AURORA'S ENGINEERING COLLEGE

BHONGIR, NALGONDA DIST. – 508116.

Lab manual of

IC APPLICATIONS LAB

3rd Year 1st Sem. ECE

2014-15

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING

PREFACE

Integrated circuits are the present state of art of IC Technology. It is one of the core area of ECE and constitutes the largest applications in use today. IC Technology has entered into every part of today's world.

This laboratory is intended to make students understand the use of different linear and digital IC. This laboratory consists of linear IC trainer kits, digital IC trainer kits etc.

In this laboratory the student will become familiar with various linear ICs such as μA741 and SE/NE 555. They will understand the applications of the μA741 operations amplifier like adder, subtractor and comparator etc. And also the various applications of SE/NE 555 like Monostable operations and Schmitt trigger. In addition to the above they will become familiar with various voltage regulators and sample and hold circuit.

Today, a single chip can contain tens of millions of transistors and can be programmed to create a system –on-a-chip –that, using technology of past, would have required hundreds of discrete chip containing millions of individual gates & flip-flop.

Second part deals with verifying the functionality of the various 74 series TTL ICs such as D Flip-flop (74LS74), Decade counter (74LS90), multiplexer ICs and RAM ICs.

LAB CODE

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 experiment 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 performed in the immediate last session should be submitted and certified by the staff member in-charge.

6. Not more than three students in a group are permitted to perform the experiment on a setup.

7. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.

8. The components required pertaining to the experiment should be collected from stores in-charge after duly filling in the requisition form.

9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

10. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.

11. Students should be present in the labs for the total scheduled duration.

12. Students are required to prepare thoroughly to perform the experiment before coming to Laboratory.

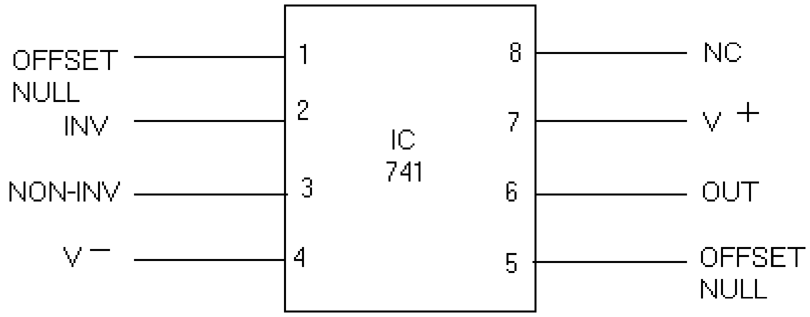
13. Procedure sheets/data sheets provided to the students' groups should be maintained neatly and to be returned after the experiment.

INDEX

PART-1: IC APPLICATIONS LAB

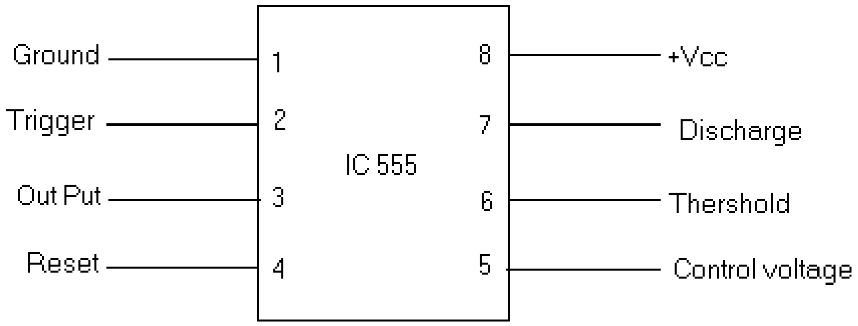
Pin configuration, Parameters and Specifications of IC 741, IC 555, IC 565

IC µA 741 OP-AMP



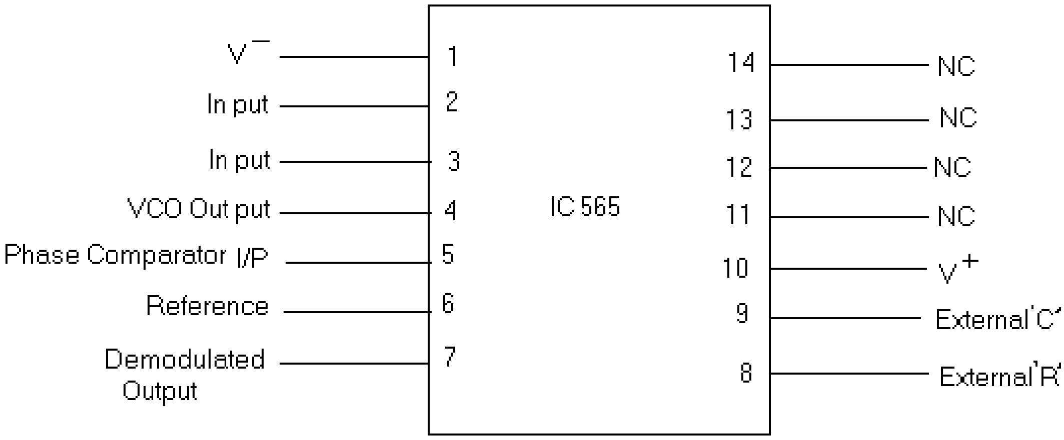
1. Supply voltage:
   µA 741A, µA 741, µA 741E ----------------- ±22V
   µA 741C ------------------- ±18 V
2. Internal power dissipation
   DIP package ---------------------- 310 Mw.
3. Differential input voltage ---------------- ±30 V.
4. Operating temperature range
   Military (µA 741A, µA 741) -- ---------- -55^0 to $+125^0$ C.
   Commercial (µA 741E, µA 741C) ---------- 0^0 C to $+70^0$ C.
5. Input offset voltage ------------ 1.0 mV.
6. Input Bias current ------------ 80 nA.
7. PSSR -------------- 30 µV/V.
8. Input resistance ------------- 2MΩ.
9. CMMR -------------- 90.
10. Output resistance ---------- 75Ω.
11. Bandwidth ----------- 1.0 MHz.
12. Slew rate ------------ 0.5 V/µ sec.

NE / SE 555 / SE 555C



1. Supply voltage ------------ 4.5 V to 18 V
2. Supply current ------------- 3mA
3. Output voltage (low) --------------- 0.1 V
4. Output voltage (high) -------- 12.5 V (15 V Vcc) & 3.3 V (5V Vcc)
5. Maximum operating frequency ------------ 500 KHz
6. Timing from μ sec to hours

Phase Locked Loop NE / SE 565



1. Maximum supply voltage : 26 V
2. Input Voltage : 3 V(P-P)
3. Power dissipation : 300Mw
4. Operating temperature : NE 565- 0^0 C to 70^0C (SE 565-55 to +125^0 C
5. Supply voltage : 12 V
6. Supply current : 8 mA
7. Output current- (sink) : 1 mA
   (Source) : 10 mA

Experiment No. 01

ADDER, SUBTRATOR, COMPARATOR USING IC 741 OP-AMP

APPLICATION OF OP-AMP AS ADDER

I. AIM: To design adder using op-amp.

II . EQUIPMENTS AND COMPONENTS:

i. APPARATUS:

S.No.	Name of the component/equipment	Quantity
1.	Op amp 741 IC	1
2.	Resistance R =1KΩ	4
3.	Resistance R_F=10KΩ	1
4.	Dual Regulated Power supply	2
5.	Bread Board	1
6.	Multimeter	1

ii. DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low-ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

2. Bread Board: Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

iii. COMPONENTS:

1. 10 kΩ Resistor – 1 No.
2. 1kΩ Resistor –4 No.
3. IC741 - 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 10kΩ Resistor.

Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 10kΩ resistor are
Rating: 10kΩ to 12kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 1kΩ Resistor.

Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 2kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

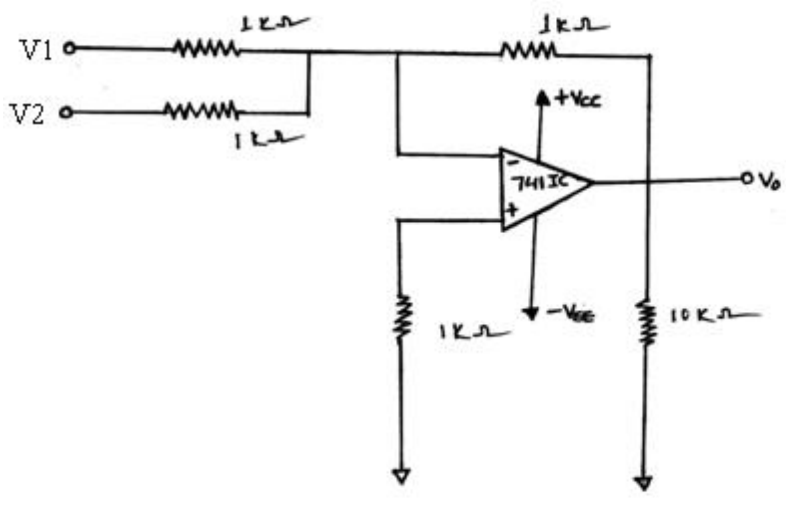
3. IC741

The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.
741C (Commercial grade op-amp)
Operating temperature range is 0 to 75 degrees centigrade.

IV. THEORY:

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 a adder. There are two types of summers. First one is Inverting and second one is Non-inverting summing amplifiers. In this experiment we used Non-inverting Summing Amplifier.

V. CIRCUIT DIAGRAM



ADDER

VI. PROCEDURE:

1. Connect the circuit as shown in figure.
2. Apply +Vcc =+15V and –Vcc = – 15V to Pin 7 and 4 of 741IC
3. Apply the i/p voltage V_1 and V_2.
4. Measure the o/p voltage using Multi meter.

5. Verify with theoretical value.
6. Repeat the above for different values of V_1 and V_2.

VII. RESULT:

In the above circuit Op-Amp works as summing amplifier.

VIII. INFERENCE:

i. The working of summing amplifier is observed..
ii. The out put is calculated theoritically and practically.

IX. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the variable resistor connection between pin no.2 and ground
iii. Check the continuity of the connecting wires.

APPLICATION OF OPAMP AS SUBTRACTOR

I. AIM: To design subtractor using 741opamp.

II. EQUIPMENTS AND COMPONENTS:

i. APPARATUS:

S.No.	Name of the component/equipment	Quantity
1.	Op amp 741 IC	1
2.	Resistance R_F=10KΩ	7
3.	Dual Regulated Power supply	2
4.	Bread Board	1
5.	Multimeter	1

ii. DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low-ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

2. Bread Board: Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

iii. COMPONENTS:

1. 10 kΩ Resistor – 7 No.
2. IC741 - 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 10kΩ Resistor.

Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 10kΩ resistor are
Rating: 10kΩ to 12kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. IC741

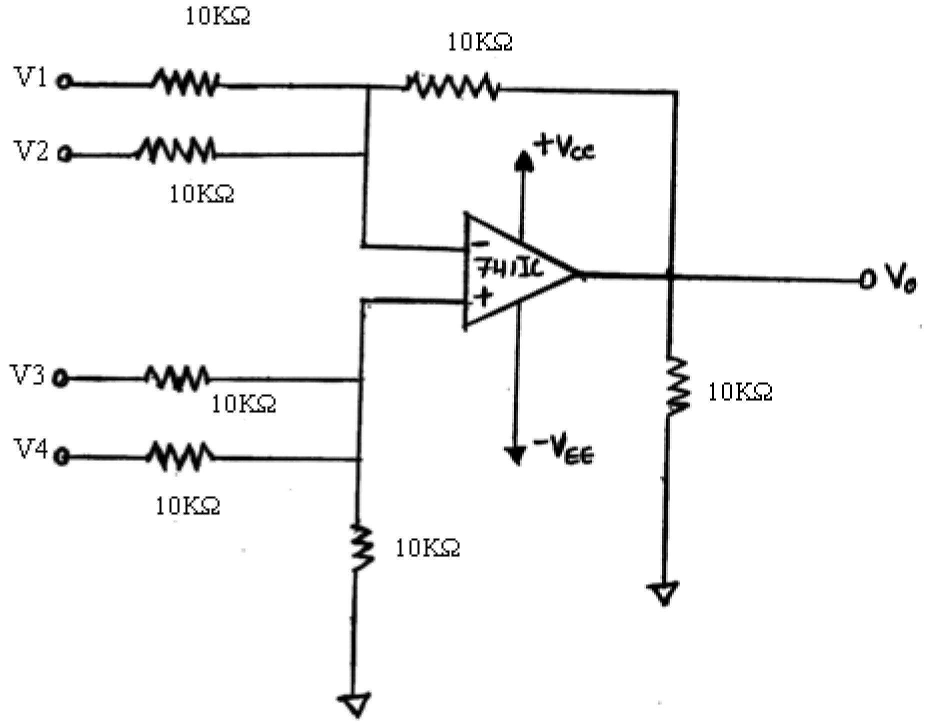
The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called

inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.
741C (Commercial grade op-amp)
Operating temperature range is 0 to 75 degrees centigrade.

IV. THEORY

A basic differential amplifier can be used as a subtractor. It can also be used to perform addition and subtraction with single Op-amp. From the circuit given below we will get output as Vo=(V3+V4)–(V1+V2)

V. CIRCUIT DIAGRAM



SUBTRACTOR

VI. PROCEDURE

1. Connect the circuit as shown in figure.
2. Apply +Vcc =+15V and –Vcc = – 15V to Pin 7 and 4 of 741IC
3. Apply the i/p voltage V_1 and V_2.
4. Measure the o/p voltage using Multi meter.
5. Verify with theoretical value.
6. Repeat the above for different values of V_1 and V_2.

VII. RESULT.

In the above circuit Op amp works as subtractor.

VIII. INFERENCE:

i. The working of subtractor is verified and the output is obtained.
ii. Checked the output with different values of inputs.

IX. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the variable resistor connection between pin no.2 and ground
iii. Check the continuity of the connecting wires.

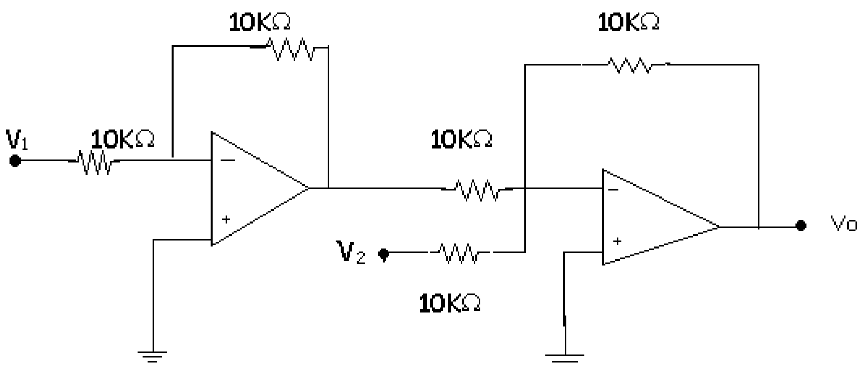
X. APPLICATIONS:

Instrumentation amplifier.

XI. REVIEW QUESTIONS :

1. Draw an Op- amp circuit whose output Vo is $V_1 + V_2 - V_3 - V_4$.

2. Calculate V_O for the above circuit for $V_1 = 5V$, $V_2 = 2V$.



3 Show that the o/p of Inverting adder is $V_0 = -\frac{R_f}{R_1}(v_a + v_b + v_c + -----$

4. Draw the circuit of non-inverting adder with 3 inputs and find the o/p Voltage V_0
5. What is a mixed adder and how do you construct using Op-Amp IC 741.
6. Design a mixed adder for $V_0=V_1+2V_2-V_3-5V_4$.
7. Design a subtractor for $V_0 = V_a - 5V_b - 2Vc$

8. Mention the other mathematical operations obtained using Op-Amps.

APPLICATION OF OPAMP AS COMPARATOR

I. AIM: To Study the operation of comparator

II. EQUIPMENTS AND COMPONENTS:

(i).APPARATUS

1. DC power supply - 1 No.
2. CRO - 1 No.
3. Bread Board - 1 No.
4. Function Generator - 1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

2. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

3. Bread Board : Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Function Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mV to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

iii. COMPONENTS:

1. 10 kΩ Resistor – 1 No.
2. 1kΩ Resistor – 1 No.
3. IC741 - 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 10kΩ Resistor.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 10kΩ resistor are
Rating: 10kΩ to 12kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

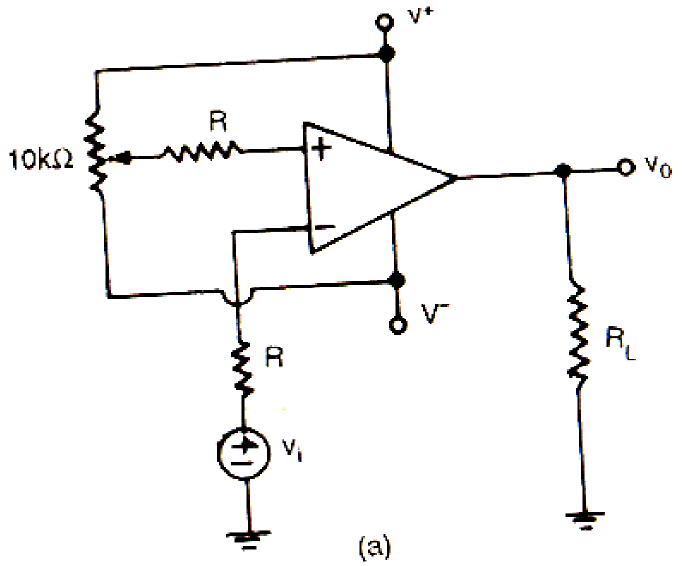
2. 1kΩ Resistor.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 2kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. IC741
The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.
741C (Commercial grade op-amp)
Operating temperature range 0 to 75 degrees centigrade

III. THEORY:

A comparator is a circuit which compares a signal voltage applied at one input of an OPAMP with a known inference voltage at the other input. It is basically an open loop OPAMP with output $\pm V_{sat}$. It may be seen that change in output state takes place with an increment in input V_i of only 2mV. There are basically two types of comparators, non-inverting comparator and inverting comparator.

IV. CIRCUIT DIAGRAM:



V. PROCEDURE:

1. Connect the circuit shown in Fig. And adjust the 10 kΩ potentiometer so that V_{ref} = +0.5V
2. Adjust the signal generator so that v_i = 2V pp sine wave at 1 kHz.
3. Using a CRO observe the input and output waveform simultaneously. Plot the output waveform.
4. Adjust the 10 kΩ potentiometer so that V_{ref} = -0.5V. Repeat step 3
5. To make a zero crossing detector, set V_{ref} = 0V and observe the output waveforms.

