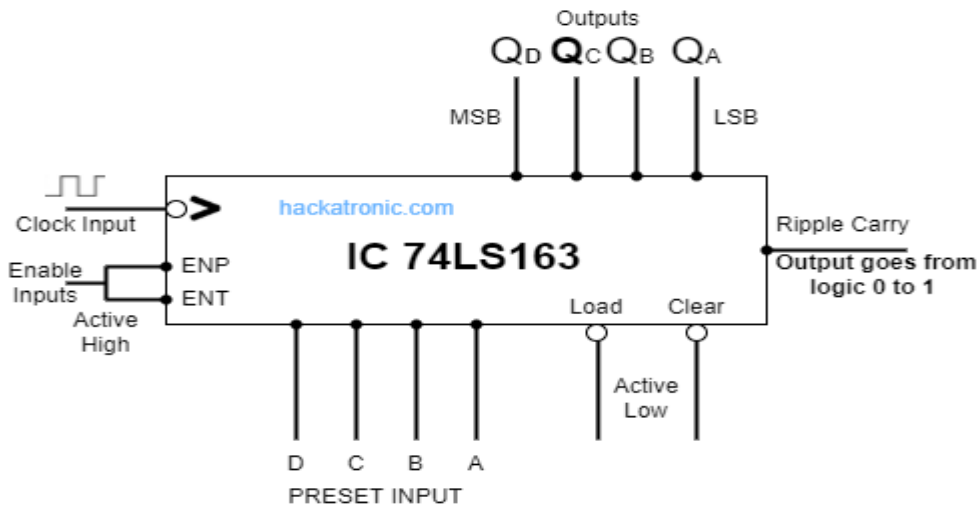
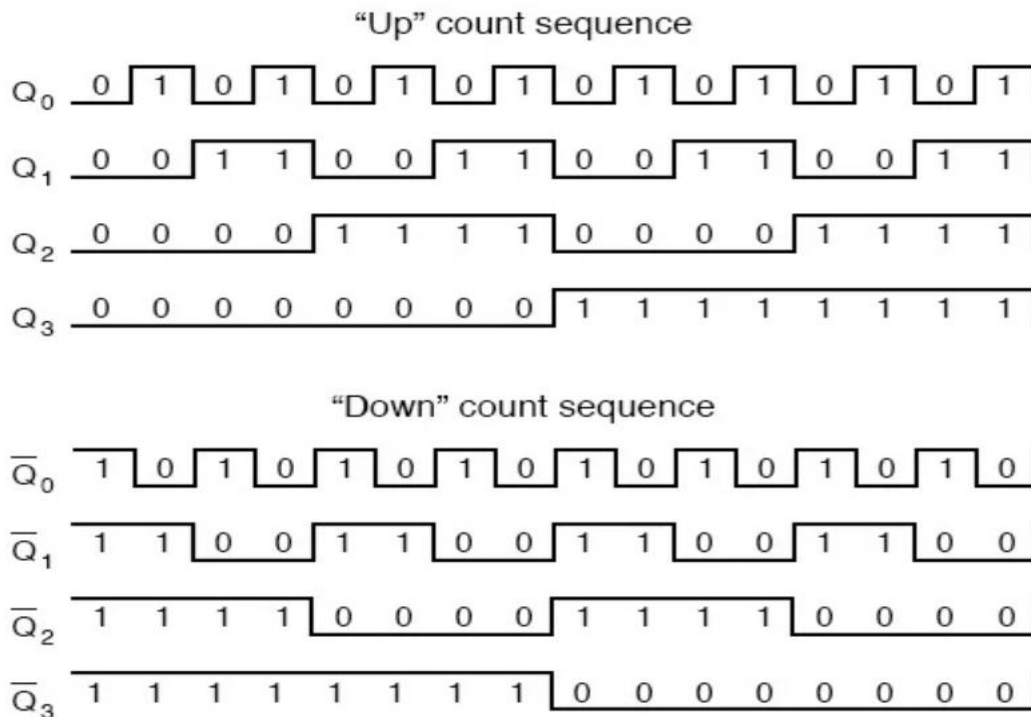
1. IC 74163 (4-bit synchronous counter)
2. Breadboard
3. Connecting wires
4. power supply
5. function generator/clock source
6. switches
7. LEDs
8. CRO/DSO.

THEORY:

IC 74163 is a 4-bit synchronous binary counter. All flip-flops are triggered simultaneously by a common clock, reducing propagation delay. It can be configured for up/down counting using control logic. The counter increments or decrements its state based on the control input. It also has features like synchronous clear, load, and enable inputs.

