INDEX

Sr. No.	Experiment Description	Page No. Experiment Date	Submission Date	Remarks/Signatures
1.	Verify the open loop transfer characteristics of Op-amplifier using IC-741.	1 to 2		
2.	Design square wave generator using IC-741 and calculate the duty cycle of the generated waveform.	3 to 5		
3.	Design an Astable Multi-vibrator using IC-555 timer and calculate the duty cycle and pulse width of the generated waveform.	6 to 8		

INDEX

Sr. No.	Experiment Description	Page No. / Experiment Date	Submission Date	Remarks/Signat
4.	Design 2nd order active low pass filter, active high pass filter, active band pass filter using IC 741 Op-amp.	9 to 11		
5.	Calculate the lock range and capture range of PLL using IC-565.	12 to 14		
6.	Design of binary adder and Subtractor.	15 to 18		
7.	Design of counter	19 to 22		
8.	Study of Multiplexer and demultiplexer/ decoder.	23 to 26		
9.	Implementation of combination logical ckt.	27 to 28		
10.	Study of ADC and DAC.	29 to 30		

A Gayal Product

Date : Page : 01

Topic : Experiment - 1

AIM:- Operational Amplifiers (IC 741) characteristics and applications

Apparatus-

- Op-Amp (IC-741)

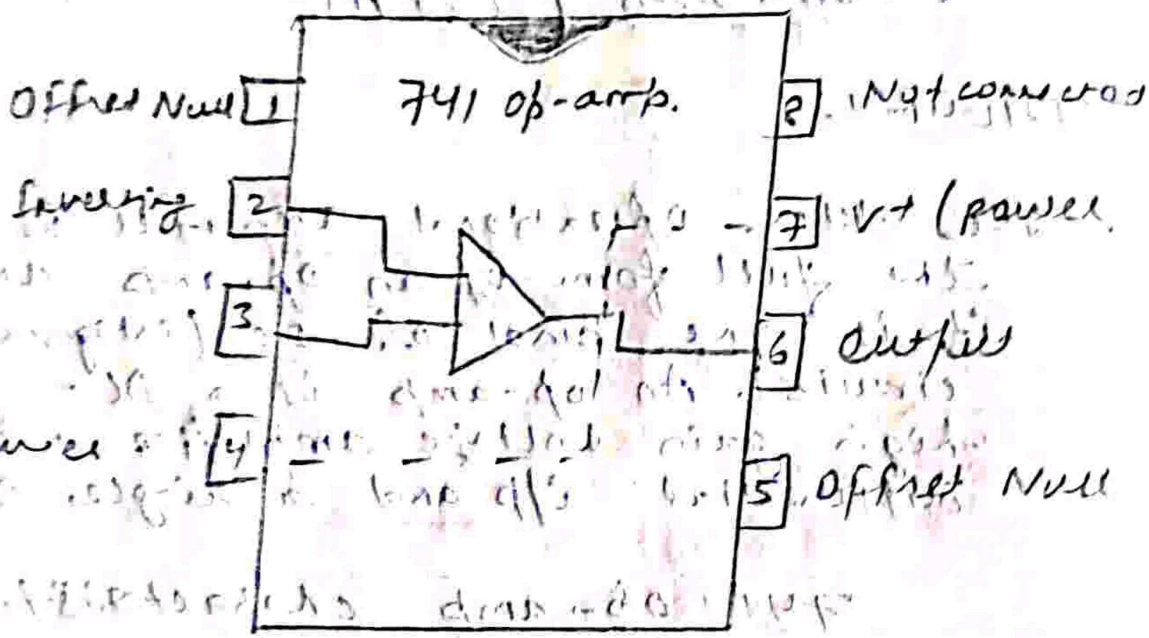
THEORY:-

The term operational amplifier is the full form of an op-amp and it is one kind of IC (integrated circuits). An op-amp is a DC-coupled high gain voltage amplifier with a differential i/p and a single o/p.