VI. OBSERVATIONS:

V_{out} = __________

V_{in} = __________

VII. CALCULATIONS:

V_{ref} = 0.5 V

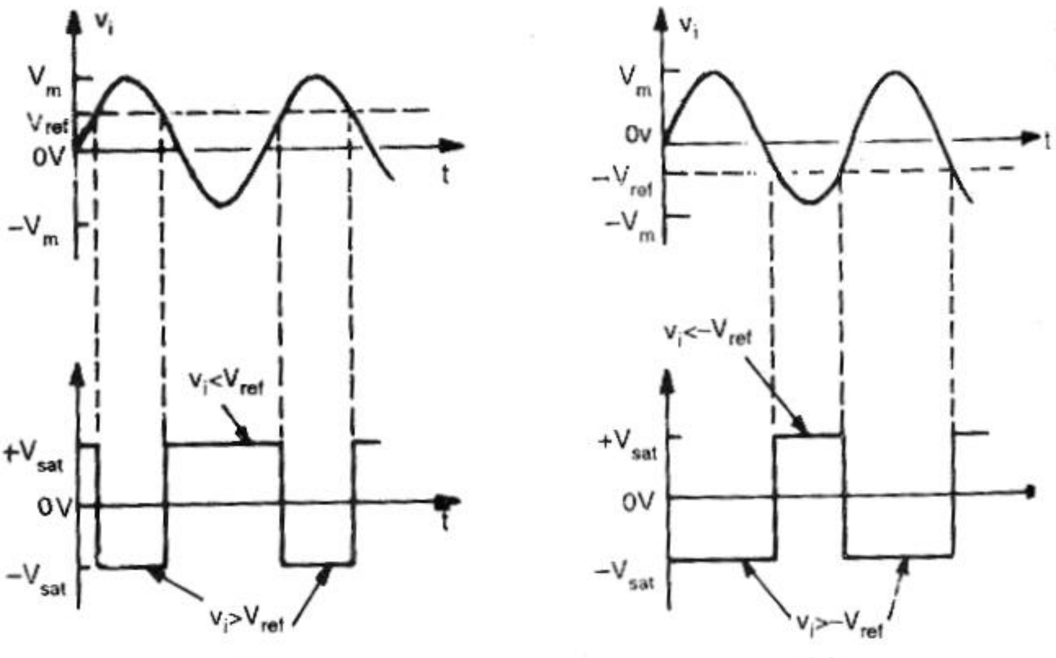
V_O = _________

V_{ref} = -0.5V

V_O = ________

Time period of output waveform = ____________

VIII. GRAPH:



(b) (c)

IX. RESULT:

V_{in} = ________

V_O = ________

V_{ref} = _________

X. INFERENCE:

i. The working of comparator is observed and the output is plotted.
ii. The time period of the output waveform is calculated
iii. Frequency of the output wave form is calculated

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the connection between pin 2 and 6
iii. Check the variable resistor connection between pin no.2 and ground
iv. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. Zero crossing detector
ii. Window detector
iii. Time marker generator
iv. Phase meter.

XIII. EXTENSION:

i. Design the circuit so that it can act as zero crossing detector
ii. Check the output waveform at Pin no. 6

XIV. REVIEW QUESTIONS

i. Discuss the characteristics of an ideal comparator.
ii. List the different types of comparators.
iii. What is the meaning of Voltage limiting?
iv. What is window detector?
v. What is zero crossing detector?
vi. What is Schmitt trigger circuit?
vii. What is time maker generator?
viii. What are the differences between ideal and practical comparator?
ix. What are the applications of comparator?
x. In which mode the operational amplifier is connected in the comparator circuit.

Experiment No. 02

INTEGRATOR AND DIFFERENTIAOR USING IC741 OP-AMP

I. AIM:

Design and verify the functionality of Differentiator and Integrator using IC 741 Op-Amp

II. EQUIPMENTS AND COMPONENTS:

(i) APPARATUS

1.	DC power supply	-	1 No.
2.	CRO	-	1 No.
3.	Bread Board	-	1 No.
4.	Function Generator	-	1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

2. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

3. Bread Board: Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Function Generator : This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mV to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

(iii) COMPONENTS:

i. 100 kΩ Resistor – 1 No.
ii. 10k Ω Resistor – 1 No.
iii. 0.01 μF Capacitor – 1 No
iv. 10 nF Capacitor – 1 No
v. IC741 - 1 No.

(iv) DESCRIPTION OF COMPONENTS:

1. 100 kΩ Resistor.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 100kΩ resistor are

Rating: 100kΩ to 110kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 10kΩ Resistor.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 10kΩ resistor are
Rating: 10kΩ to 12kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

4. 0.01 μF Capacitor – 1No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.

The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.01μF capacitor are
1) Capacity – 0.01 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

4. 10 nF Capacitor – 1No.

Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.

The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 10nF capacitor are
1) Capacity – 10nF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

5. IC741

The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.

741C (Commercial grade op-amp)
Operating temperature range 0 to 75 degrees centigrade

III. THEORY

Differentiator:

The operational amplifier can e used in many applications. It can be used as differentiator and integrator. In differentiator the circuit performs the mathematical operation of differentiation that is the output waveform is the derivative of the input wave form for good differentiation, one must ensure that the time period of the input signal is larger than or equal to R_fC_1. The Practical Differentiator eliminates the problem of instability and high frequency noise.

$$V_{out} = R_F C_1 \frac{dV_{in}}{dt}$$

Integrator:

The circuit provides an output voltage which is proportional to the time integral of the input and R_1C_F is the time constant of the integrator. It may be noted that there is a negative sign in the output voltage, and therefore, this integrator is also known as an inverting integrator. The gain Av is infinite for an ideal op-amp, so the effective time constant of the op-amp integrator becomes very large which results in perfect integration.

$$V_o = -\frac{1}{R_f C_1} \int V_{in}\, dt$$

IV. CIRCUIT DIAGRAM:

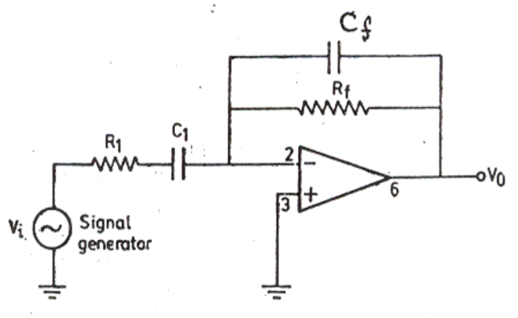


Fig 1 differentiator

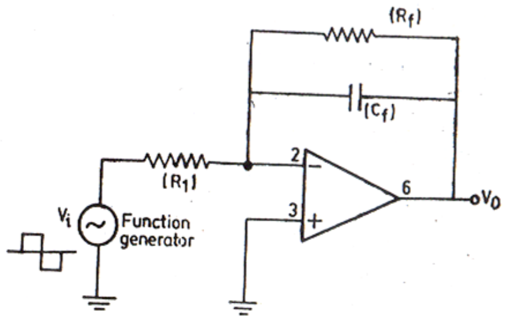


Fig. 2 integrator

V. PROCEDURE:

i. Connect the differentiator circuit as shown in fig 1.adjust the signal generator to produce a 5 volt peak sine wave at 100 Hz.

ii. Observe input Vi and Vo simultaneously on the oscilloscope measure and record the peak value of Vo and the phase angle of Vo with respect to Vi.

iii. Repeat step 2 while increasing the frequency of the input signal. Find the maximum frequency at which circuit offers differentiation. Compare it with the calculated value of f_a Observe & sketch the input and output for square wave.

iv. Connect the integrator circuit shown in Fig2. Set the function generator to produce a square wave of 1V peak-to-peak amplitude at 500 Hz. View simultaneously output V_o and V_i.

v. Slowly adjust the input frequency until the output is good triangular waveform. Measure the amplitude and frequency of the input and output waveforms.

vi. Verify the following relationship between R_1C_f and input frequency for good integration $f>f_a$ & $T< R_1C_1$, Where R_1C_f is the time constant

vii Now set the function generator to a sine wave of 1 V peak-to-peak and frequency 500 Hz. Adjust the frequency of the input until the output is a negative going cosine wave. Measure the frequency and amplitude of the input and output waveforms.

VI. OBSERVATIONS:

i. The time period and amplitude of the output waveform of differentiator circuit

ii. The time period and amplitude of the integrator waveform

VII. CALCULATIONS:

Design a differentiator to differentiate an input signal that varies in frequency from 10 Hz to 1 kHz.

$$f_a = \frac{1}{2\pi R_f C_1}$$

f_a = 1 kHz, the highest frequency of the input signal

Let $C_1 = 0.01\ \mu F$,

Then $R_f = 15.9\ k\Omega$

Therefore choose R_f = 15.0 kΩ

$$f_a = \frac{1}{2\pi R_1 C_1}$$

Choose: f_b= 20x f_a = 20 KHz
Hence R_1 = 795 Ω
Therefore choose R_1 = 820 Ω
Since $R_1C_1 = R_f C_f$ (compensated attenuator)
C_f = 0.54 nF
Therefore choose C_f = 0.5nF

Integrator: Design an integrator that integrates a signal whose frequencies are between 1 KHz and 10 KHz

$$f_b = \frac{1}{2\pi R_1 C_f}$$

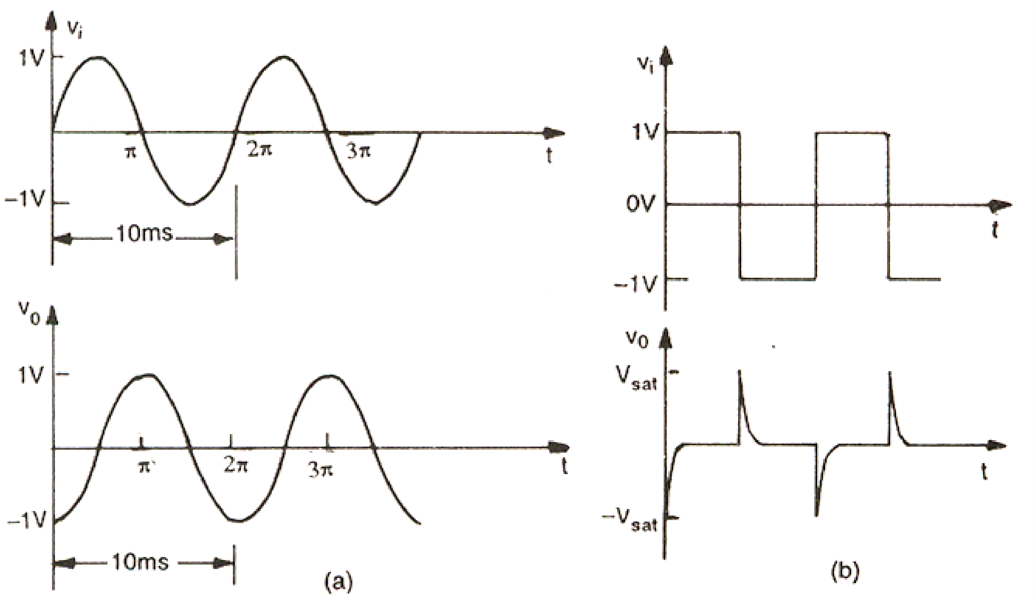
the frequency at which the gain is 0 dB.

$$f_a = \frac{1}{2\pi R_f C_f}$$

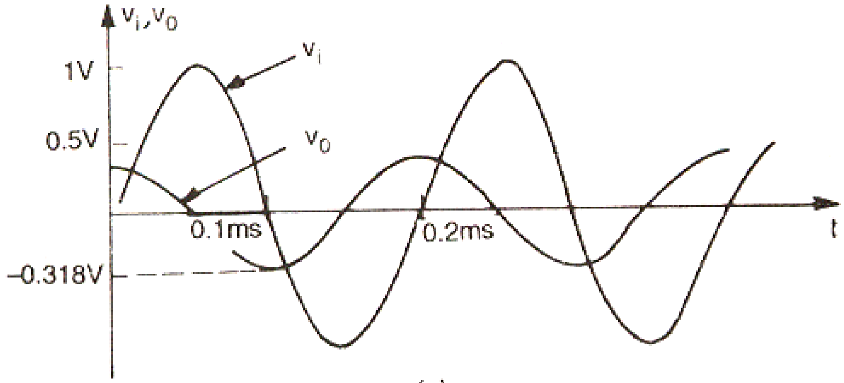
f_a: Gain limiting frequency,
The circuit acts as integrator for frequencies between f_a and f_b
Generally $f_a < f_b$ [Ref. Frequency response of the integrator]
Therefore choose f_a = 1KHz
F_b = 10 KHz
Let C_f = 0.01 μF
Therefore R_1= 1.59kΩ
Choose R_1= 1.5 KΩ
R_f = 15 KΩ

VIII. GRAPH:

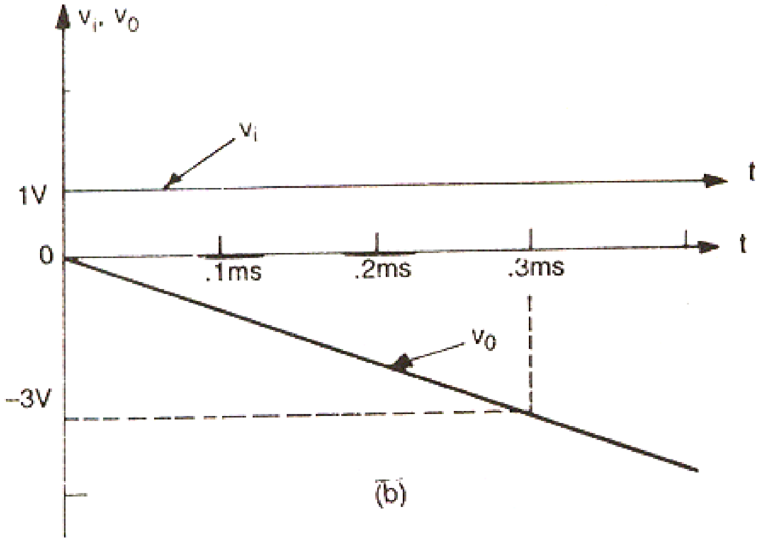
Differentiator



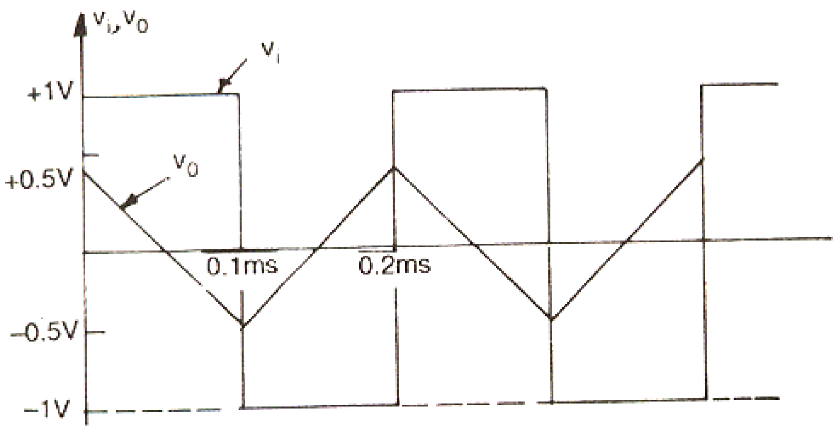
Integrator



(a)



(b)



(c)

IX: RESULT:

Differentiator

$$f_b = \frac{1}{2\pi R_1 C_f} = \_\_\_\_\_\_$$

T> R_f C_1 = _______

Integrator

$$f_a = \frac{1}{2\pi R_f C_f} = \_\_\_\_\_\_\_$$

T = _________

X. INFERENCE:

i. The working of differentiator and integrator is observed and the output is plotted.
ii. The time period of the output waveform is calculated
iii. The maximum frequency of differentiation and integration is observed

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the capacitor connection between pin 2 and pin 6
iii. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. In Electronic Analog computation
ii. In generation of step, ramp, square waveforms
iii. In ADC's

XIII. EXTENSION:

i. Design the circuit so that it can provide square wave form, ramp wave form
ii Design the circuit for the simulation of second order differential equation

XIV. REVIEW QUESTIONS

i. Define differentiator
ii. Define integrator
iii. What are the limitations of an ordinary differentiator?
iv. Explain how the practical differentiator will overcome the limitations
v. What are the limitations of an ideal integrator?
vi. What are the initial conditions of a loss integrator?
vii. What are the differences between integrator and differentiator?
viii. State the applications of integrator
ix. State the applications of differentiator
x. Explain why integrators are preferred over differentiators in analog computer.

Experiment No. 03

ACTIVE LOW PASS & HIGH PASS BUTTERWORTH (SECOND ORDER)

(i) LOWPASS FILTER

I. AIM:

To Design a Low pass, second order Butterworth Filter with a cut-off frequency of fH=1.0 kHz and pass band gain of 1.5.

II. EQUIPMENTS AND COMPONENTS:

i. APPARATUS

1.	CRO (Dual slope)	-	1 No
2.	Signal Generator	-	1 No
3.	Bread Board	-	1 No.
4.	Dual channel power supply	-	1 No

ii. DESCRIPTION OF EQUIPMENT:

1.CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

2.Signal Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mV to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

3. Bread board Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique.
The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

iii. COMPONENTS:

1. 1.6kΩ Resistor – 2 No.
2. 10kΩ Resistor – 1 No.
3. 5.86k Ω Resistor – 1 No
4. 0.1 μF Capacitor – 2 No.
5. Operational Amplifier -1 No

iv. DESCRIPTION OF COMPONENTS:

1. 1.6kΩ Resistor – 2 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 10kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 10kΩ Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 10kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 5.86k Ω Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 10kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

4. 0.1 μF Capacitor – 2 No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.1 μF capacitor are

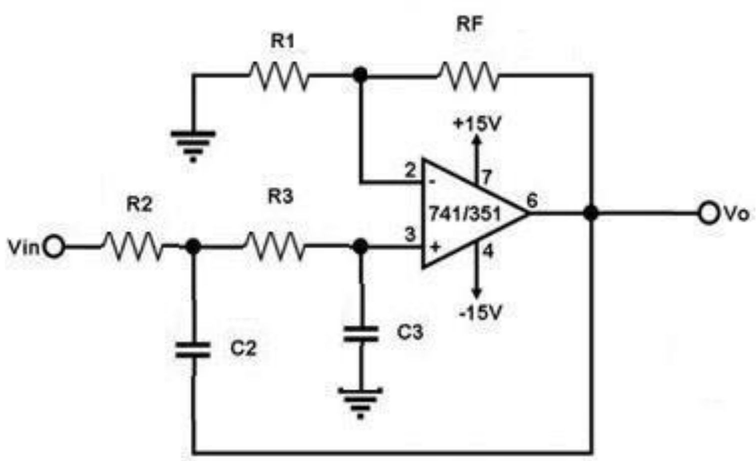
1) Capacity – 0.1 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

5. Operational Amplifier
The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.
741C (Commercial grade op-amp)
Operating temperature range 0 to 75 degrees centigrade

III. THEORY:

A frequency selective electric circuit that passes electric signals of specified band of frequencies and attenuates the signals of frequencies outside the brand is called an electric filter. The first order low pass filter consists of a single RC network connected to the non-inverting input terminal of the operational amplifier. Resisters R1 and R_F determine the gain of the filter in the pass band. The low pass filter as maximum gain at f = 0Hz. The frequency range from 0 to F_H is called the pass band the frequency range f > fh is called the stop band.

IV. CIRCUIT DIAGRAM:



R1=10kΩ
R2, R3=1.6kΩ
RF=5.86kΩ
C2, C3=0.1 μF

V. PROCEDURE:

i. Construct the circuit as shown in circuit diagram.
ii. Apply an input sine wave and measure the amplitude of output waveform for different values of input frequencies.
iii. Calculate the gain in dB.
iv. Plot the frequency response.

VI. OBSERVATIONS:

Sl.No	Input frequency	Output voltage	Gain	20 log Vo/Vi
1.	100			
2	200			
3	500			
4.	1kHz			
5.	1.5KHz			
6.	2.0kHz			
7.	5kHz			

VII. CALCULATIONS:

i. Choose a standard value of Capacitor C say 0.1 μF.