In an Up counter, the output sequence increases with each clock pulse (0000 → 0001 → 0010 → ... → 1111). In a Down counter, the sequence decreases (1111 → 1110 → 1101 → ... → 0000). The direction of counting is controlled by a mode control input (often denoted as M or UP/DOWN). When the control input is HIGH, the counter operates in one mode (e.g., Up), and when LOW, it operates in the other mode (Down).

Up/Down counters can be implemented using flip-flops or using integrated circuits such as IC 74163 or IC 74193. In synchronous counters like IC 74163, all flip-flops are triggered simultaneously by a common clock, which reduces propagation delay and ensures faster operation compared to asynchronous (ripple) counters.

CIRCUIT DIAGRAM:**WAVEFORMS:****PROCEDURE:**

1. Place IC 74163 on the breadboard.

2. Connect power supply (+5V and GND).
3. Apply clock pulses using function generator.
4. Enable counting by setting ENP and ENT high.
5. Use control input to select Up or Down counting.
6. Observe outputs on LEDs.
7. Verify counting sequence for both modes.
8. Use CRO/DSO to observe output waveforms.

RESULT:

The Up/Down counter using IC 74163 was successfully designed and verified. The counter performed correct counting in both upward and downward directions, and the waveforms were observed as expected.

VIVA QUESTIONS:

1. What is a counter?
2. What is an Up counter?
3. What is a Down counter?
4. What is an Up/Down counter?
5. Which IC is used in this experiment?
6. What is the function of IC 74163?
7. Is IC 74163 synchronous or asynchronous?
8. What is the advantage of synchronous counter?
9. What is propagation delay?
10. What is clock input?
11. What are ENP and ENT?
12. Why are enable inputs required?
13. What is synchronous clear?
14. What is load input?
15. What is parallel loading?
16. What are QA, QB, QC, QD?
17. Which output toggles fastest?
18. Which output toggles slowest?
19. What is binary counting sequence?
20. What is modulus of a counter?
21. What is MOD-16 counter?
22. Why is IC 74163 called MOD-16?
23. What is frequency division in counters?
24. What is ripple counter?
25. What is difference between ripple and synchronous counter?
26. What is control input for Up/Down operation?
27. How is Down counting achieved?
28. What happens when enable is low?
29. What is the power supply for TTL ICs?
30. What are logic levels in TTL?
31. What is the role of LEDs?
32. What is a breadboard?
33. What is a clock pulse?
34. What is duty cycle?
35. What is waveform?
36. Why CRO/DSO is used?
37. What is timing diagram?

38. What is the importance of this experiment?
- ~~39. What are applications of counters?~~
40. What is digital IC?
41. What is fan-in?
42. What is fan-out?
43. What is overflow condition?
44. What happens after 1111 in up counting?
45. What happens after 0000 in down counting?
46. What precautions should be taken?
47. Can IC 74163 be cascaded?
48. What is cascading of counters?
49. What is terminal count?
50. What is the difference between IC 74163 and 74193?

EXPERIMENT:15**DESIGN OF UNIVERSAL SHIFT REGISTER USING IC 74194 / 74195 AND VERIFICATION OF SHIFTING OPERATION****AIM:**

To design and implement a Universal Shift Register using IC 74194/74195 and verify its shifting operations (left shift, right shift, parallel load, and hold).

APPARATUS REQUIRED:

1. IC 74194 / IC 74195 (Universal shift register)
2. Breadboard
3. connecting wires
4. power supply
5. switches
6. LEDs
7. clock pulse generator.

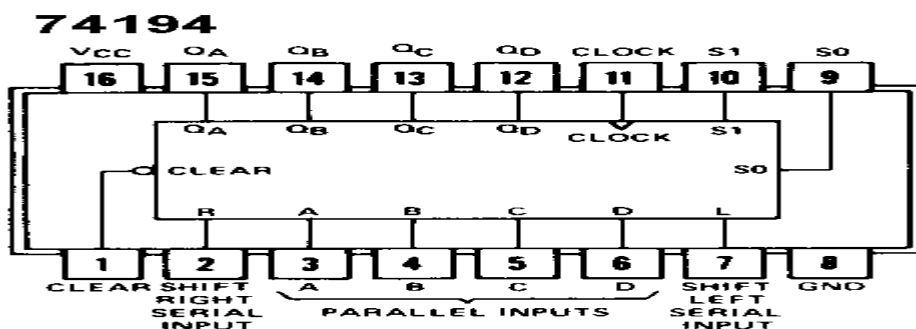
THEORY:

A Universal Shift Register is a sequential circuit capable of performing multiple operations such as shift left, shift right, parallel load, and hold. IC 74194 is a 4-bit bidirectional universal shift register with parallel input and output capability.