741 op-amp characteristics

The characteristics of the IC 741 operational amplifiers include the follow

→ The input impedance of the IC 741 op-amp is above 100 kilo-ohms.
→ The o/p of the IC 741 op-amp is below 100 ohms.
→ The frequency range of amplifier signals for IC 741 op-amp is from $0Hz - 1MHz$



DC 741 Pin-diagram

→ The offset current and offset voltage of the IC 741 op-amp is low.
→ The voltage gain of the IC-741 is about 2,00,000.

741 op-amp applications.

There are many el. circuits are built with IC 741 op-amp namely voltage follower, analog-digital converter, sample and hold ckt, the voltage to current and current to voltage converting.
→ Variable audio frequency oscillator using IC-741 op-amp.
→ IC 741 op-amp based adjustable ripple RPS.
→ Audio mixture for four channels using IC-741 op-amp.
→ IC-741 op-amp and LDR based automatic light operated switch.
→ e-room thermometer using IC 741 op-amp.
→ Microphone amplifier using IC 741 op-amp.
→ Thermal touch switch using IC741 op-amp.
→ Conversion of V to F using IC741 op-amp.

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Date _____ Page 03

Topic: Experiment - 7

AIM:- Waveform Generation using Op-amp (RC

APPARATUS:-

- Op-amp IC 741 - 2 No.
- Bread board
- Capacitor 0.1 μF - 3 No.
- RPS (0-30 V) - 1 No.
- Resistors - 10 kΩ - 2 No, 470 kΩ - 1 No, 1 kΩ - 3
- connecting wires
- CRO (20 MHz)

THEORY:-

RC oscillator is build using an amplifier and RC network in feedback. For any oscillator the two prime requirements to generate sustained and constant oscillations are -

(i) The total phase shift around loop must be 0° to 360° degrees.

(ii) The loop gain should be equal to unity.

- This known as "Barkhausen Criterion".

The circuit oscillates at a frequency, $F = \frac{1}{2\pi RC\sqrt{6}}$

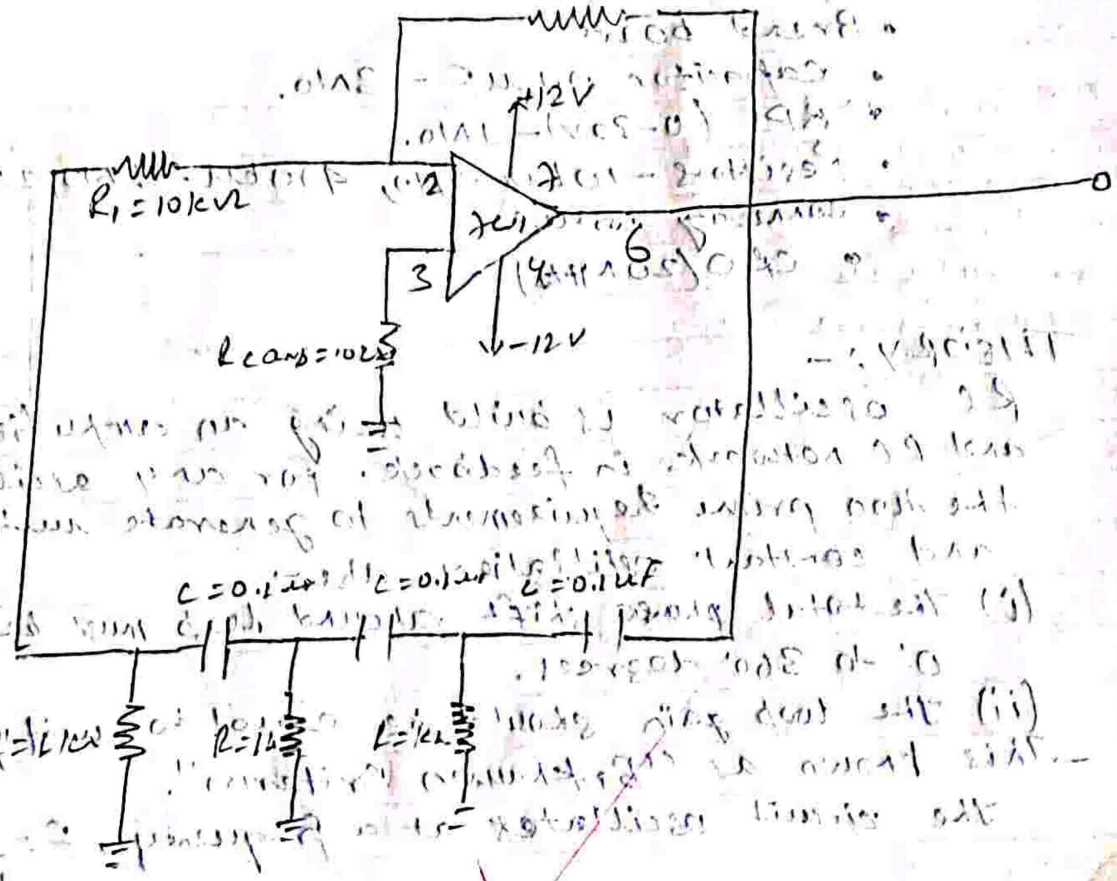
The common equation for the time period can be simplied as -