Then $R = \frac{1}{2\pi fC} = \frac{1}{2\pi x 1x10^3 x 0.1x10^{-6}}$

$= 1.6k\Omega$

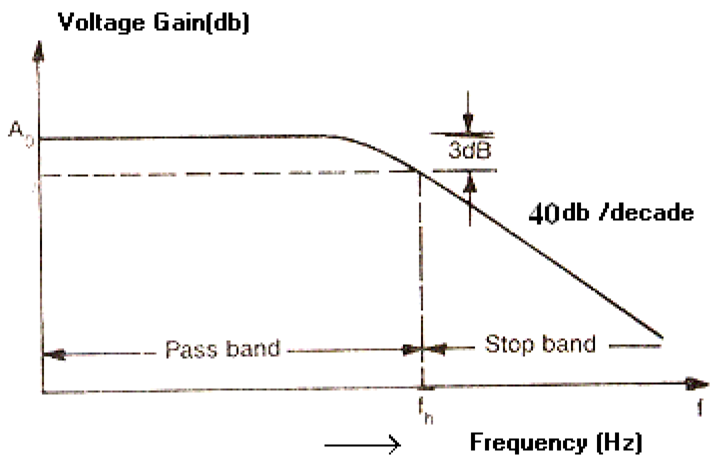
ii. $A_o = 1 + \frac{RF}{R_1} = 1.58$

$R_f = 0.58R_1$

Choose a value of 10kΩ for R_1

Then $R_f = 5.8\ k\Omega$

VIII. GRAPH:



IX. RESULT:

i. The cut-off frequency of the low pass filter = kHz
ii. The pass band gain of low pass filter =

X. INFERENCE:

i. The working of active low pass filter is observed and the output is plotted.
ii. The frequency response of the low pass filter is plotted on a semi-log graph paper.
iii. It is observed that the gain rolls of at the rate of 40dB per decade at the cut of frequency.

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Pin No.1 and Pin No.8 should be left free.
iii. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. To remove high frequency noise.
ii. To generate sweep.
iii. To generate saw-tooth waveform.

XIII. EXTENSION:

i. Design the circuit for higher order and observe that the flat pass band and flat stop band characteristics are observed.
ii. For higher order the gain becomes nearly constant and should be observed.
iii. Check the condition when a low pass filter will act as a integrator.

XIV. REVIEW QUESTIONS

i. Define an electric filter.
ii. Classify filters
iii. Discuss the disadvantages of passive filters
iv. Why are active filters preferred?
v. List the commonly used filters.
vi. Define pass band and stop band of a filter.
vii. What is roll-off rate of a second order filter?
viii. Why do we use higher order filters?
ix. On what does the damping coefficient of a filter depend?
x. What is Sallen key filter?

(ii) HIGH PASS FILTER

I. AIM:

To Design a Low pass, second order Butterworth Filter with a cut-off frequency of fL=1.0 kHz and pass band gain of 1.5.

II. EQUIPMENTS AND COMPONENTS:

i. APPARATUS

1. CRO (Dual channel) - 1 No
2. Signal Generator - 1 No
3. Bread Board - 1 No.
4. Dual channel power supply –1 No

ii. DESCRIPTION OF EQUIPMENT:

1. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

2.Signal Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mv to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

3. Bread board Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v, 1 amp, 50Hz, single phase AC.

iii. COMPONENTS:

1. 1.6kΩ Resistor – 2 No.
2. 10kΩ Resistor – 1 No.
3. 5.86k Ω Resistor – 1 No
4. 0.1 μF Capacitor – 2 No.
5. Operational Amplifier- 1No

iv. DESCRIPTION OF COMPONENTS:

1. 1.6kΩ Resistor – 2No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 10kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 10kΩ Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 10kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 5.86k Ω Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 10kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

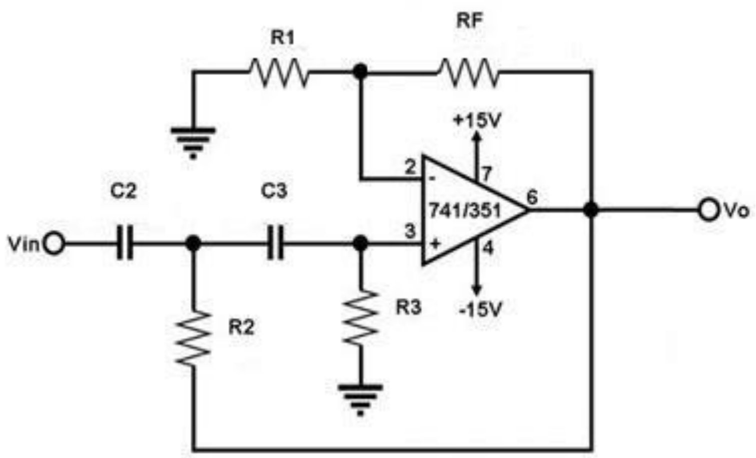
4. 0.1 μF Capacitor –2 No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.1 μF capacitor are
1) Capacity – 0.1 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

5. Operational Amplifier
The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.
741C (Commercial grade op-amp)
Operating temperature range 0 to 75 degrees centigrade

III. THEORY:

A frequency selective electric circuit that passes electric signals of specified band of frequencies and attenuates the signals of frequencies outside the brand is called an electric filter. The first order high pass filter consists of a single RC network connected to the non-inverting input terminal of the operational amplifier. Resisters R1 and R_F determine the gain of the filter in the pass band. The high pass filter has maximum gain at f = f_l Hz. The frequency range from 0 to F_l is called the stop band the frequency range f > fl is called the pass band.

IV. CIRCUIT DIAGRAM:



R1=10kΩ
R2, R3=1.6kΩ
RF=5.86kΩ
C2, C3=0.1 μF

V. PROCEDURE:

i. Construct the circuit as shown in circuit diagram.
ii. Apply an input sine wave and measure the amplitude of output waveform for different values of input frequencies.
iii. Calculate the gain in dB.
iv. Plot the frequency response.

VI. OBSERVATIONS:

Sl.No	Input frequency	Output voltage	Gain	20 log Vo/Vi
1.	100			
2	200			
3	500			
4.	1kHz			
5.	1.5KHz			
6.	2.0kHz			
7.	5kHz			

VII. CALCULATIONS:

i. Choose a standard value of Capacitor C say 0.1 μF.

Then $R = \frac{1}{2\pi fC} = \frac{1}{2\pi x 1x10^3 x0.1x10^{-6}}$

$= 1.6k\Omega$

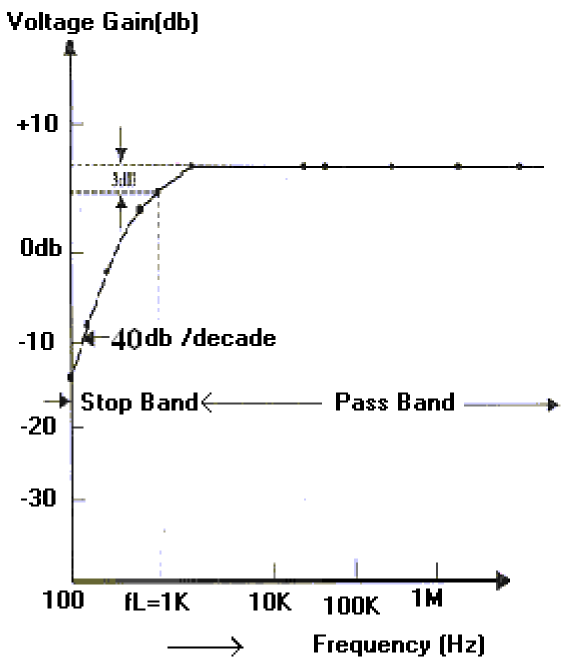
ii. $A_o = 1 + \frac{RF}{R_1} = 1.58$

$R_f = 0.58R_1$

Choose a value of 10kΩ for R_1

Then $R_f = 5.8k\Omega$

VIII. GRAPH:



IX. RESULT:

The lower cutoff frequency of the high-pass filter = ------- KHz.
The pass band gain = -------

X. INFERENCE:

i. The working of active high pass filter is observed and the output is plotted.
ii. The frequency response of the high pass filter is plotted on a semi-log graph paper.
iii. It is observed that the gain increases at the rate of 40dB per decade at the cut of frequency.

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Pin No.1 and Pin No.8 should be left free.
iii. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. To remove low ripple.
ii. To generate sweep.
iii. To generate spike waveform.

XIII. EXTENSION:

i. Design the circuit for higher order and observe that the flat pass band and flat stop band characteristics are observed.
ii. For higher order the gain becomes nearly constant and should be observed.
iii. Check the condition when a high pass filter will act as a differentiator.

XIV. REVIEW QUESTIONS

i. Define Bessel, Butterworth and Chebyshev filters, and compare their response.
ii. What are the important parameters of a band pass filter?
iii. Define Notch filter.
iv. How do we get a notch filter from a band pass filter?
v. Define state variable filter.
vi. What is switched capacitor?
vii. Discuss the importance of switched capacitors.
viii. Give the circuit of a switched capacitor low pass filter
ix. Discuss the advantages of active filters
x. What is the roll-off rate of second order filter?

Experiment No. 04

RC PHASE SHIFT AND WIEN BRIDGE OSCILLATORS USING IC741 OP-AMP.

(i) RC PHASE SHIFT OSCILLATOR

I. AIM:

To Design a RC Phase Shift Oscillator for the output frequency is 200 Hz.

II. EQUIPMENTS AND COMPONENTS:

(i). APPARATUS

1. CRO (Dual channel) - 1 No
2. Bread Board – 1 No
3. Dual Channel Power Supply – 1 No

1. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

2. Bread Board : Wire Connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v, 1 amp, 50Hz, single phase AC.

iii. COMPONENTS:

1. 3.3kΩ Resistor – 1 No.
2. 33kΩ Resistor – 1 No.
3. 1MΩ Resistor – 1 No.
4. 0.1 μF Capacitor – 1 No.
5. Operational Amplifier – 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 3.3kΩ Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 3.3kΩ resistor are
Rating: 3.3kΩ to 10kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 33kΩ Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 33kΩ resistor are
Rating: 33kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 1M Ω Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1MΩ resistor are
Rating: 1MΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

4. 0.1 μF Capacitor –1 No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.1 μF capacitor are
1) Capacity – 0.1 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

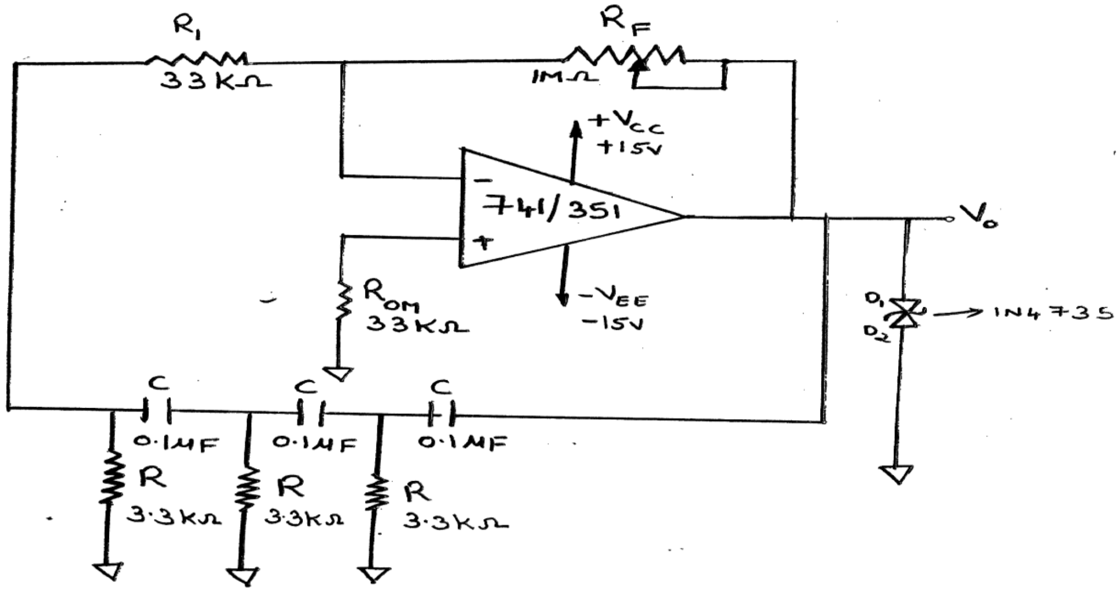
5. Operational Amplifier
The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.

741C (Commercial grade op-amp)
Operating temperature range 0 to 75 degrees centigrade

III. THEORY:

The Phase Shift Oscillator consist of an operational amplifier as the amplifying stage and three RC cascaded networks as the feed back circuits the amplifier will provide 180 degrees phase shift. The feed back network will provide another phase shift of 180 degrees.

IV. CIRCUIT DIAGRAM:



V. PROCEDURE:

i. Construct the circuit as shown in the circuit diagram.
ii. Adjust the potentiometer R_f such that an output wave form is obtained.
iii. Calculate the output wave form frequency and peak to peak voltage.
iv. Compare the theoretical and practical values of the output waveform frequency.

VI. OBSERVATIONS:

The frequency of oscillation = ______

VII. CALCULATIONS:

i. The frequency of oscillation f_o is given by

$$f_o = \frac{1}{2\pi\sqrt{6}RC} = \frac{0.065}{RC}$$

ii. The gain A_V at the above frequency must be at least 29

i.e. $\frac{R_F}{R_1} = 29$

iii. f_o = 200Hz

Let C = 0.1μF Then

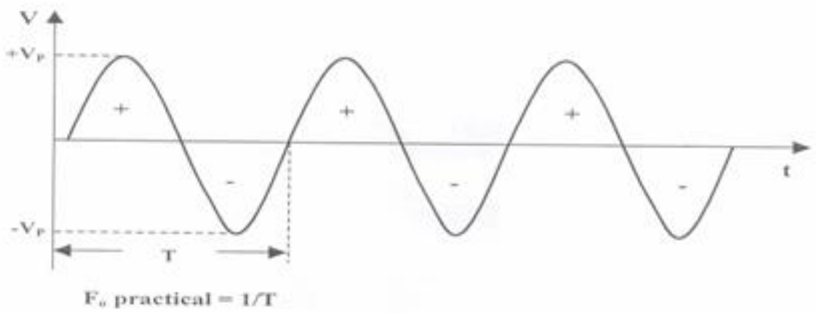
R= $\frac{0.065}{200X10^{-7}} = 3.25k\Omega$ (choose 3.3kΩ)

To prevent the loading of the amplifier because of RC networks it is necessary that

$R_1 \geq 10R$ Therefore R_1=10R=33 kΩ

Then R_F = 29 (33 kΩ) = 957 kΩ (choose R_F=1MΩ)

VIII. GRAPH:



IX. RESULT:

The frequency of oscillation of the RC phase shift oscillator = --------Hz

X. INFERENCE:

i. The working of RC phase shift oscillator is observed and the output is plotted.
ii. The frequency response of the RC phase shift oscillator is plotted
iii. It is observed that the gain doesn't sustain beyond 5 KHz

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Pin No.1 and Pin No.8 should be left free.
iii. Check the continuity of the connecting wires.

XII. APPLICATIONS:

These are used in sine wave oscillators for audio frequencies

XIII. EXTENSION:

i. Design the circuit for different frequencies of oscillations.
ii. For higher frequencies the gain does not sustain and should be observed.

XIV REVIEW QUESTIONS

i. State the two conditions of oscillations
ii. Classify the oscillators
iii. What is the phase shift in case of the rc phase shift oscillator?
iv. Explain how to measure the phase difference of two signals
v. In phase shift oscillator what phase shift does the opamp provide?
vi. In what mode the opamp is used in the phase shift oscillator?
vii. What phase shift is provided by the feedback network?
viii. What is the minimum gain that the inverting opamp should have?
ix. For high frequencies which kind of opamp should be used?
x. what is the condition for so that the oscillations will not die out?

(ii) WEIN BRIDGE OSCILLATOR

I. **AIM:** To Design Wein Bridge Oscillator so that the output frequency is 965 Hz.

II. EQUIPMENTS AND COMPONENTS:

(i) APPARATUS

1. CRO (Dual channel) - 1 No
2. Bread Board – 1 No
3. Dual Channel Power Supply – 1 No

1.CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

2. Bread Board: Wire Connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, and transistors etc., for testing the circuit.

3. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v, 1 amp, 50Hz, single phase AC.

iii. COMPONENTS:

1. 12kΩ Resistor – 1 No.
2. 50kΩ Resistor – 1 No.
3. 3.3kΩ Resistor – 1 No.
4. 0.05µF Capacitor – 1 No.
5. Operational Amplifier – 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 12kΩ Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 12kΩ resistor are
Rating: 12kΩ to 20kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 50kΩ Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 50kΩ resistor are
Rating: 50kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 3.3 kΩ Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 3.3.kΩ resistor are
Rating: 3.3kΩ to 6kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

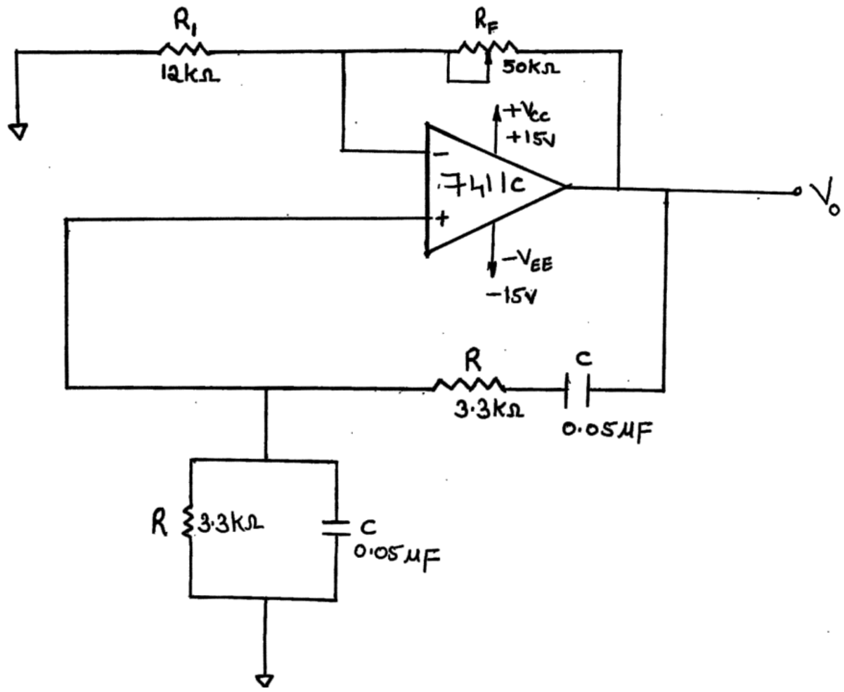
4. 0.05 µF Capacitor –1 No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.5 µF capacitor are
1) Capacity – 0.5 µF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

5. Operational Amplifier
The operational amplifier has five basic terminals that is two input terminals one output terminal and two power supply terminals. The terminal with a (-) sign is called inverting input terminal and the terminal with (+) sign is called non-inverting input terminal.
741C (Commercial grade op-amp)
Operating temperature range 0 to 75 degrees centigrade

III. THEORY:

In this oscillator the Wein Bridge Circuit is connected between the amplifier input terminals and the output terminal. The bridge has a series RC network in one arm and parallel RC network in the adjoining arm. In the remaining two arms of the bridge resistors R1 and RF are connected. The total phase-shift around the circuit is 0^{o} when the bridge is balanced.

IV. CIRCUIT DIAGRAM:



V. PROCEDURE:

i. Construct the circuit as shown in the circuit diagram.
ii. Adjust the potentiometer R_f such that an output wave form is obtained.
iii. Calculate the output wave form frequency and peak to peak voltage.
iv. Compare the theoretical and practical values of the output waveform frequency.