It has two mode control inputs (S1, S0) which determine the operation of the register:

- 00 → No change (Hold)
- 01 → Shift right
- 10 → Shift left
- 11 → Parallel load

The register shifts data with each clock pulse depending on the selected mode. It also includes serial inputs for both left and right shifting and parallel inputs for loading data simultaneously.

CIRCUIT DIAGRAM:

PROCEDURE:

1. Place IC 74194/74195 on the breadboard.
2. Connect +5V supply and ground.
3. Apply clock pulses to the clock input.
4. Set control inputs S1 and S0 using switches.
5. Apply parallel input data.
6. Observe outputs on LEDs.
7. Verify hold, shift left, shift right, and parallel load operations.

RESULT:

The Universal Shift Register using IC 74194/74195 was successfully designed and implemented. All operations such as shift left, shift right, parallel load, and hold were verified correctly.

VIVA QUESTIONS:

1. What is a shift register?
2. What is a universal shift register?
3. Which IC is used in this experiment?
4. What is the function of IC 74194?
5. What is the function of IC 74195?
6. What are the modes of operation?
7. What is shift left?
8. What is shift right?
9. What is parallel loading?
10. What is hold condition?
11. What are S1 and S0?
12. What happens when S1S0 = 00?
13. What happens when S1S0 = 01?
14. What happens when S1S0 = 10?
15. What happens when S1S0 = 11?
16. What is serial input?
17. What is parallel input?
18. What are QA, QB, QC, QD?
19. What is clock pulse?
20. What is synchronous operation?
21. What is propagation delay?
22. What is flip-flop?
23. What type of flip-flops are used?
24. What is data shifting?
25. What is the use of shift registers?
26. What is digital storage?
27. What is the difference between 74194 and 74195?
28. What is reset/clear?
29. What is the role of clock?
30. What happens if clock is not applied?
31. What is the advantage of universal shift register?
32. What is serial-in serial-out?
33. What is serial-in parallel-out?
34. What is parallel-in serial-out?

35. What is parallel-in parallel-out?
36. What is timing diagram?
37. What is waveform?
38. What is LED indication?
39. What is a register?
40. What is data transfer?
41. What is buffering?
42. What is the speed of operation?
43. What are applications of shift registers?
44. What is digital IC?
45. What is fan-in?
46. What is fan-out?
47. What precautions should be taken?
48. What is synchronous clear?
49. Can shift registers be cascaded?
50. What is the importance of this experiment?

EXPERIMENT-16

DESIGN OF 16×4 RAM USING 74189 IC AND STUDY OF READ/WRITE OPERATIONS

AIM:

To design a 16×4 RAM using 74189 IC and study its read and write operations.

APPARATUS REQUIRED:

1. 74189 RAM IC,
2. breadboard, power supply (+5V),
3. connecting wires,
4. switches,
5. LEDs,
6. resistors.

THEORY:

The 74189 is a high-speed static RAM with a memory capacity of 16 words × 4 bits. It has 4 address lines (A0–A3) to select one of 16 memory locations. Data is stored in 4-bit words. The IC provides separate control for read and write operations. It has active low chip select and write enable signals. The outputs are typically inverted, so external inverters may be required depending on the application.

Pin Description (Important Signals):