$T = 2.1976 R_1 C_1$.

The frequency can be determined by the equation, $F = \frac{1}{T}$.

Circuit diagrams:

Sine wave Generator: (RC phase shift oscillator)



PROCEDURE:-

for sine wave generation

(i) Connect the circuits as per the circuit diagram.

(ii) Give +12V, -12V and ground to circuit from power supply.

(iii) Observe the output on the CRO.

(iv) Calculate theoretical and practical output signal frequency and compare them.

for square and Triangular wave generation

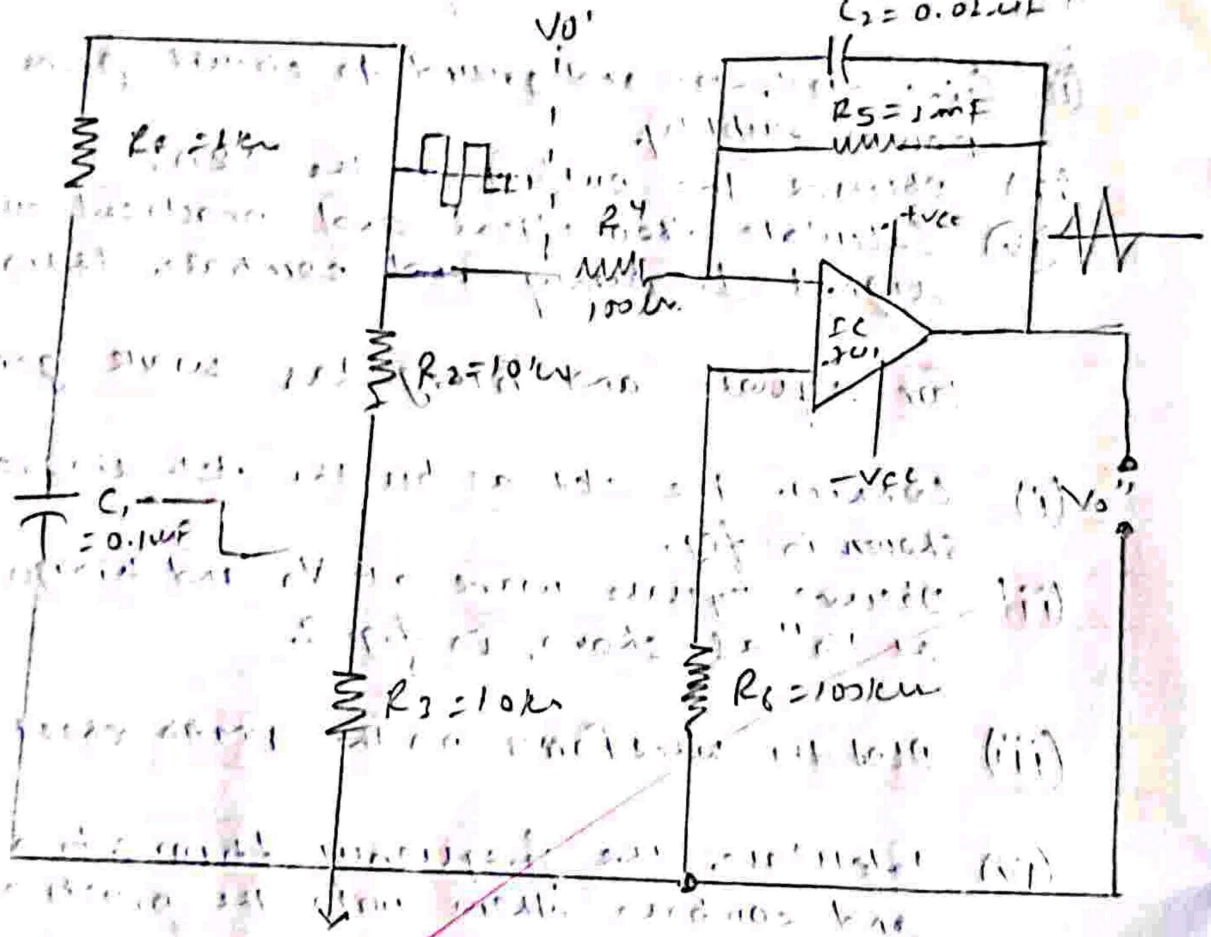
(i) Connect the ckt as per the ckt diagram shown in fig.