VI. OBSERVATIONS:

The frequency of oscillation = ______

VII. CALCULATIONS:

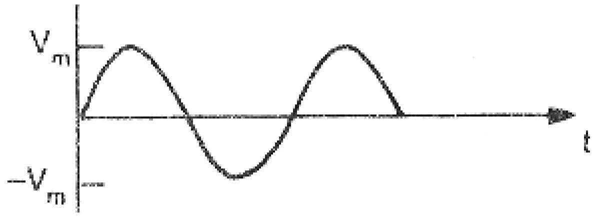
The frequency of oscillation f_o is exactly the resonant frequency of the balanced Wein Bridge and is given by $f_o = 1/(2\pi RC)$

$= 0.159 / RC$

The gain required for sustained oscillations is given by $A_v = 3$. i.e., $R_f = 2R_1$

Let $C = 0.05\ \mu F$
Then $f_o = 1/(2\pi RC)$
→ $R = 1/(2\pi f_o C)$
→ $= 3.3\ k\Omega$
Now let $R_1 = 12\ k\Omega$
Then $R_f = 2R_1 = 24\ k\Omega$
Use $R_f = 50\ k\Omega$ potential meter.

VIII. GRAPH:



IX. RESULT:

The frequency of oscillation of the Wein Bridge oscillator =----------

X. INFERENCE:

i. The working of Wein Bridge oscillator is observed and the output is plotted.
ii. The frequency response of the Wein Bridge oscillator is plotted
iii. It is observed that the gain doesn't sustain beyond 5 KHz

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Pin No.1 and Pin No.8 should be left free.
iii. Check the continuity of the connecting wires.

XII. APPLICATIONS:

These are used in sine wave oscillators for audio frequencies
Generally they are used in the application of function generators.

XIII. EXTENSION:

i. Design the circuit for different frequencies of oscillations.
ii. For higher frequencies the gain does not sustain and should be observed.

XIV. REVIEW QUESTIONS

i. State the two conditions of oscillations
ii. Classify the oscillators
iii. What is the phase shift in case of the phase shift oscillator?
iv. Explain how to measure the phase difference of two signals
v. In WEIN BRIDGE oscillator what phase shift does the opamp provide?
vi. In what mode the opamp is used in the wein bridge oscillator?
vii. What phase shift is provided by the feedback network?
viii. What is the minimum gain that the inverting opamp should have?
ix. For high frequencies which kind of opamp should be used?
x. What is the condition for so that the oscillations will not die out?

Experiment No. 05

IC 555 TIMER IN MONOSTABLE OPERATION

I. AIM: To design and test Monostable multi-vibrator using IC555 Timer.

II. EQUIPMENTS AND COMPONENTS:

(i). APPARATUS

1. DC power supply - 1 No.
2. CRO - 1 No.
3. Bread Board - 1 No.
4. Function Generator - 1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

2. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

3. Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Function Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mv to

20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

iii. COMPONENTS:

1. 11.8 kΩ Resistor – 1 No.
2. 1kΩ Resistor – 1 No.
3. 0.1 μF Capacitor – 1 No
4. 0.01 μF Capacitor – 1 No
5. IC555 - 1 No.
6. 1N4148 Diode – 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 11.8kΩ Resistor – No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 11.8kΩ resistor are
Rating: 11.8kΩ to 13kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 1kΩ Resistor – No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 2kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 0.1 μF Capacitor – No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances

The Specifications of 0.1μF capacitor are
1) Capacity – 0.1 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

4. 0.01 μF Capacitor – No.
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are

1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.01μF capacitor are
1) Capacity – 0.01 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

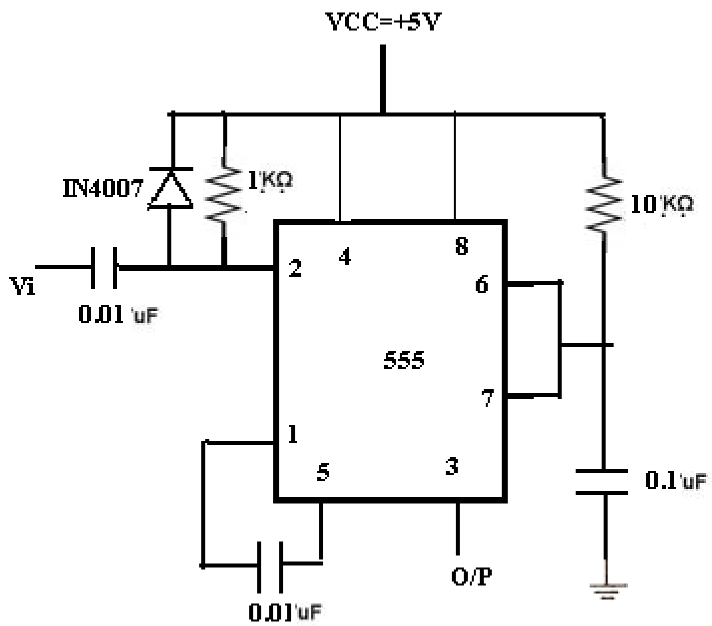
5. IC555
The 555 timer is a highly stable device for generating accurate time delay or oscillations. Signet Corporation first introduced this device as the SE555 / NE555 and it is available in two package styles, 8-pin circular style, TO-99 can or 8-pin mini DIP package or as a 14-pin DIP.

6.Diode1N4148:
This is a silicon Pnjunction diode . this is a point contact diode. The maximum reverse voltage possible is 30v. the maximum current possible is 20 mA.

III. THEORY:

The 555 timer can be used with supply voltage in the range of +5 v to +18 v and can drive upto 200 mAmps. It is compatible with both TTL and CMOS logic circuits because of the wide range of supply voltage the 555 timer is versatile and easy to use in monostable multivibrator we will provide external triggering in order to make the timer to switch over to high state (unstable). This is also called as one-short multivibrator.

IV. CIRCUIT DIAGRAM:



V. PROCEDURE:

i. Connect the circuit using the component values as per the design
ii. Set the square wave 2.5V peak and 1KHz trigger input on function generator
iii. Apply the trigger input at pin-2 through capacitor C1. Observe both trigger input and the output of the multivibrator on CRO simultaneously and sketch the waveforms
iv. Repeat the step 3 for trigger input of 2KHz frequency

VI. OBSERVATIONS:

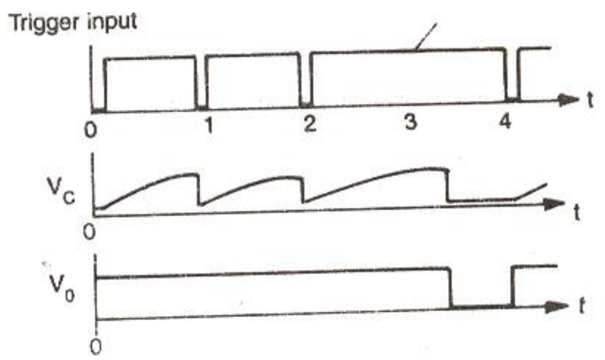
T_P = 1.1 R.C. = 1.3 m/sec
T = 1/ f = 1m/sec

VII. CALCULATIONS:

i. To produce a pulse of 1.3 m/sec duration:
T_P = 1.3mSec
T_P = 1.1 R.C.
Let C = 0.1μ F
R = 11.8KΩ

ii. To provide negative edge triggering a circuit of fig.2 is to be connected between pin 2 and 8.
Design of Differentiator:
Let the trigger input frequency is 1KHz
i.e., T = 1/f = 1mSec
Assume $\tau_1 = R_1 C_1$ = 0.01mSec
Let C = 0.01 μF
Therefore R_1 = 1.0 KΩ

VIII. GRAPH:



IX. RESULT:

T_p = 1.1R.C. =

X. INFERENCE:

i. The working of 555 timer monostable multivibrator is observed and the output is plotted.
ii. The time period of the output waveform is calculated
iii. Frequency of the output wave form is calculated

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the diode connection between pin 2 and 8
iii. Check the connections between pin no.1 and pin no.5
iv. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. To construct missing pulse detector circuit
ii. To construct linear ramp generator circuit
iii. To construct Frequency divider circuit

XIII. EXTENSION:

i. Design the circuit so that it can provide pulse width modulation
ii. Check the output waveform at Pin no. 3

XIV. REVIEW QUESTIONS

i. Explain the functional block diagram of a 555 timer
ii. Explain the function of reset
iii. What are the modes of operation of timer?
iv. What is the expression of time delay of a monostable multivibrator?
v. Discuss some applications of timer in monostable mode.
vi. Define duty cycle
vii. Give methods of obtaining symmetrical waveform.
viii. How is an monostable multivibrator connected into a pulse position modulator
ix. How Schmitt trigger circuit is constructed using 555 timer
x. Draw the pin diagram of 555 timer.

Experiment No. 06

SCHMITT TRIGGER CIRCUITS USING IC 741 & IC 555

(i) SCHMITT TRIGGER CIRCUITS – USING IC 741

I. AIM

To design and verify a Schmitt trigger for V_{UT} = 0.5V and V_{LT}= -0.5V.

II. EQUIPMENTS AND COMPONENTS:

(i). APPARATUS

1.	DC power supply	-	1 No.
2.	CRO	-	1 No.
3.	Bread Board	-	1 No.
4.	Function Generator	-	1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v, 1 amp, 50Hz, single phase AC.

2. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

3. Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Function Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mv to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

iii. COMPONENTS:

1. 27kΩ Resistor – 1 No.
2. 1000 Ω Resistor – 1 No
3. IC 741 - 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 27kΩ Resistor.

Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 27kΩ resistor are
Rating: 27kΩ to 37kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

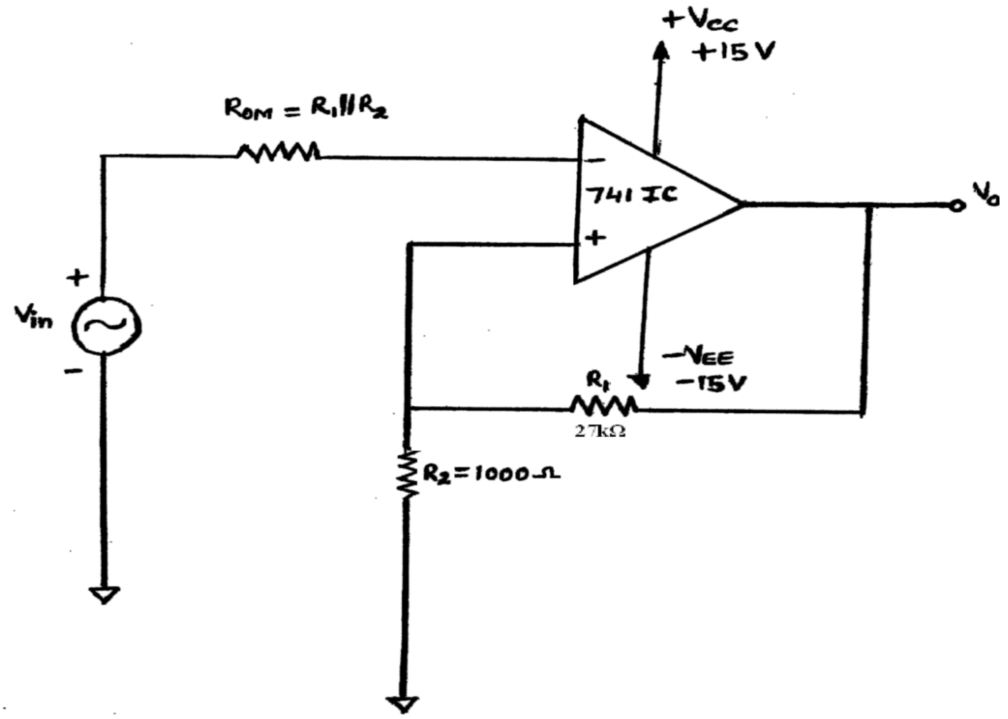
2. 1000Ω Resistor.

Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1000Ω resistor are
Rating: 900Ω to 1100Ω
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above

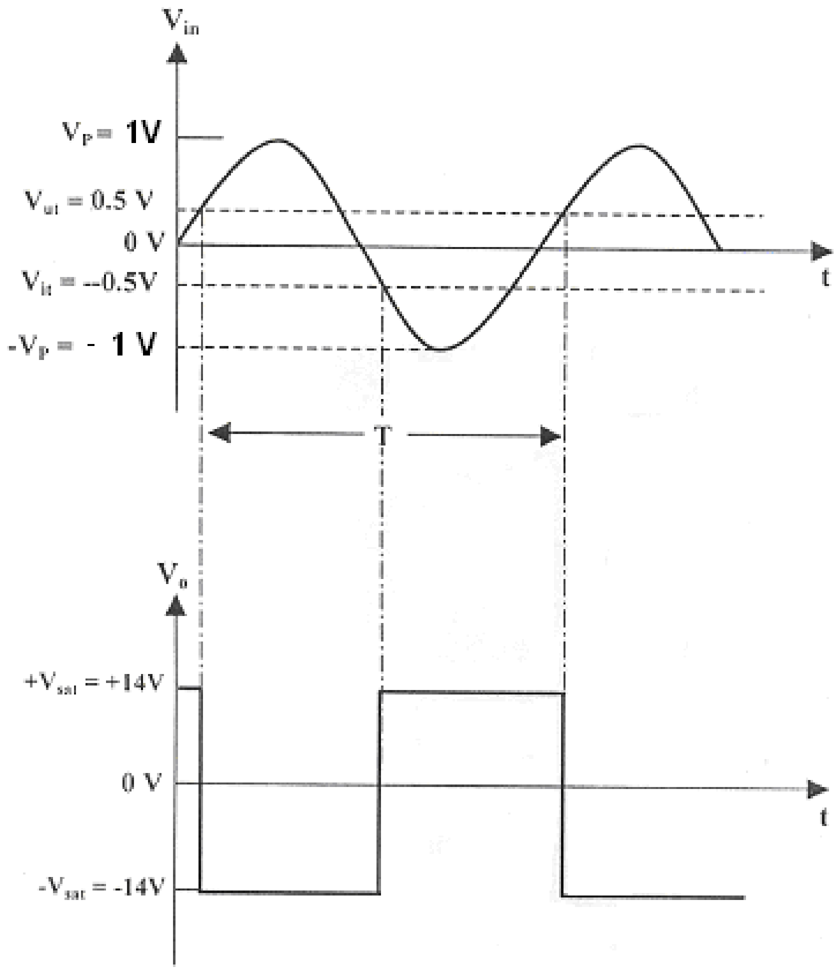
III. THEORY:

If positive feedback is added to the comparator circuit, gain can be increased greatly. Regenerative Comparator is also known as Schmitt Trigger .The input voltage is applied to the –ve input terminal and feedback voltage to the +ve input terminal .The input voltage Vi triggers the output Vo every tome it exceeds certain voltage levels. These voltage levels are called upper threshold (V_{UT}) and Lower threshold voltage(V_{LT}).The hysteresis width is the difference between V_{UT} and $V_{LT.}$

IV. CIRCUIT DIAGRAM:



V. MODEL GRAPH:



VI. PROCEDURE:

i. Connect the circuit as shown in figure.
ii. Apply +Vcc =+15V and –Vcc = – 15V to Pin 7 and 4 of 741IC
iii. Connect the o/p of the oscillator to CRO and observe the waveform
iv. Calculate upper trigger potential and Lower trigger potential.
v. Verify with theoretical value V_{ut} =+V_{sat} (R_2/R_1+R_2) and V_{lt} = –V_{sat} (R_2/R_1+R_2).

VII. CALCULATIONS

$$V_{UT} = \frac{R_2}{R_1 + R_2} V_{sat}$$

$$V_{LT} = \frac{R_2}{R_1 + R_2} (-V_{sat})$$

For 741, with supply voltages = $\pm$ 15V, the saturation voltage $\pm$ V_{sat}=$\pm$ 14V.

So, $$0.5V = \frac{R_2}{R_1 + R_2}(14V)$$

Or, $R_1=27R_2$
Choose, $R_2=1K\Omega$
So, $R_1=27k\Omega$ (take a 50 kΩ pot)

VII. RESULT.

Square wave has been observed using Schmitt trigger .

VIII. INFERENCE:

i. The working of Schmitt Trigger is observed and the output is plotted.
ii. The upper and lower Threshold voltages are measured.

IX. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Pin No.1 and Pin No.8 should be left free.
iii. Check the continuity of the connecting wires.

X. APPLICATIONS:

This can be used as frequency divider, pulse width modulator, burglar alarm, FSK generator, ramp generator, pulse position modulator, waveform generator, etc.

(ii) SCHMITT TRIGGER USING 555

I. AIM: To construct and study of the Schmitt Trigger using IC 555 timer.

II. EQUIPMENTS AND COMPONENTS:

(i). APPARATUS

1.	DC power supply	-	1 No.
2.	CRO	-	1 No.
3.	Bread Board	-	1 No.
4.	Function Generator	-	1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v, 1 amp, 50 Hz, single phase AC.

2. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

3. Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Function Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mv to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

iii. COMPONENTS:

1. 1 kΩ Resistor – 1 No.
2. 100 kΩ Resistor – 2 No.
3. 10 nF Capacitor – 1 No
4. 1nF Capacitor – 1 No
5. IC555 - 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 1 kΩ Resistor.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 3kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 100 kΩ Resistor.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of are100kΩ resistor
Rating: 100kΩ to 10MΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 10 nF Capacitor
Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 10 nF capacitor are
1) Capacity – 10 nF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

III. THEORY:

In Schmitt Trigger two internal comparators are tied together and externally biased at VCC/2 through R1 & R2. Since the upper comparator will trip at (2/3) VCC and lower comparator at (2/3) VCC the bias provided by R1 & R2 is centered within these two thresholds.

Thus a sine wave of sufficient amplitude (>VCC/6 = 2/3 VCC – VCC/2) to exceed the reference levels causes the internal flip –flop to alternately set and reset providing a square wave output.

IV. CIRCUIT DIAGRAM:

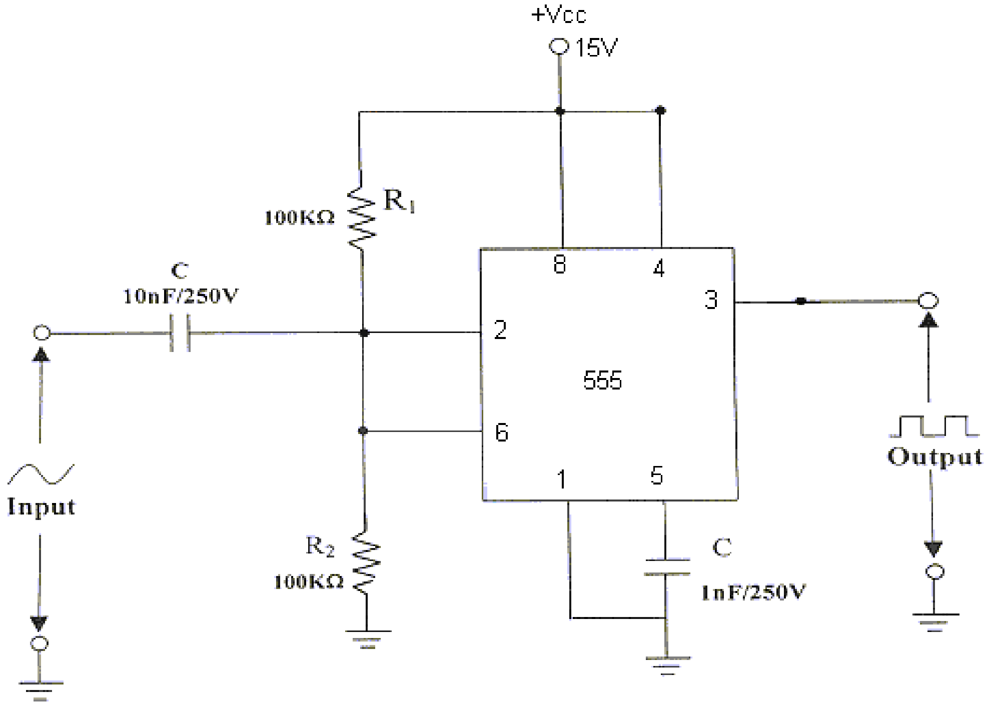


Fig (1)

V. PROCEDURE:

i. Connect the circuit as shown in fig (1).

ii. Switch ON the power supply to the trainer.

iii. Apply the input sine wave 5V (P-P) using function generator at 1KHz frequency.

iv. Observe the output waveform at Pin No: 3.

v. Calculate the duty cycle using formula.