A0–A3: Address inputs

D0–D3: Data inputs

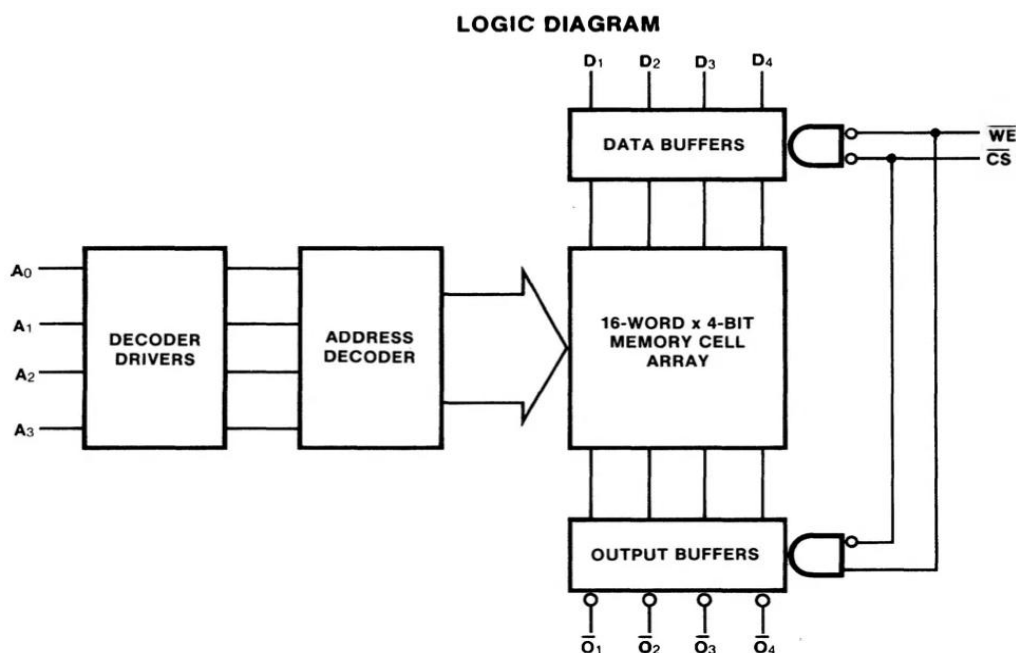
O0–O3: Data outputs

\overline{CS} : Chip select (active low)

\overline{WE} : Write enable (active low)

CIRCUIT DESCRIPTION:

- Connect A0–A3 to switches to select memory locations.
- Connect D0–D3 to input switches for entering data.
- Outputs O0–O3 are connected to LEDs (through resistors) to observe data.
- \overline{CS} is grounded to enable the chip.
- \overline{WE} is used to control read/write operation.



READ/WRITE OPERATION:**Write Operation:**

- Apply address on A0–A3.
- Apply data on D0–D3.
- Make $\overline{WE} = 0$ (active low).
- Data is written into the selected memory location.

Read Operation:

- Apply address on A0–A3.
- Make $\overline{WE} = 1$.
- Stored data appears at outputs O0–O3 (inverted form).

TRUTH TABLE:

\overline{CS}	\overline{WE}	Operation
0	0	Write
0	1	Read
1	X	Disabled

PROCEDURE:

1. Make the circuit connections as per the design.
2. Switch ON the power supply.
3. Select a memory location using address inputs.
4. Apply input data through switches.
5. Perform write operation by making $\overline{WE} = 0$.
6. Change $\overline{WE} = 1$ to read the stored data.
7. Observe output on LEDs.
8. Repeat for different addresses and data values.

Result:

The 16×4 RAM was successfully designed using 74189 IC and read/write operations were verified.

VIVA QUESTIONS:

1. What is RAM?
2. What is the full form of RAM?
3. What is the function of memory in digital systems?
4. What is the difference between RAM and ROM?
5. What type of memory is 74189?
6. What is the memory capacity of 74189 IC?
7. What does 16×4 RAM mean?
8. How many address lines are required for 16 memory locations?

9. How many data bits are stored in each location of 74189?

10. What are the address inputs of 74189?
11. What are the data inputs of 74189?
12. What are the data outputs of 74189?
13. What is the function of chip select (\overline{CS})?
14. Why is \overline{CS} active low?
15. What is the function of write enable (\overline{WE})?
16. What happens when $\overline{WE} = 0$?
17. What happens when $\overline{WE} = 1$?
18. What is the role of address lines?
19. How is a memory location selected?
20. What is the difference between read and write operations?
21. What is meant by volatile memory?
22. Is 74189 volatile or non-volatile?
23. Why is RAM called read/write memory?
24. What is the significance of active low signals?
25. What happens when $\overline{CS} = 1$?
26. Why are outputs of 74189 inverted?
27. How can inverted outputs be corrected?
28. What is propagation delay in RAM?
29. What is access time of memory?
30. What is the importance of access time?
31. What type of RAM is 74189 (static or dynamic)?
32. What is static RAM?
33. What is dynamic RAM?
34. Why is SRAM faster than DRAM?
35. What are the advantages of SRAM?
36. What are the disadvantages of SRAM?
37. How many memory locations are present in 74189?
38. What is meant by word length?
39. What is the function of LEDs in the experiment?
40. Why are resistors used with LEDs?
41. What is the purpose of a breadboard?
42. What is meant by memory decoding?
43. Can we expand memory capacity using multiple ICs?

44. How can you design a larger RAM using 74189 ICs?
45. What is the power supply required for 74189?
46. What will happen if power supply is removed?
47. What is data retention in RAM?
48. What are the applications of RAM?
49. What is meant by memory organization?
50. Why is RAM important in microprocessor systems?