(ii) Observe square wave at V_0 and triangular at V_0'' as shown in fig. 3.

(iii) Plot the waveforms on the graph sheet.

(iv) Calculate the frequency theoretically and compare them with the practical one.

Square and Triangular wave Generator



RESULT :-

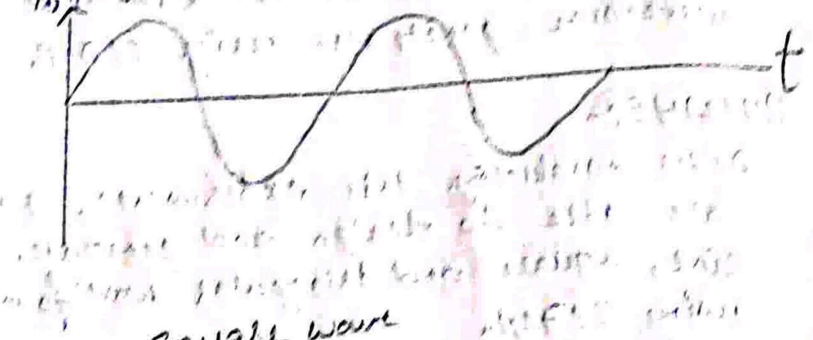
Designed and verified the waveforms of waveform generator using IC741.

OUTCOME :-

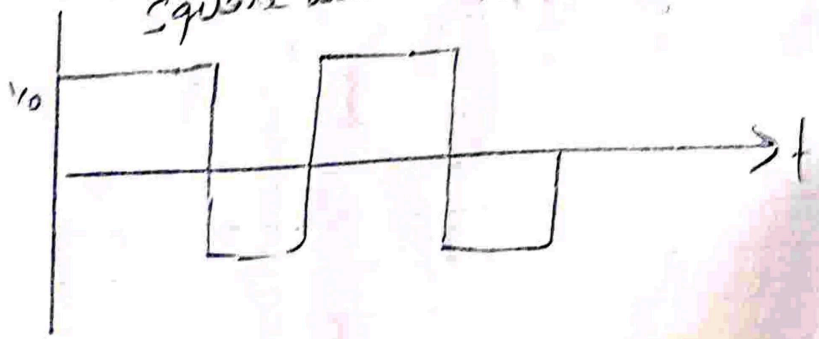
After conducting this experiment, students are able to design and generate sine, square and triangular waveforms using IC741.