D = [R_2 / R_1+R_2]

= [100K / 100K + 100K]

= 50%

VI. INPUT AND OUTPUT WAVEFORMS:

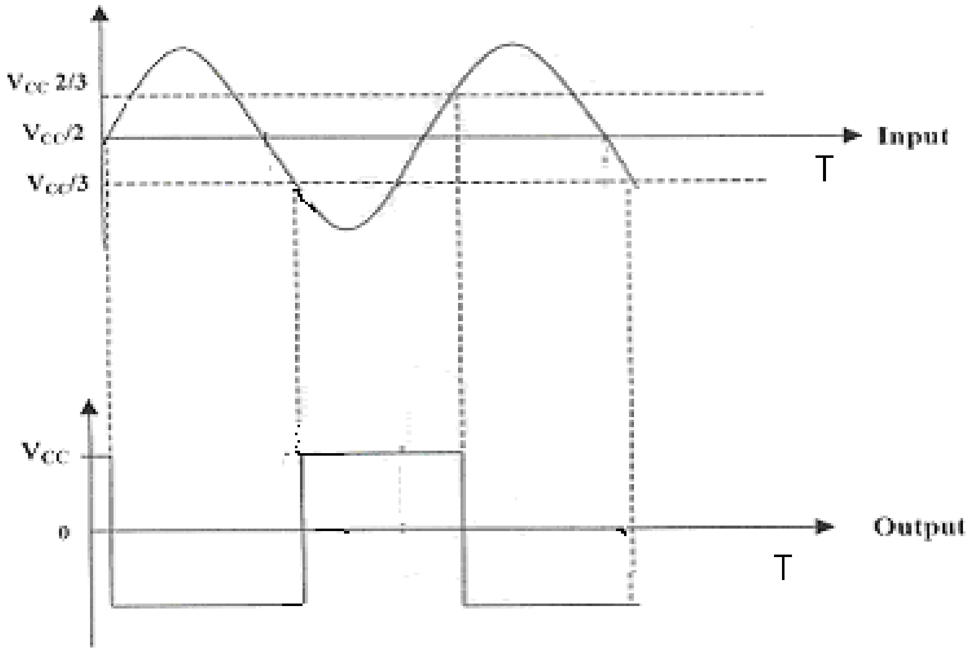


Fig (2)

VII. RESULT.

Square wave has been observed using Schmitt trigger .

VIII. INFERENCE:

i. The working of Schmitt Trigger is observed and the output is plotted.
ii. The upper and lower Threshold voltages are measured.

IX. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the continuity of the connecting wires.

X. APPLICATIONS:

This can be used as Square wave converter

XI. REVIEW QUESTIONS

1. Explain how a square wave is obtained at the output of timer when sine wave input is given.

2. What type of waveform is obtained when a triangular or ramp waveforms are applied to Schmitt trigger circuit?

3. Explain how upper trigger and lower trigger levels are obtained in the Schmitt trigger circuit.

4. Why do we short pin 2 and pin 6 of IC 555 timer for Schmitt trigger operation.

5. Why do we connect pin 4 of 555 timer to Vcc.

6. What is the function of pull up resistor R_L in the Schmitt trigger circuit?

7. Why do we call Schmitt trigger as square wave generator.

8. How do you vary the duty cycle of the output waveform?

9. Draw and explain the functional diagram of a 555 timer.

10. Explain the function of reset.

11. What are the modes of operation of a timer?

Experiment No. 07

IC 565 – PLL APPLICATIONS

I. AIM:

i. To study the operation of NE565 PLL
ii. To use NE565 as a multiplier

II. EQUIPMENTS AND COMPONENTS:

(i).APPARATUS

1. DC power supply - 1 No.
2. CRO - 1 No.
3. Bread Board - 1 No.
4. Function Generator - 1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v,1 amp,50Hz,single phase AC.

2. CRO: The 20 MHz dual channel oscilloscope 201 is a compact, low line and light weight instrument. It is a general purpose Dual Trace Oscilloscope having both vertical amplifiers offering a bandwidth of DC-20 MHz and maximum sensitivity of 2mv/cm. The 201 offers five separate add-on modules.

- Frequency counter
- Curve Tracer
- Power Supply
- Function Generator
- Digital Voltmeter

The add-on modular enhance measuring capabilities of instrument at low cost.

3. Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

4. Function Generator: This instrument is meant for giving three types of periodic waveforms – SINUSOIDAL, SQUARE and TRIANGULAR waveforms – whose frequency can be selected from 0.1 Hz to 1 MHz and (whose amplitude also can be selected from 0.1 to 1 MHz and) whose amplitude also can be selected from 0 to 20 volts peak to peak independently.

The power on switch in pressed position will connect supply to the instrument. The amplitude switch varies the amplitude of output waveforms from 20 mv to 20v (p-p). The function is a interlocked 3 station push button which switches to select the desired waveform for output.

iii. COMPONENTS:

1. 6.8 kΩ Resistor – 1 No.
2. 0.1 μF Capacitor – 1 No
1. 0.001 μF Capacitor – 2 Nos
2. IC565 - 1 No.

iv. DESCRIPTION OF COMPONENTS:

1. 6.8kΩ Resistor.

Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 6.8kΩ resistor are
Rating: 6.8kΩ to 8kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 0.1 μF Capacitor

Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.1μF capacitor are
1) Capacity – 0.1 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

3. 0.001 μF Capacitor

Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.
The factors to be considered in the choice of capacitors are
1) Required Capacity
2) Working Voltage
3) Tolerances
The Specifications of 0.001μF capacitor are
1) Capacity – 0.001 μF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

4. IC565

The IC565 phase locked loop is an important building block of linear systems
It is used to measure the phase difference between the input and output frequencies. It is available in a 14-pin DIP package. And as an 10-pin metal can package. The main specifications of 565PLL are

i. Operating frequency range = 0.001Hz to 500 kHz
ii. Operating voltage range = ± 6V to ±12V
iii. Input Level= 10mV rms min. to 3V pp max
iv. Triangle wave amplitude = 2.4 V_{PP} at ± 6V supply voltage
v. Square wave amplitude = 5.4 V_{pp} at ± 6V supply voltage
vi. Bandwidth adjustment range = < ± 1 to ±60%

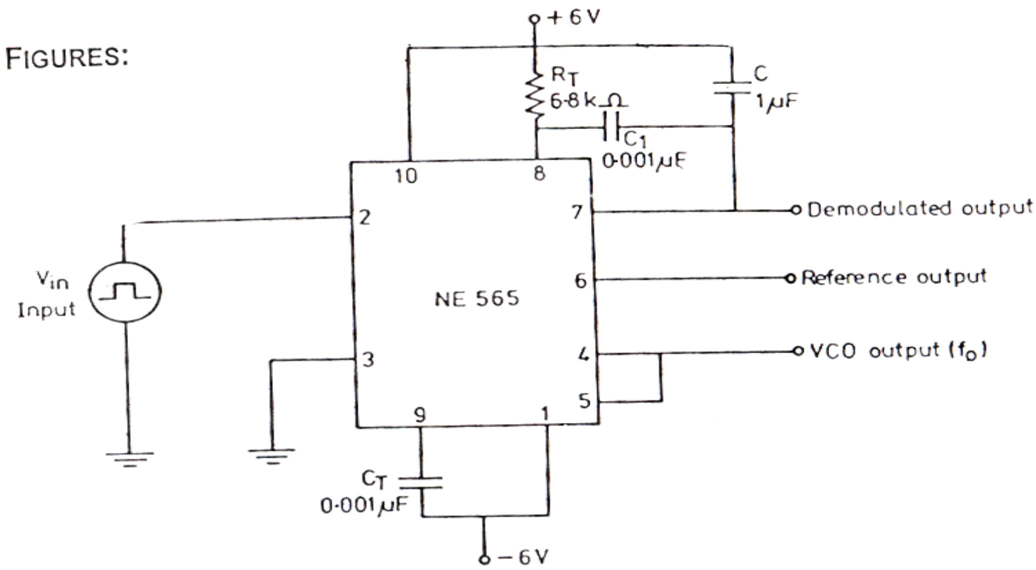
III. THEORY:

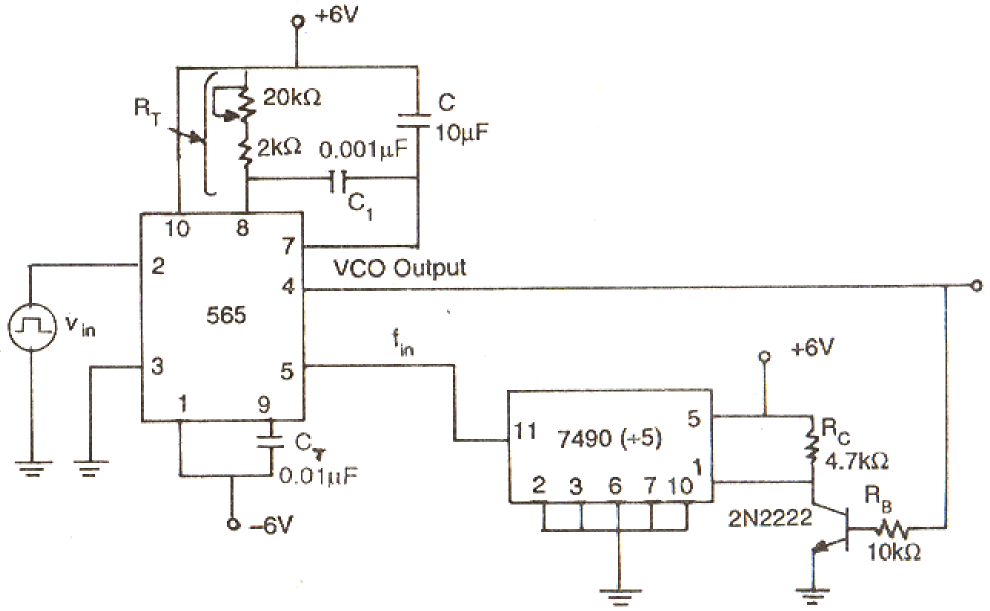
The 565 is available as a 14-pin DIP package. It is produced by signatic corporation. The output frequency of the VCO can be rewritten as

$$f_o = \frac{0.25}{R_T C_T} Hz$$

where R_T and $C_T$are the external resistor and capacitor connected to pin 8 and pin 9. A value between 2 kΩ and 20 kΩ is recommended for R_T. The VCO free running frequency is adjusted with R_T and C_T to be at the centre fo the input frequency range.

IV. CIRCUIT DIAGRAM:





V. PROCEDURE:

i. Connect the circuit using the component values as shown in the figure

ii. Measure the free running frequency of VCO at pin 4 with the input signal V_{in} set = zero. Compare it with the calculated value = 0.25/ $R_T C_T$

iii. Now apply the input signal of 1Vpp square wave at a 1kHz to pin 2

iv. Connect 1 channel of the scope to pin 2 and display this signal on the scope

v. Gradually increase the input frequency till the PLL is locked to the input frequency. This frequency $f_1$gives the lower ends of the capture range. Go on increase the input frequency, till PLL tracks the input signal, say to a frequency f_2. This frequency f_2 gives the upper end of the lock range. If the input frequency is increased further the loop will get unlocked.

vi. Now gradually decrease the input frequency till the PLL is again locked. This is the frequency $f_{3,}$ the upper end of the capture range. Keep on decreasing the input frequency until the loop is unlocked. This frequency f_4 gives the lower end of the lock range

vii. The lock range $\Delta f_L = (f_2 - f_4)$ compare it with the calculated value of $\frac{\pm 7.8 fo}{12}$

Also the capture range is $\Delta f_c = (f_3 - f_1)$. Compare it with the calculated value of capture range.

$$\Delta f_c = \pm \left[\frac{\Delta f_L}{(2\pi)(3.6)(10^3) x C)} \right]^{1/2}$$

viii. To use PLL as a multiplie5r, make connections as showin in fig. The circuit uses a 4-bit binary counter 7490 used as a divide-by-5 circuit.

ix. Set the input signal at 1Vpp square wave at 500Hz

x.. Vary the VCO frequency by adjusting the 20KΩ potentiometer till the PLL is locked. Measure the output frequency

xi. Repeat step 9 and 10 for input frequency of 1kHz and 1.5kHz.

VI. OBSERVATIONS:

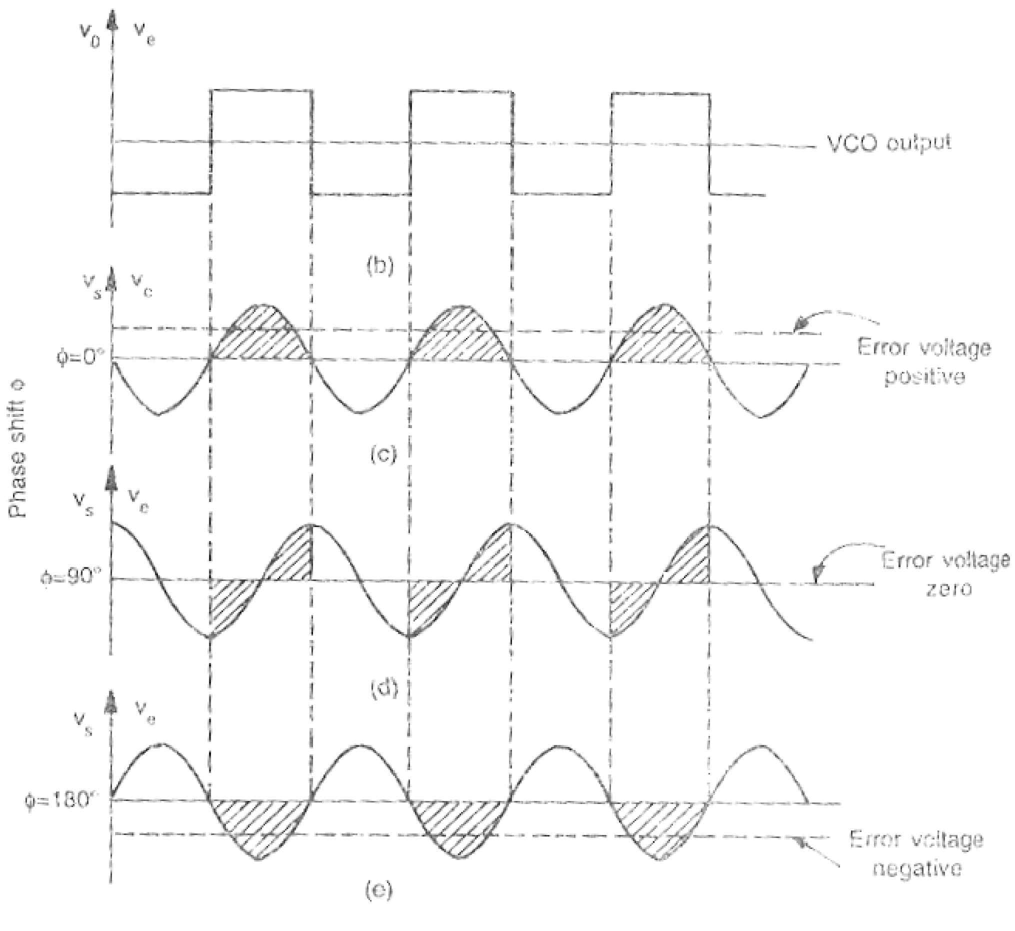
fo = __________
f_L = __________
f_C = __________

VII. CALCULATIONS:

$$\Delta f_L = (f_2 - f_4) = \frac{\pm 7.8\, fo}{12}$$

$$\Delta f_c = (f_3 - f_1) = \pm\left[\frac{\Delta f_L}{(2\pi)(3.6)(10^3)xC)}\right]^{1/2}$$

VIII. GRAPH:



IX. RESULT:

fo = __________
f_L = __________
f_C = __________

X. INFERENCE:

i. The working of 565 PLL is observed and the output is plotted.
ii. The time period of the output waveform is calculated
iii. Frequency of the output wave form is calculated
iv. The Lock range and Capture range of the PLL are calculated.

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the connection between pin 7 and 8
iii. Check the connections at the input.
iv. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. To construct missing frequency multiplier circuit
ii. To construct AM demodulator circuit
iii. To construct FSK demodulator circuit

XIII. EXTENSION:

i. Design the circuit so that it can provide frequency shift keying.
ii. Design the circuit so that it can provide FM demodulation.

XIV. REVIEW QUESTIONS

i. List the basic building blocks of a PLL.
ii. Define capture range
iii. Define lock range
iv. Define pull in time
v. Which is greater capture range or lock range?
vi. What is the major difference between digital and analog PLLs
vii. List the applications of PLL,
viii. Explain about phase detector
ix. Explain about PLL based AM detector
x. Explain the operation of multiplier circuit.

Experiment No. 08

VOLTAGE REGULATOR IC 723, THREE TEMRINAL VOLTAGE REGULATORS – 7805, 7809, 7912

(i) VOLTAGE REGULATOR IC 723

I. AIM:

To study the operation of Voltage regulator IC 723, three temrinal voltage regulators – 7805, 7809, 7912

II. EQUIPMENTS AND COMPONENTS:

(i). APPARATUS

1. DC power supply - 1 No.
2. Digital Multimeter - 1 No.
3. Ammeter - 1 No.
4. Bread Board - 1 No.

(ii) DESCRIPTION OF EQUIPMENT:

1. Dual channel power supply: this power supply unit is specially developed for laboratory use, where low ripple and noise and high voltage regulation is to be maintained both the voltage or current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault this is a cv/cc type power supply employing a well known series regulator technique. The unit operates on a supply voltage of 230v, 1 amp, 50 Hz, single phase AC.

2. Digital multimeter: This DMM has a 31\2 digit Liquid crystal display. DMM is accurate, sensitive instrument. It has high resistance as voltmeter and low resistance as ammeter. It is superior to moving coil ammeters and voltmeters. DMM can read AC, DC voltages and currents in many ranges it can check Diode polarities, read capacitors, read resistances and many more.

3.Ammeter:moving coil systems are usually manufactured for a full scale deflection for 10 microamperes to 50 milli amperes.the size of the coil should not exceed certain measures. Secondly self heating of the coil due to its power dissipation should be low to avoid temperature effects. Thirdly the leads which are usually the spiral pose mechanical limitations. The ammeter is connected in series the voltage drop across the instrument should be low.

4. Bread Board : Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. This component divided into a number of modes. This component has a provision on which any circuit can be constructed by interconnecting components such as registers, capacitors, diodes, transistors etc., for testing the circuit.

iii. COMPONENTS:

1. 1kΩ Resistor – 1 No.
2. 33Ω Resistor – 1 No.
3. 10k Ω Resistor – 1 No
4. 680 Ω Resistor – 1 No.
5. 2.2 kΩ Resistor – 1 No.
6. 100 pF Capacitor – 1 No
7. IC723

iv. DESCRIPTION OF COMPONENTS:

1. 1kΩ Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 1kΩ resistor are
Rating: 1kΩ to 10kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

2. 33Ω Resistor – 1No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 33Ω resistor are
Rating: 33Ω to 100Ω
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

3. 10k Ω Resistor –1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 10kΩ resistor are
Rating: 10kΩ to 100kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

4. 680Ω Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 680Ω resistor are
Rating: 680Ω to 1kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

5. 2.2kΩ Resistor – 1 No.
Most circuits need contrast resistances. There are different types of resistors available for different applications. Typical specifications of 2.2kΩ resistor are
Rating: 2.2kΩ to 10kΩ
Wattage: ¼ W to 2 W
Tolerance: Normally ±5% and above.

6. 100 pF Capacitor –1 No.

Capacitors are made by sandwiching an insulating material between two conductors which from the electrodes. These are rated by their maximum working voltage. The breakdown voltage depends upon temperature and hence upon the losses in the dielectric.

The factors to be considered in the choice of capacitors are

1) Required Capacity
2) Working Voltage
3) Tolerances

The Specifications of 100 pF capacitor are

1) Capacity – 100 pF
2) Voltage range 16v to 3kv
3) Tolerance ±10%

6. IC723

The IC723 is a general purpose regulator which can be adjusted over a wide range of both +ve or –ve regulated voltage. This is an 14-pin DIP package. . This IC is inherently low current device but can be boosted to provide 5 amps or more current by connecting external components. The limitation of 723 is that it has no in-built thermal protection. It also has no short-circuit current limits. The IC723 has two sections. The first section consists of Zener Diode constant current source and a reference amplifier. The other section of the IC consists of an error amplifier series pass transistor and a current limit transistor. This is a 14-pin DIP package. The main features of 723 include an input voltage of 40v max, output voltage is adjustable from 2V to 37V, 150mA output current without external pass resistor, can be used as either a linear or a switching regulator.

III. THEORY:

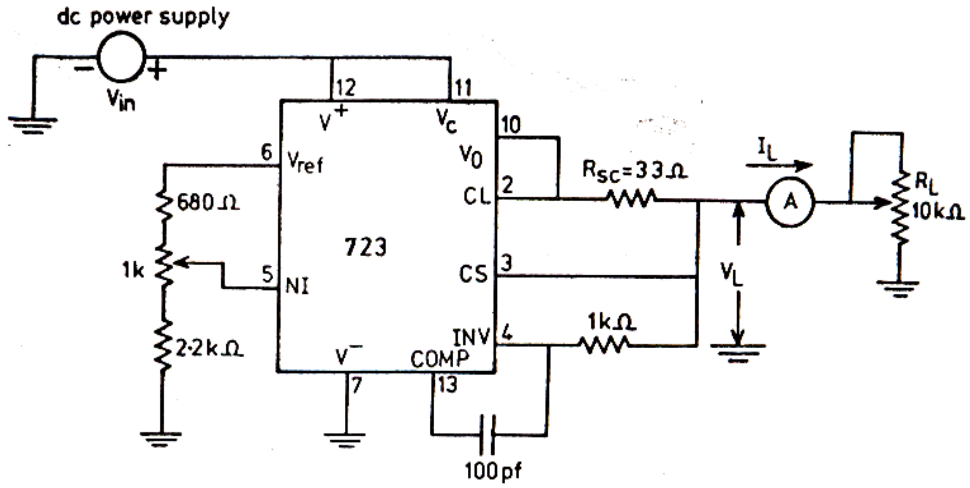
The three-terminal regulators have the following limitations

No short-circuit protection

Output voltage (+ve or –ve) is fixed

These limitations have been overcome in 723 general purpose regulator. This IC is inherently low current device but can be boosted to provide 5 amps or more current by connecting external components. The limitation of 723 is that it has no in-built thermal protection. It also has no short-circuit current limits. The IC723 has two sections. The first section consists of Zener Diode constant current source and a reference amplifier. The other section of the IC consists of an error amplifier series pass transistor and a current limit transistor. This is a 14-pin DIP package. The main features of 723 include an input voltage of 40v max, output voltage is adjustable from 2V to 37V, 150 mA output current without external pass resistor, can be used as either a linear or a switching regulator.

IV. CIRCUIT DIAGRAM:



723 voltage regulatoı

V. PROCEDURE:

i. Connect the 723 regulator as shown in the circuit diagram

ii. Set Dc power supply voltage V_{in} to +10V measure and record V_{ref} with respect to ground. With load R_L(10kΩ pot) removed from the circuit (output open). Measure the minimum and maximum output voltage by rotating the 1kΩ pot through its full range.

iii. Now adjust the 1kΩ pot so that V_o is +5V dc. Measure the voltage between the wiper arm of the 1 kΩ pot and ground.

iv. Adjust the load R_L (10 kΩ) pot until the load current I_L = 1 mA. Record V_L. Repeat for different values of load currents 5mA, 10mA, 15mA, 18mA. Calculate the load regulation and compare with manufacturer's specifications

v. Gradually increase the load current above 18mA, you will see that the load voltage suddenly decreases when the load current is about 18 to 20 mA. Now the voltage across R_{SC} is enough to begin current limiting. Measure and record a few values of load current and load voltage below and above the current limiting point. Plot a graph of V_L vs I_L from the data obtained in steps 4 and 5

VI. OBSERVATIONS:

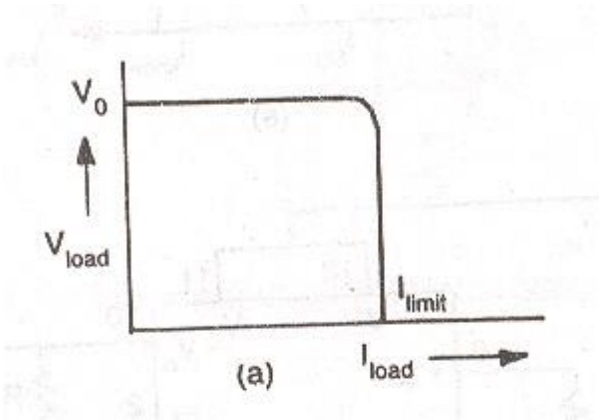
The load regulation = _____ %
The line regulation = ______%

VII. CALCULATIONS:

i. The load regulation can be calculated by using the below formulae %load regulation = $((V_{fl} – V_{nl}) / (V_{fl})) * 100$

ii. The line regulation can be calculated by using the below formulae %line regulation = $(\Delta V_o / \Delta V_i)$

VIII. GRAPH:



IX. RESULT:

i. The % load regulation =
ii. The % line regulation =

X. INFERENCE:

i. The working of 723 regulator is observed and the output is plotted.
ii. The load regulation is calculated
iii. The line regulation is calculated

XI. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the connections between pin no.2 and ground.
iii. Check the continuity of the connecting wires.

XII. APPLICATIONS:

i. To construct the current boosted low voltage regulator
ii. To achieve variable voltage regulation

XIII. EXTENSION:

i. Design the circuit so that it can provide 140mA output current
ii. Check the current fold back characteristic curve
iii. To construct current limit protection circuit.

XIV REVIEW QUESTIONS

i. What is the maximum input voltage that we can give to 723 regulator?
ii. What output voltage range we can obtain from 723 regulator?
iii. What is the output current in case of 723 regulator?
iv. What are the applications of 723 regulator?
v. Define line regulation
vi. Define load regulation
vii. Define ripple rejection
viii. Define long term stability
ix. What is the current limit protection?
x. What are the ideal values of load and line regulations?

(ii) THREE TERMINAL VOLTAGE REGULATORS USING – 7805, 7809, 7912

I. AIM:

To calculate the percentage line and load regulation of voltage regulator using IC 7805, IC 7809, IC7912.

II. EQUIPMENTS AND COMPONENTS:

i. APPARATUS:

1. IC 7805
2. IC 7809
3. IC 7912
4. Resistors
5. Voltmeters
6. Power Supply
7. Bread Board

III. THEORY:

78xx series are three terminal positive fixed voltage regulators. Thee are seven output voltage options such as 5, 6, 8, 12, 15, 18 and 24V. In 78XX the last two numbers indicate the output voltage. Thus 7805 represents a 5V generator. These are also available in 79XX series of fixed output, negative are also available in 79XX which are complement to the 78XX series device. There are four characteristics of three terminal IC regulators.

V_0: The regulated output voltage is fixed at a value as specified by manufacture. eg. 78XX has output voltage at 5, 6, 8, ….. etc.

$|Vin| \geq 1Volt + 2Volts$: The unregulated output voltage must be at least 2V more than the regulated output voltage.

I_0 (Max): The load current may vary from 0 to rated maximum output current. The IC is usually provided with a heat sink.

Thermal Shut down: The IC has a temperature sensor which turns off the IC when it becomes too hot. The output current will drop and remain there until the IC has cooled significantly.

Line Input Regulation : It is defined as percentage change in the output voltage for a change in the input voltage

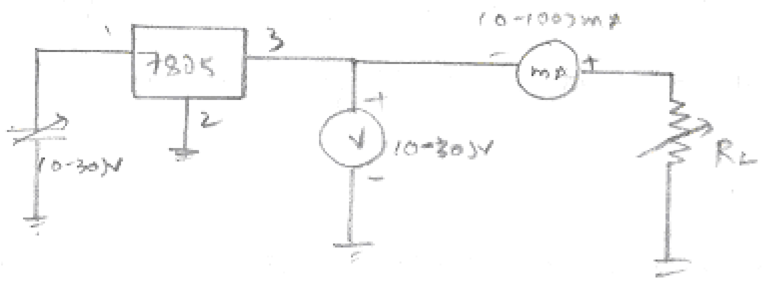
$$\%Lineregulation = \frac{V_{L2} - V_{L1}}{V_{in2} - V_{in1}} X100$$

Load Regulation : It is defined as the change in the output voltage for a change in the output voltage for a change in load current and is also expressed in millivolts or as a percentage of V_o.

$$\%Load\ regulation = \frac{V_{NL} - V_{FL}}{V_{FL}}\ X\ \ 100$$

IV. CIRCUIT DIAGRAM

VOLTAGE REGULATOR USING 7805



V. OBSERVATION TABLE

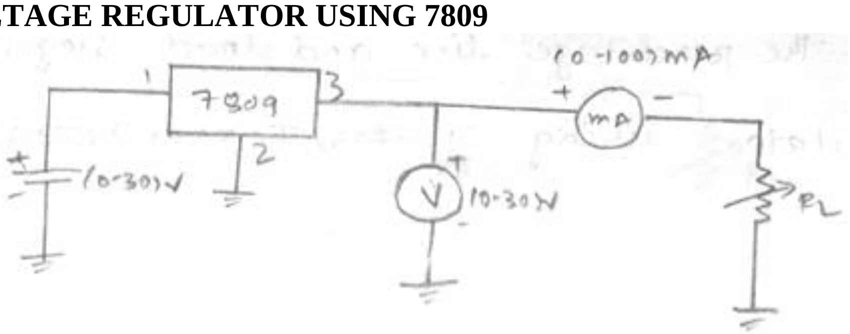
Load Regulation

Sl No.	R_L	I_L	V_L

Line Regulation

Sl. No.	V_{in}	I_L	V_L

V. VOLTAGE REGULATOR USING 7809



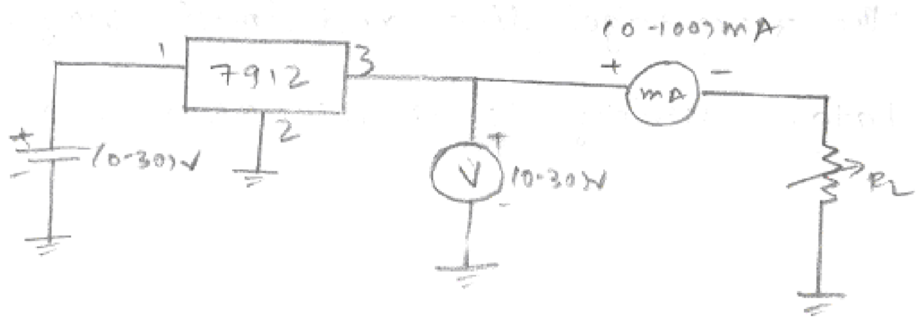
Load Regulation

Sl No.	R_L	I_L	V_L

Line Regulation

Sl. No.	V_{in}	I_L	V_L

VOLTAGE REGULATOR USING 7912



Load Regulation

Sl No.	R_L	I_L	V_L

Line Regulation

Sl. No.	V_{in}	I_L	V_L

VI. PROCEDURE:

1. Connect the circuit as per the circuit diagram
2. By keeping input voltage constant vary the load resistance from 100Ω to 1KΩ
3. Note down load current and load voltage from ammeter and voltmeter
4. Calculate percentage load regulation using formula.
5. Now keep the load resistance constant and vary the input voltage V_{in}
6. Note down the load current and load voltage from the ammeter and voltmeter
7. Calculate percentage line regulation using the formula.
8. Repeat the above procedure for IC 7809, 7812

VII. RESULT:

For IC 7805
% Line regulation =
% Load regulation =

For IC 7809
% Line regulation =
% Load regulation =

For IC 7812
% Line regulation =
% Load Regulation =

VIII. INFERENCE:

i. The working of 78XX regulator is observed and the output is plotted.
ii. The load regulation is calculated
iii. The line regulation is calculated

IX. PRECAUTIONS:

i. Check the circuit connections before switching on the power supply.
ii. Check the continuity of the connecting wires.

X. APPLICATIONS:

i. Used as an fixed voltage regulator
ii. Used as an current source

XIII. EXTENSION:

It is possible to boost the output current of a three terminal regulator simply by connecting an external pass transistor in parallel with the regulator.

XIV. REVIEW QUESTIONS

i. What is the function of a voltage regulator?
ii. What is a voltage reference? Why is it needed?
iii. What voltage options are available in 78XX voltage regulators?
iv. Explain the protections used in 78XX.
v. Explain the important parameters listed in the data sheet of 78XX.
vi. Discuss the limitations of linear voltage regulators.
vii. Give the important parts of a series regulated power supply using discrete components.
vii. Define line and load regulation.
viii. Mention the application of voltage regulator.
ix. List the types of voltage regulator.
x. List the different types of 3- terminal voltage regulator IC"s?
xi. Draw and explain the internal block diagram of 3- terminal regulator IC.
xii. Why do we use capacitors at input and output terminal of a regulator?
xiii. Define "dropout" voltage of a regulator.
xiv. What is the difference between a +ve and a –ve voltage regulator.
xv. Compare three terminal voltage regulator with 723 voltage regulator.
xvi. List the features of IC voltage regulators.

Part-2:
To Verify the Funcationality of the following 74 series TTL ICs.

INTRODUCTION

GATES

1. **AND GATE:** This is a logical AND operation which yields an output logic 1 if and only if all inputs are logic 1 and 0 in all the other cases. Is is represented by the symbol "**.** " .Commercially available IC's are IC 74x11,IC 74x08,IC 74x21.

2. **OR GATE:** This is a logical OR operation which yields an output logic 1 if any of the input is at logic 1 and 0 if non of the input is at logic 1 . It is represented by the symbol "**+** " .Commercially available IC's are IC 74x32.

3. **NOT GATE:** This is logical inversion operation in Boolean logic since there are only two levels, the result of NOT operation on logic level yields the output as the other logic level. It is represented by a prime or a bar symbol. Commercially available as IC 74x04,IC 74x14.

4. **NAND GATE:** This is the AND operation followed by NOT operation. It is denoted as Z = (X.Y)'.It is possible to implement any Boolean function using this gate alone. Hence it comes under the category of universal gate. Most of the practical implementations use the NAND gates only. Commercially available as IC74x00, IC74x03, IC 74x10, IC 74x20, IC 74x30.

5. **NOR GATE:** This is OR operation followed by NOT operation. It is denoted as Z=(X+Y)'.It is possible to implement any Bolen function using this gate ,it also comes under the category of universal gate..It is commercially available as IC 74x02, IC 74x27.

6. **EX-OR GATE:** This operation produces a high output whenever no two inputs are at the same logic level. Commercially available as IC 74x86,IC 74x266.

<u>BOOLEAN EXPRESSIONs:</u>

AND OPERATION: C=AB.

OR OPERATION : D=A + B.

NAND OPERATION: E= C'.

NOR OPERATION: F= D'

EXOR OPERATION: G= AB' + A'B.

NOT OPERATION: H= A'.

TRUTH TABLE:

A	B	C=A AND B	D=A OR B	E= C'	F=D'	H=A'	G= A XOR B
0	0	0	0	1	1	1	0
0	1	0	1	1	0	1	1
1	0	0	1	1	0	0	1
1	1	1	1	0	0	0	0

Hardware Implementation:
Theory:

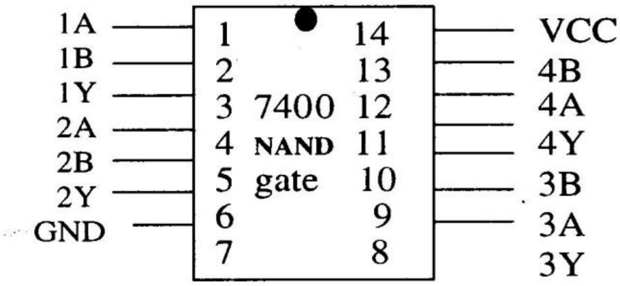
All digital circuits consists of either fundamental gates or universal gates. The signal in a digital circuit will have either a "0" logic level or a "I" logic level. In a Transistor Transistor Logic (TTL) family of gate logic "0" is equal to 0 - 1.5V and logic " 1 " is equal to + 3.5V to + 5V and this is called as positive logic. If the logic "0" is equal to + 3.5V to 5V and logic " 1 " is equal to 0 to 1.5 V, then it is called as negative logic.

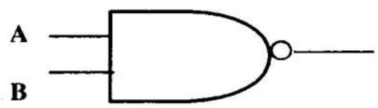
These two levels i.e. 0 & 1 are used as binary levels in digital circuits. A binary digit (0 or 1) is referred as a bit. Since a digital signal can have only one of the two possible levels i.e. either 1 or 0 the binary number system can be used for analysis and design of Digital System.

The basic fundamental logic gates available are:

a) 7400 Quad - 2 - input NAND gate
b) 7402 Quad - 2 - input NOR gate
c) 7404 Hex Inverter
d) 7408 Quad - 2 - input AND gate
e) 7432 Quad - 2 - input OR gate
f) 7486 Quad - 2 - input Ex-OR gate

a)<u>7400 Quad – 2 – input NAND gate:</u>





$Y = \overline{A.B}$

Circuit symbol for NANDgate

Fig.1.Pin Configuration of 7400

<u>OPERATION</u>:

The NOT – AND operation is known as the NAND operation. The output is "O" if and only if all the inputs are "1".

The logic equation of NAND operation is $Y = \overline{A.B}$

<u>N.B.</u> NAND gate and NOR gates are known as UNIVERSAL gates because these two gates are sufficient for the realization of any logical expression.

Truth Table for 2 input NAND gate :

Inputs		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Boolean expression Y = A.B

b) <u>7402 Quad – 2 – input NOR gate:</u>

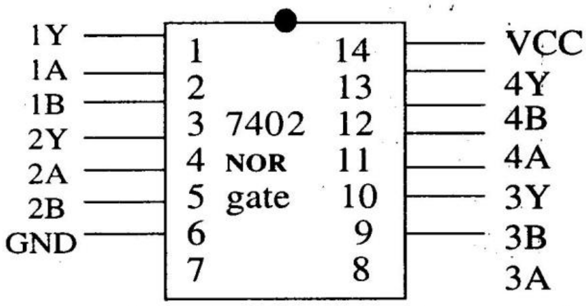
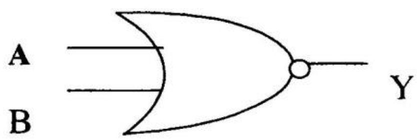


Fig 2. Pin Configuration of 7402



$Y = \overline{A + B}$

Circuit symbol for NOR gate

<u>OPERATION</u>:

The NOT – OR operation is known as the NOR operation. The output is " 1 " if and only if all the inputs are "1".