Expected Waveforms:

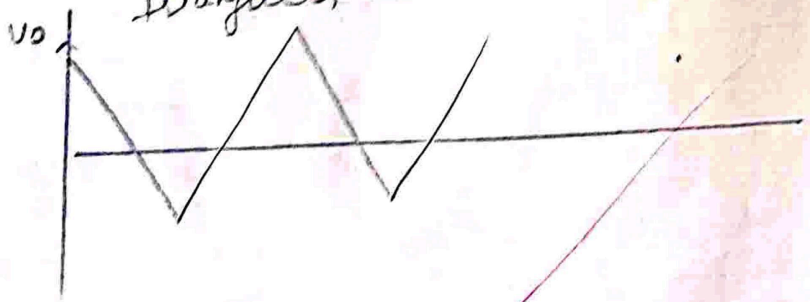
Sine wave



Square wave



Triangular wave.



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Date : Page : 06

Topic : Experiment - 3

AIM:- Applications of timer IC555.

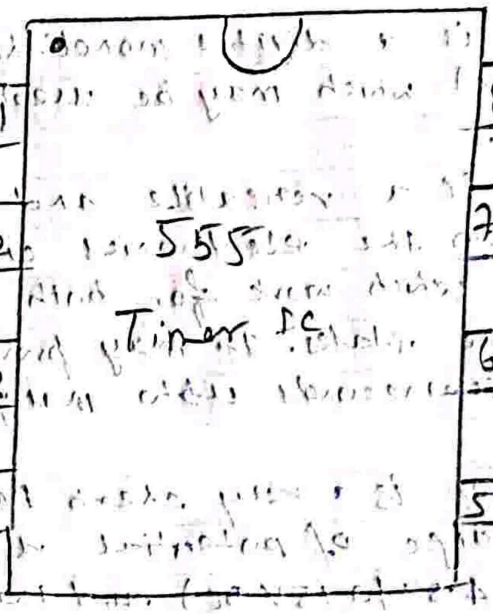
THEORY:-

555 Timer is a digital monolithic integrated circuit (IC) which may be used as a clock generator.

555 Timer is a versatile and most usable device in the electronics circuits and designs which work for both stable and monostable states. It may provide time delay from microseconds upto many hours.

555 timer is a very cheap IC which works for wide range of potential difference (typically from 4.5 to 15V DC) and the different provided input voltages do not affect the timer output.

555 Timer is a linear device and it can be directly connected to the CMOS or TTL (Transistor-Transistor logic) digital circuits due to its compatibility but, interfacing is must to use 555 timer with other signal digital circuits.



555 Timer IC pin diagram

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Date :

Page : 07

Topic : Experiment - 3

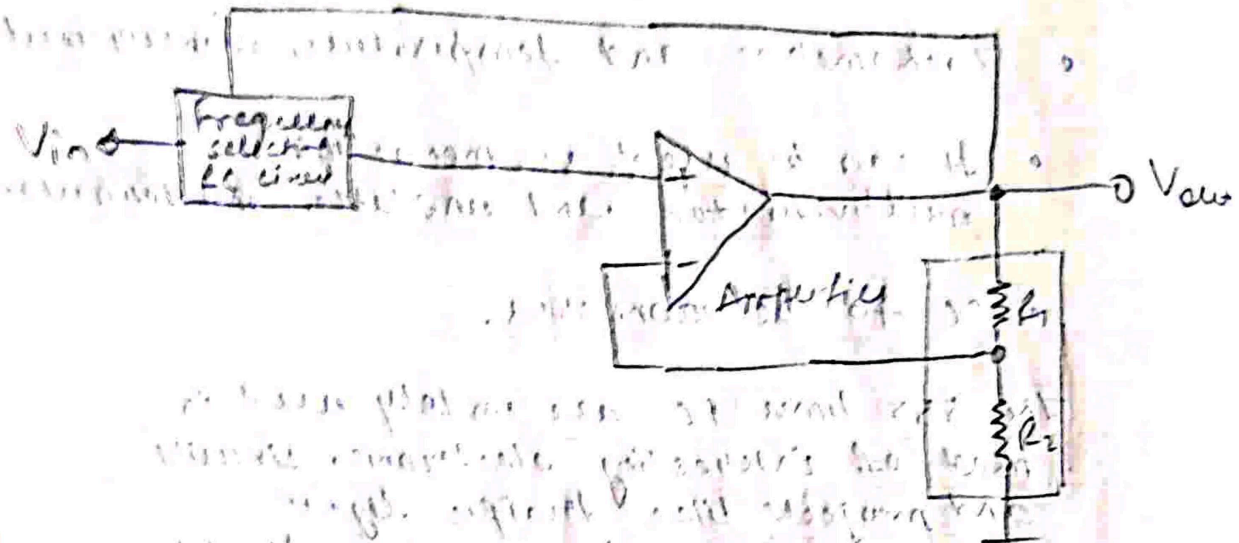
Applications of 555 timer.

555 timer is most important integrated circuit (chip) used widely in digital electronics. Some common use and application of 555 timer IC are as follow-

- PWM (pulse width modulation) & PPM (Pulse Position modulation)
- Duty cycle oscillator
- Lamp Dimer
- To provide accurate time delays.
- As a flip-flop element
- Digital logic probes
- Analog - frequency meters
- Quad Timer Applications
- Pulse, Waveform and Square wave generation.

- Stepped tone and tone burst generator and linear ramp generation.
- Tachometres and temperature measurement.
- It can be used as monostable multivibrator and unstable multivibrator.
- DC to DC converter.

The 555 times IC are widely used in most of interesting electronic circuits and projects like traffic light circuit using 555 times, LED flashing circuits, police siren, LED dice, Joystick and game paddles and low cost line recievers, clap switch activated circuit and lots of other projects and circuits design.



Negative feedback circuit

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Date : Page 09

Topic : Experiment - 1

AIM:- Design of Active filter.

THEORY:-

An active filter is a type of filter that includes one or more active circuit components such as a transistor or an operational amplifier (Op-amp). They derive their energy from an external source of energy and use it to increase or amplify signal output.

An Op-amp has a high input impedance, a low output impedance and a voltage gain within its feedback loop arising from the mixture of the resistor.

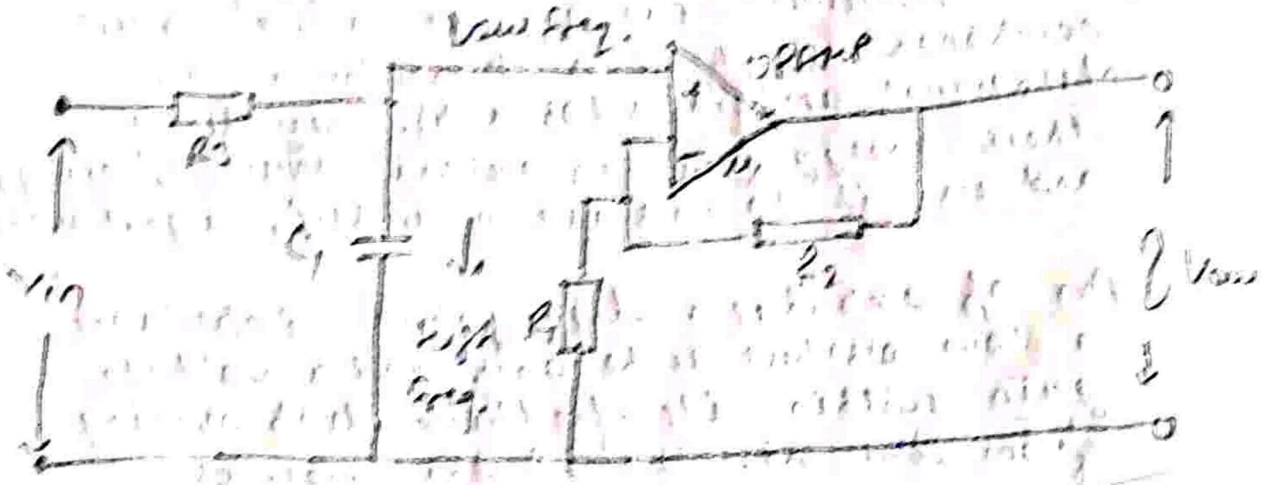
⇨ Active Low Pass filter.