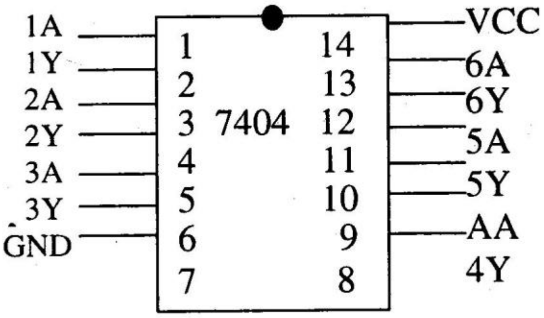
<u>N.B.</u> NOR gate is known as UNIVERSAL gate. With the combinationof NAND gate any Boolean expression can be realized.

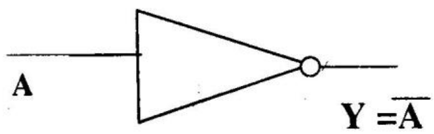
Truth Table for 2 input NOR gate:

Inputs		Output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Boolean expression $Y = \overline{A+B}$

c) **<u>7404 Hex Invertor:</u>**





Circuit symbol & Ex for INVERTER gate

Fig 3. Pin Configuration

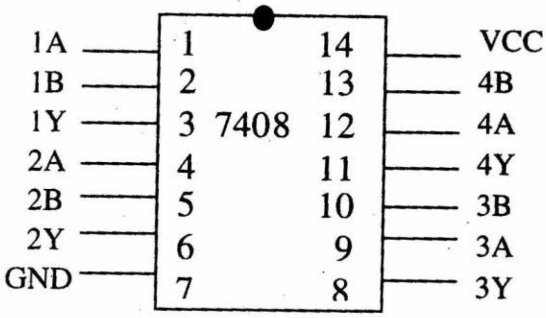
<u>OPERATION</u>:

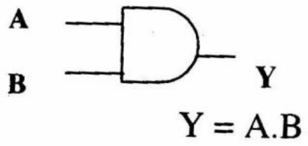
The operation is such that the output is "<u>O</u>" if the input is "1' & vice versa.
The logic equation of inverter operation is Y = A

<u>Truth Table:</u>

INPUT	OUTPUT
0	**1**
1	**0**

d) 7408 Quad – 2 – input AND gate:





Circuit symbol for AND gate

Fig 4.Pin Configuration:

OPERATION:

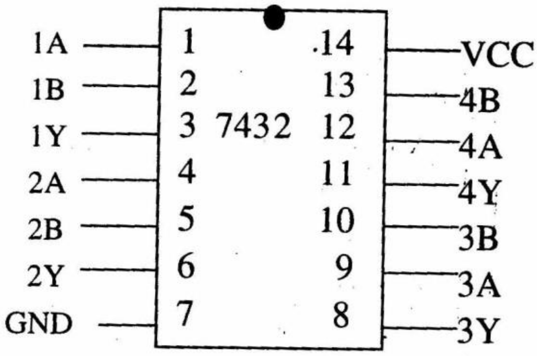
In an AND operation the output is "1" if and only if the both the inputs or all the inputs are equal to "1"

Truth Table for 2 input AND gate

Inputs		Output
A	**B**	**Y**
0	**0**	**0**
0	**1**	**0**
1	**0**	**0**
1	**1**	**1**

Boolean expression Y = A.B

e) 7432 Quad – 2 – input OR gate:



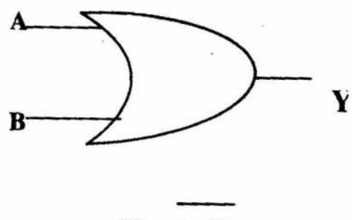


Fig 5. Pin Configuration

Circuit symbol for OR gate:

OPERATION:

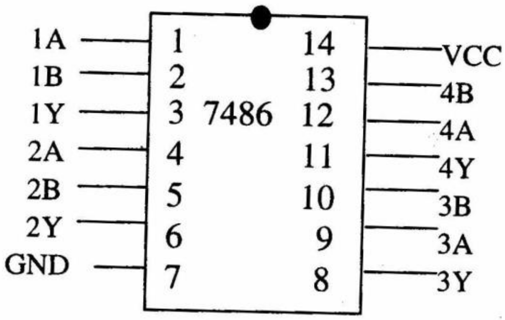
The operation of an OR gate is such that the output is equals " 1 " if any of the inputs equals "1" & both the inputs equals 1.

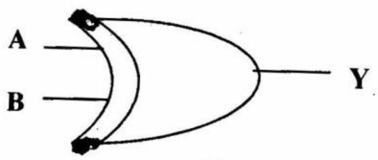
Truth Table for 2 input OR gate:

Inputs		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Boolean expression Y = A+B

f) 7486 Quad – 2 – Ex - OR gate:





$Y = A \oplus B$
$Y = A\bar{B} + \bar{A}B$

Circuit symbol for Ex-OR gate

Fig. 6 Pin Configuration

<u>OPERATION</u>:

The operation of an Ex-OR gate is such that the output equals " 1 " only if any of the inputs equals "1" and the output is "O" for both the inputs equals "O" as well for both the inputs equals "1"

Truth Table for 2 input Ex-OR gate

Inputs		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Boolean expression $Y = A \oplus B$

$Y = A.\bar{B} + \bar{A}.B$

Experiment 1

D-flip-flop(74LS74) and JK Master-Slave Flip-Flop(74LS73)

I. **AIM:** To verify the functionality of D-flip-flop (74LS74) and JK Master-Slave Flip-Flop (74LS73) with Hardware.

II. **EQUIPMENTS AND COMPONENTS:**

(i).APPARATUS

1. Digital IC Trainer kit
2. IC 74LS74, IC 74LS73
3. Regulated Power Supply
4. Multimeter / Volt Meter
5. Connecting wires.

III. **THEORY:**

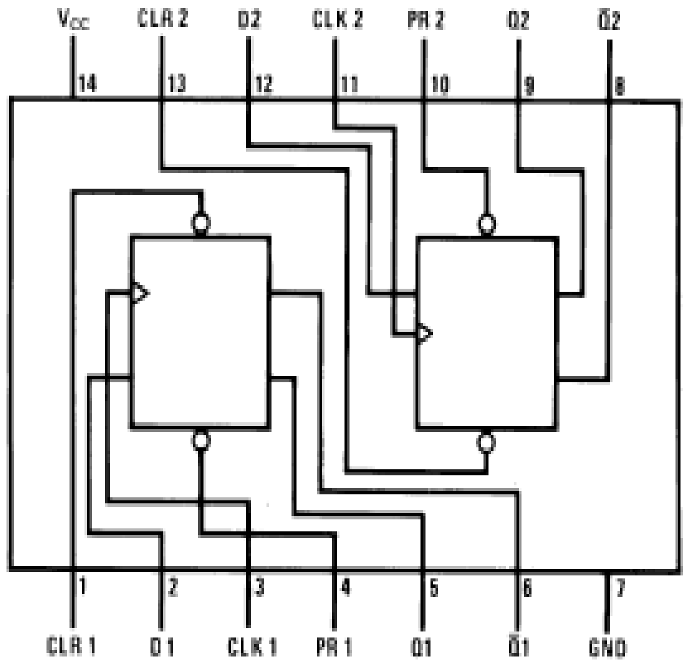
IC 7474

This device contains two independent positive-edge-triggered D flip-flops with complementary outputs. The information on the D input is accepted by the flip-flops on the positive going edge of the clock pulse. The triggering occurs at a voltage level and is not directly related to the transition time of the rising edge of the clock. The data on the D input may be changed while the clock is low or high without affecting the outputs as long as the data setup and hold times are not violated. A low logic level on the preset or clear inputs will set or reset the outputs regardless of the logic levels of the other inputs.

IC 7473

This device contains two independent positive pulse triggered J-K flip-flops with complementary outputs. The J and K data is processed by the flip-flops after a complete clock pulse. While the clock is LOW the slave is isolated from the master. On the positive transition of the clock, the data from the J and K inputs is transferred to the master. While the clock is HIGH the J and K inputs are disabled. On the negative transition of the clock, the data from the master is transferred to the slave. The logic states of the J and K inputs must not be allowed to change while the clock is HIGH. Data transfers to the outputs on the falling edge of the clock pulse. A LOW logic level on the clear input will reset the outputs regardless of the logic states of the other inputs.

Pin diagram of IC 74LS74(D Flip-Flop):



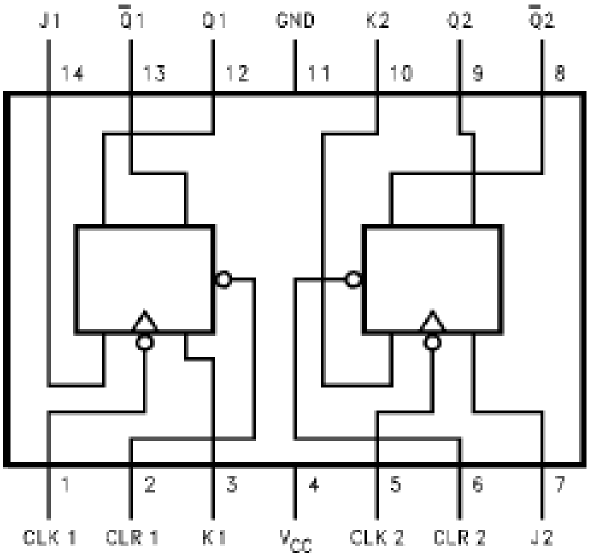
Truth table of IC 74LS74(D Flip-Flop)::

Inputs				Outputs	
PR	CLR	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H (Note 1)	H (Note 1)
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

H = High Logic Level
X = Either Low or High Logic Level
L = Low Logic Level
↑ = Positive-going transition of the clock.

Note 1: This configuration is nonstable ; that is, it will not persist when either the preset and/or clear inputs return to their inactive (high) level. Q0 = The output logic level of Q before the indicated input conditions were established.

Pin diagram of IC 7473(Master-Slave J-K Flip-Flop):



Truth Table:

Inputs				Outputs	
CLR	CLK	J	K	Q	$\overline{Q}$
L	X	X	X	L	H
H	⎍	L	L	Q_0	$\overline{Q_0}$
H	⎍	H	L	H	L
H	⎍	L	H	L	H
H	⎍	H	H	Toggle	

H = HIGH Logic Level
L = LOW Logic Level
X = Either LOW or HIGH Logic Level
Q0 = The output logic level before the indicated input conditions were established.
Toggle = Each output changes to the complement of its previous level on each HIGH level clock pulse.

Procedure:

1. Connect the circuit as shown in figure.
2. Apply the inputs and verify the truth table of D-flip-flop.
3. Repeat the same for the master-slave JK flip-flop.

Tutorial:

1. Realize the D-flip-flop using J-K flip-flop
2. Realize the T-flip-flop from D-flip-flop

Conclusion: The Functionality of D-FlipFlop and master-slave JK flip-flop is verified using ICs.

Experiment No.2

Decade counter and Up-Down counter

I. AIM: To verify the functionality of Decade counter (74LS90) and Up-Down coutner (74LS192) with hardware

II. EQUIPMENTS AND COMPONENTS:

(i).APPARATUS

1. Digital IC Trainer kit
2. IC 74LS90,IC74LS193
3. Regulated Power Supply
4. Connecting wires

II. THEORY:

IC 7490

The 7490 integrated circuit counts the number of pulses arriving at its input. The number of pulses counted (up to 9) appears in binary form on four pins of the IC. When the tenth pulse arrives at the input, the binary output is reset to zero (0000) and a single pulse appears at another output pin So for ten pulses in there is one pulse out of this pin. The 7490 therefore divides the frequency of the input by ten.

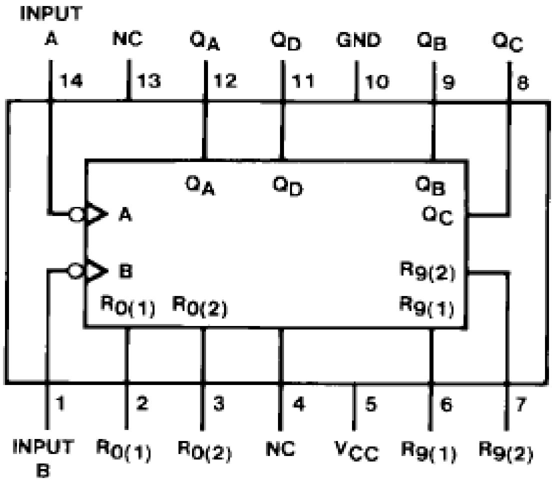
The 7490 monolithic counter contains four masterslave flip-flops and additional gating to provide a divide-by two counter and a three-stage binary counter for which the count cycle length is divide-by-five. The counter has a gated zero reset and also has gated set to-nine inputs for use in BCD nine's complement applications. To use as decade counter, the B input is connected to the QA output. The input count pulses are applied to input A and the outputs are as described in the appropriate Function Table.

IC 74193

The 74LS193 is an UP/DOWN MODULO-16 Binary Counter. Separate Count Up and Count Down Clocks are used and in either counting mode the circuits operate synchronously. The outputs change state synchronous with the LOW-to-HIGH transitions on the clock inputs.

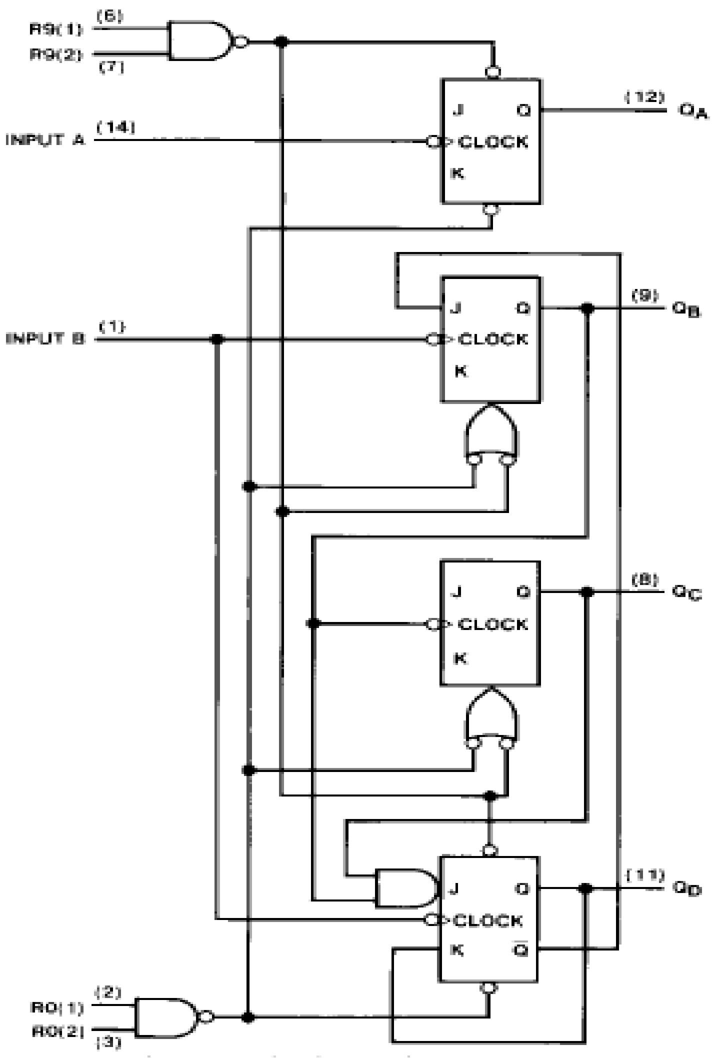
Separate Terminal Count Up and Terminal Count Down outputs are provided which are used as the clocks for subsequent stages without extra logic, thus simplifying multistage counter designs. Individual preset inputs allow the circuits to be used as programmable counters. Both the Parallel Load (PL) and the Master Reset (MR) inputs asynchronously override the clocks.

Pin diagram of IC 7490(Decade Counter):



Note: To use as decade counter the B input is connected to the QA output. The input count pulses are applied to input A, and pins 2,3,6 and 7 should be grounded.

Logic diagram of IC 7490(Decade Counter):



The J and K inputs shown without connection are for reference only and are functionally at a HIGH level.

Truth table of IC7490(Decade Counter):

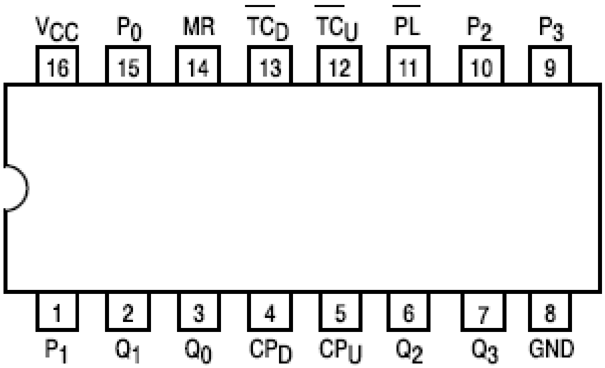
Table-1: Truth table for a Decade counter:

Input pulse count	Counter states			
	Q_D	Q_C	Q_B	Q_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	0	0	0	0

Procedure of IC7490(Decade Counter):

1. Apply the Vcc to pin 5 and GND to pin 10
2. Pin 12 should be connected to the pin 1.
3. Pin 2,3,6 and 7 should be grounded.
4. Apply clock input to the pin 14 and observe the output at 11, 8, 9 and 12 pins.

Pin diagram of IC74193(mod 16 up-down counter):



PIN NAMES

CP_U	Count Up Clock Pulse Input
CP_D	Count Down Clock Pulse Input
MR	Asynchronous Master Reset (Clear) Input
PL	Asynchronous Parallel Load (Active LOW) Input
P_n	Parallel Data Inputs
Q_n	Flip-Flop Outputs (Note b)
$\overline{TC_D}$	Terminal Count Down (Borrow) Output (Note b)
TC_U	Terminal Count Up (Carry) Output (Note b)

MODE SELECT TABLE

MR	$\overline{PL}$	CP_U	CP_D	MODE
H	X	X	X	Reset (Asyn.)
L	L	X	X	Preset (Asyn.)
L	H	H	H	No Change
L	H	↑	H	Count Up
L	H	H	↑	Count Down

L = LOW Voltage Level
H = HIGH Voltage Level
X = Don't Care
↑ = LOW-to-HIGH Clock Transition

Procedure if IC 74193(mod 16 up-down counter)::

1. Connect the circuit as per the pin diagram..
2. Apply the inputs as shown in the mode table and observe the outputs for upcount, down count and parallel load.

OBSERVATIONs : Verify the Truth table

TUTORIALS :

1. Design divide by 8 counter using 7490.
2. What is the difference between Synchronous & Asynchronous counter.

Conclusion:

- The Functionality of 4-Bit Decade Counter is verified using IC 7490
- The Functionality of Mod 16 up-down counter is verified using IC 74193

Experiment No. 3

UNIVERSAL SHIFT REGISTERS (7495)

I. AIM: To verify the functionality of Universal Shift registers – 74LS95 with hardware.

II. EQUIPMENTS AND COMPONENTS:

(i).APPARATUS

1. Digital IC Trainer kit with IC 7495
2. Regulated Power Supply
3. Connecting wires

III. THEORY:

.

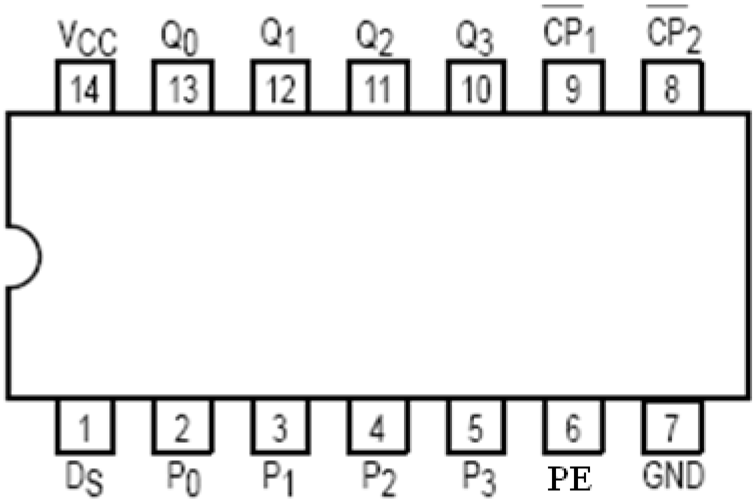
The LS95B is a 4-Bit Shift Register with serial and parallel synchronous operating modes. It has a Serial (DS) and four Parallel (P0–P3) Data inputs and four Parallel Data outputs (Q0–Q3). The serial or parallel mode of operation is controlled by a Mode Control input (PE) and two Clock Inputs (CP1) and (CP2). The serial (right-shift) or parallel data transfers occur synchronous with the HIGH to LOW transition of the selected clock input.

When the Mode Control input (PE) is HIGH, CP2 is enabled. A HIGH to LOW transition on enabled CP2 transfers parallel data from the P0–P3 inputs to the Q0–Q3 outputs. When the Mode Control input (PE) is LOW, CP1 is enabled. A HIGH to LOW transition on enabled CP1 transfers the data from Serial input (DS) to Q0 and shifts the data in Q0 to Q1, Q1 to Q2, and Q2 to Q3 respectively (right-shift). A left-shift is accomplished by externally connecting Q3 to P2, Q2 to P1, and Q1 to P0, and operating the LS95B in the parallel mode (PE = HIGH).

For normal operation, PE should only change states when both Clock inputs are LOW. However, changing PE from LOW to HIGH while CP2 is HIGH, or changing PE from HIGH to LOW while CP1 is HIGH and CP2 is LOW will not cause any changes on the register outputs.

Hardware Implementation:

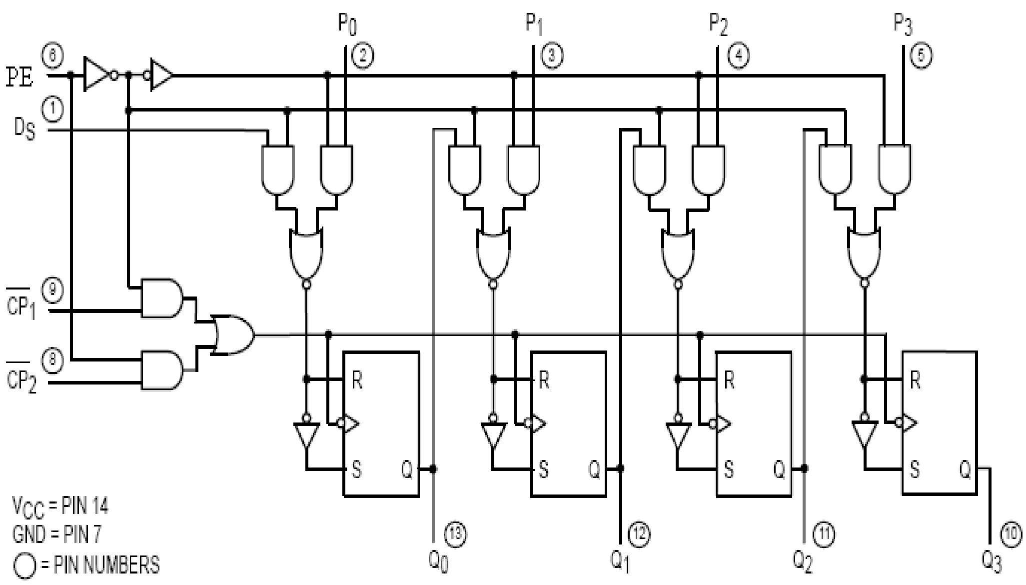
Block diagram & Pin Configuration of 7495(shift register):



PIN NAMES

PE	Mode Control Input
D_S	Serial Data Input
$P_0 - P_3$	Parallel Data Inputs
$\overline{CP_1}$	Serial Clock (Active LOW Going Edge) Input
$\overline{CP_2}$	Parallel Clock (Active LOW Going Edge) Input
$Q_0 - Q_3$	Parallel Outputs (Note b)

LOGIC DIAGRAM



Mode table:

PE	Ds	Cp1	Cp2	operation	Q0 Q1 Q2 Q3
1	X	X		Parallel load	P0 P1 P2 P0
0	SI	↓	X	Right shift	SI Q0 Q1 Q2
1	SI	X	↓	Left shift (with external connections)	Q1 Q2 Q3 SI

External connections for left shift:

A left-shift is accomplished by externally connecting Q3 to P2, Q2 to P1, Q1 to P0, and Ds to P3 and operating the 7495 in the parallel mode (PE =HIGH) .

PROCEDURE:

1. Connect the circuit as per the pin diagram.
2. Make the external connections for left shift as given above.
3. Apply the inputs as shown in the mode table and observe the outputs for parallel load ,right shift and left shift.

OBSERVATION: Verify the truth table:

Conclusion: The Functionality of Shift register is verified by using IC 7495.

Experiment No.4

3-8 Decoder -74LS138

I. AIM: To verify the functionality of 3-8 Decoder -74LS138 with hardware

II. EQUIPMENTS AND COMPONENTS:

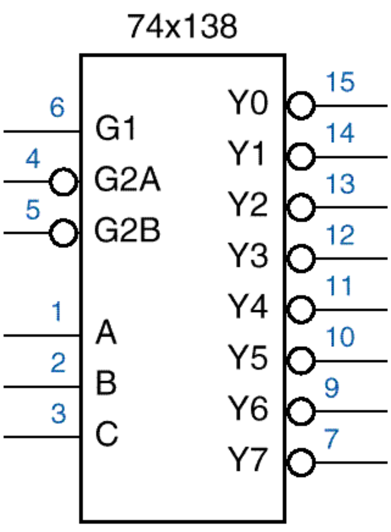
(i).APPARATUS

1. Digital IC Trainer kit
2. IC 74LS138
3. Regulated Power Supply
4. Connecting wires

III. THEORY:

A decoder is a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs, where the input and output codes are different. The 74x138 is a commercially available MSI 3 to 8 decoder. It has an 3-bit binary input code and a 1-out-of-2^3 output code. The input code word A, B, C represents an integer in the range 0 –7, the output code word Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7 which are active low outputs has Yi equal to 1 if and only if the input code word is the binary representation of 'i' and G1 = 1 , G2 A_L = 0, G2 B_L = 0, where G1, G2A_L, G2B_L are three enable inputs. An output is asserted if and only if the decoder is enabled and the output is selected.

PIN configuration:



Truth table

7 a 74x138 3-to-8 decoder.

Inputs						*Outputs*							
G1	G2A_L	G2B_L	C	B	A	Y7_L	Y6_L	Y5_L	Y4_L	Y3_L	Y2_L	Y1_L	Y0_L
0	x	x	x	x	x	1	1	1	1	1	1	1	1
x	1	x	x	x	x	1	1	1	1	1	1	1	1
x	x	1	x	x	x	1	1	1	1	1	1	1	1
1	0	0	0	0	0	1	1	1	1	1	1	1	0
1	0	0	0	0	1	1	1	1	1	1	1	0	1
1	0	0	0	1	0	1	1	1	1	1	0	1	1
1	0	0	0	1	1	1	1	1	1	0	1	1	1
1	0	0	1	0	0	1	1	1	0	1	1	1	1
1	0	0	1	0	1	1	1	0	1	1	1	1	1
1	0	0	1	1	0	1	0	1	1	1	1	1	1
1	0	0	1	1	1	0	1	1	1	1	1	1	1

PROCEDURE:

1. Connect the circuit as per the pin diagram.
2. Apply the inputs as shown in the truth table and observe the outputs.

OBSERVATIONS : Verify the Truth table

Conclusion: The Functionality of 3-to-8 decoder is verified using IC74138.

Experiment No. 5

4-BIT Comparator 74LS85

I. **AIM:** To verify the functionality of 4 bit comparator 74LS85 with hardware

II. **EQUIPMENTS AND COMPONENTS:**

(i) **APPARATUS**

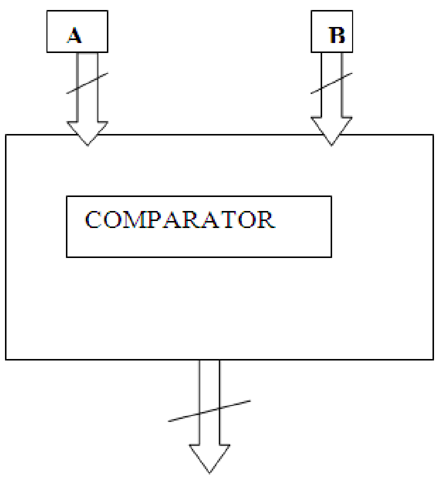
1. Digital IC Trainer kit with IC 74LS85
2. Regulated Power Supply
3. Connecting wires

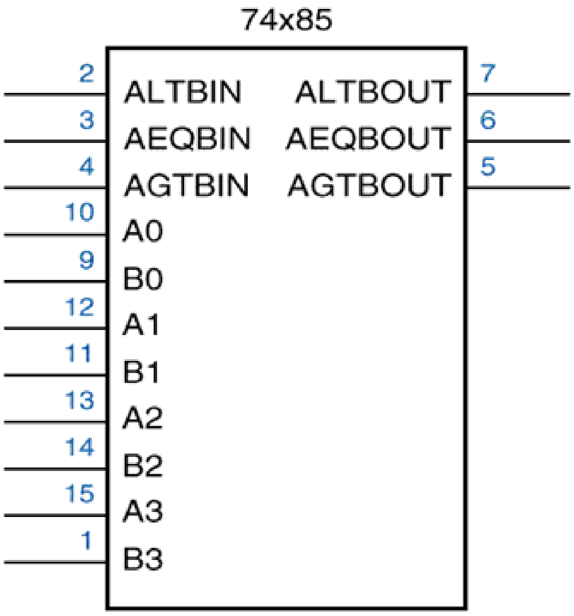
III. **THEORY:**

A single bit comparator circuit has 2 data inputs, three control inputs and there compare outputs. The 3 control inputs provide a mechanism for generation of multi bit comparators by cascading several bit comparators.

A 4 bit comparator consists of two 4 bit data inputs 3 control inputs, and 3 compare outputs. The functionality of these circuits is similar to that of the bit comparator. The a>b output is 1 when data on the a input, treated as 4-bit positive number is greater than the 4-bit positive on b or when data on a and b are w\equal and the greater than input is 1. this statement uses a for loop with index I changing from 1 to 2. the outputs are named a_gt_b, a_eq_b, a_lt_b, which are same as primary outputs of a nibble comparator.

Hardware Implementation:





Truth table:

INPUT A A3 A2 A1 A0	INPUT B B3 B2 B1 B0	ALTBOUT	AGTBOUT	AEQBOUT

PROCEDURE:

1. Connect the circuit as per the pin diagram.
2. Apply the inputs to A and B inputs and observe the outputs.
3. Verify the output with theoretical outputs.

Conclusion: The Functionality of 4-Bit Comparator is verified by IC 74LS85.

Experiment No.6

8 x 1 Multiplexer-74151 and 1X4 Demultiplexer - 74155

I. AIM: To verify the functionality of 8 x 1 Multiplexer-74151 and 2X4 Demultiplexer – 74155 with hardware

II. EQUIPMENTS AND COMPONENTS:

APPARATUS

1. Digital IC Trainer kit
2. IC 74LS151, IC 74LS155
3. Regulated Power Supply
4. Connecting wires

III. THEORY:

IC 74151(MULTIPLEXER)

Multiplexing means transmitting a large number of information units over a smaller number of channels or lines. A digital multiplexer is a combinational circuit that selects binary information from one of many inputs lines and directs it toa single output line. Normally there are 2^n input lines and n selection lines whose bit combinations determine which input is selected. The selection depends onset of selection lines. Also called as selector.

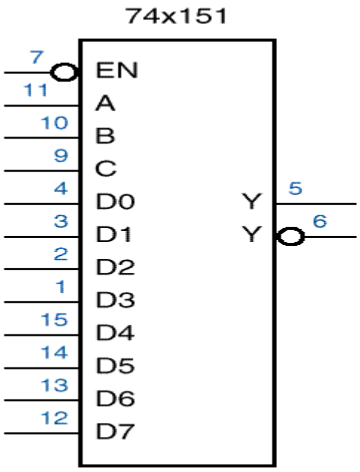
In 8to1 multiplexer, there are 3 select lines and 23 minterms by connecting the function variables directly to select inputs, a multiplexer can be made toa select and AND gate that corresponds to the minterms in the function.

The figure shows an 8-1 multiplexer. It has eight inputs. It provides two outputs, one is active high, and the other is active low.

IC 74155 (2-to-4 LINE DEMULTIPLEXER)

Demultiplexer is a combinational circuit that accepts single input and distributes it several outputs (Selectively distributes it to 1 of N output channels) & Exhastly reverse of the multiplexer

Pin configuration of IC 74151:



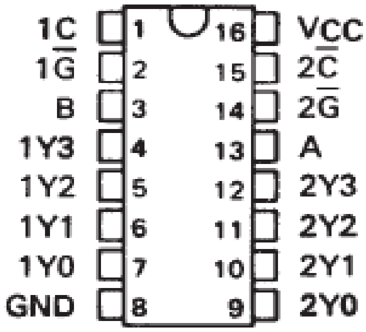
8-GND, 16-VCC

Truth Table of IC 74151

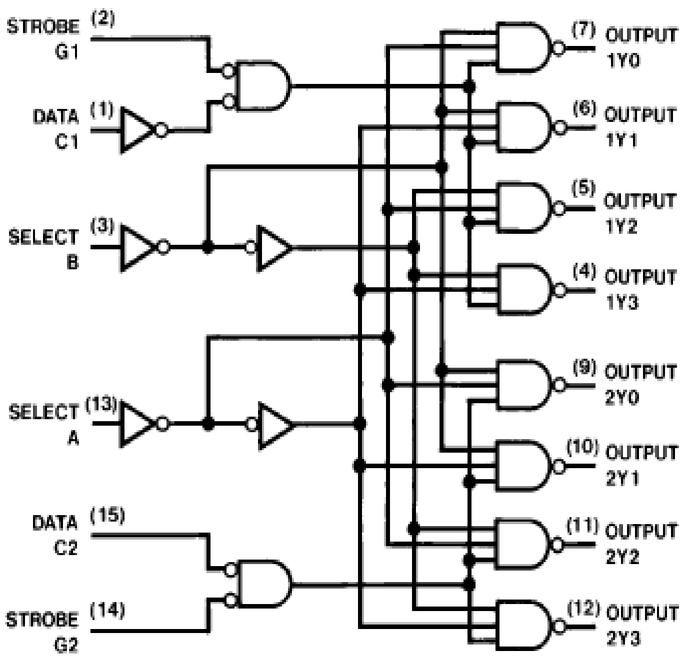
Select i/p				**Output**
EN_L	**C**	**B**	**A**	**Y**
1	X	X	X	0
0	0	0	0	D_0
0	0	0	1	D_1
0	0	1	0	D_2
0	0	1	1	D_3
0	1	0	0	D_4
0	1	0	1	D_5
0	1	1	0	D_6
0	1	1	1	D_7

.

Pin Diagram of IC 74155:



Logic Diagram of IC 74155:



Truth Table of IC 74155:

INPUTS				OUTPUTS			
SELECT		STROBE	DATA				
B	A	$1\overline{G}$	1C	1Y0	1Y1	1Y2	1Y3
X	X	H	X	H	H	H	H
L	L	L	H	L	H	H	H
L	H	L	H	H	L	H	H
H	L	L	H	H	H	L	H
H	H	L	H	H	H	H	L
X	X	X	L	H	H	H	H

PROCEDURE:

1. Connect the circuit as per the pin diagram.
2. Apply the inputs as shown in the truth table and observe the outputs.

.

Conclusion: The functionality of 8x1 multiplexer and 1x4 line demultiplexer is verified by using ICs.

Experiment No.7

RAM 16 x 8 (Read and Write Operation)

I. AIM: To verify the functionality of RAM 16 x 8 (Read and Write Operation) with hardware

II. EQUIPMENTS AND COMPONENTS:

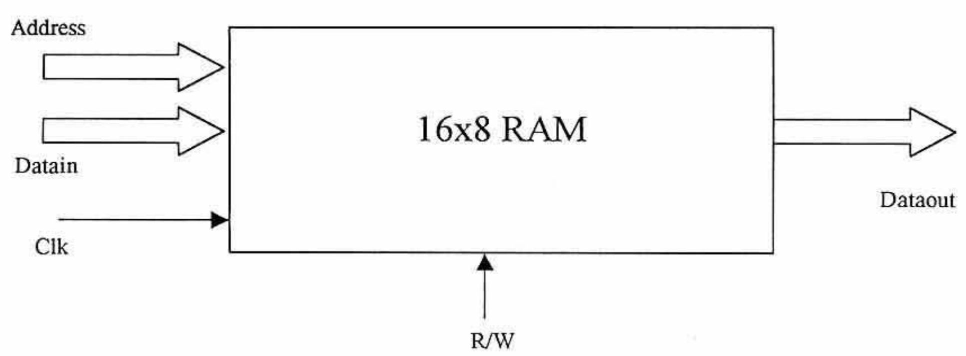
APPARATUS

1. Digital IC Trainer kit
2. Regulated Power Supply
3. Connecting wires.

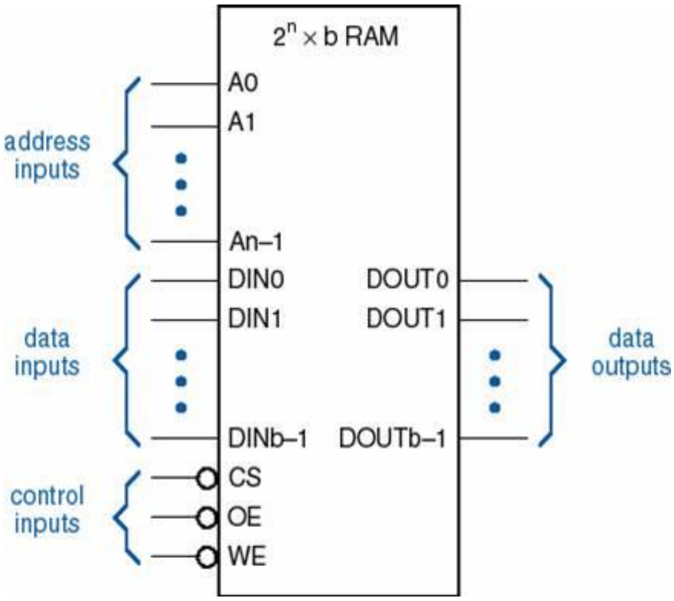
III. THEORY

Hardware Implementation:

A model for Synchronous RAM with Read/Write Enable is shown below:



Block Diagram:



TRUTH TABLE:

ME	WE	Operation	Condition Outputs
L	L	Write	Complement of data inputs
L	H	Read	Complement of selected word
H	L	In bit storage	Complement of data inputs
H	H	Do nothing	High

OBSERVATIONS: Verify the truth Table.

EXERCISE:

1. Write a VHDL code for Generic ROM.

Conclusion: The Functionality of 16x8 RAM(Read & Write operation) is verified by using software simulation and Hardware.

EQUIPMENT REQUIRED FOR LABORATORIES:

1. 20MHz / 40MHz / 60MHz Oscilloscope
2. 1 MHz Funciton Generator (Sine, Squire, Triangular and TTL)
3. Regulted Powe Supply
4. Multimeter / Volt Meter