The frequency response of Active low pass filter is same as that of the passive low pass filter, except the amplitude of the output signals. The voltage gain of the non-inverting operational amplifier is given as -

$$A_F = 1 + (R_2/R_1).$$

The gain of active low pass filter is given as -

$$A_V = \frac{V_{out}}{V_{in}} = \frac{A_F}{\left[1 + (f/f_c)^2\right]}$$



- Active low pass filter circuit diagram.

Where, • Af is the pass band gain $(1+R_2/R_1)$
• f is the frequency of input signal
• fc is the cut off frequency.

⇒ Active High Pass filter.

The simple Active high pass filter can be obtained by cascading a non-inverting or inverting operational amplifier to the passive high pass RC ckt.

In active high pass filter pass band is limited due to the open loop characteristics of op-amp. The gain of active high pass filter is given as -

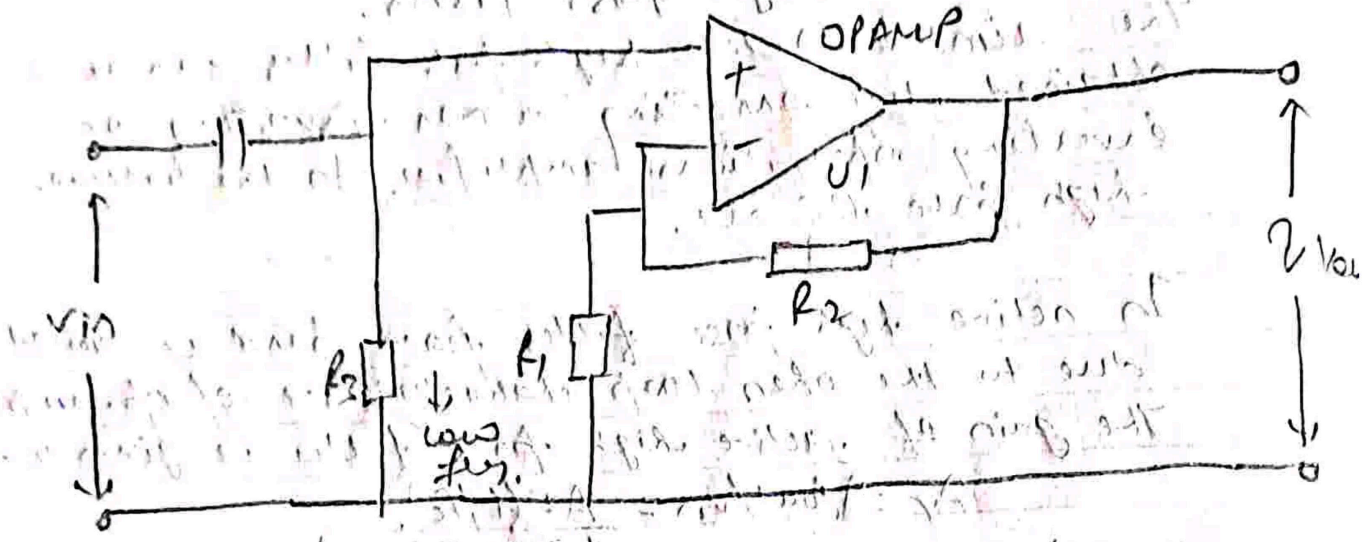
$$Ar = Vout/Vin = \frac{Af(f/fc)}{\sqrt{(1+(f/fc)^2)}}$$

Where, • Af is the pass band gain $(1+R_2/R_1)$
• f is the frequency of input signal.
• fc is the cut-off frequency.

Voltage gain in dB is given as -

$$Ar(dB) = 20\log_{10}(Vout/Vin)$$

$$-3dB = 20\log_{10}(0.707 \times Vout/Vin)$$



• Active High Pass filter ckt. Diagram

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Date: Page: 1

Topic: Instrument - 1

⇨ Active Band Pass filter.

Band Pass is a filter is frequency selective filter used in electronic system to allows a particular band or certain range of frequency. The range of frequencies is set between these cut-off frequency. (f_L, f_H).

The cascade connection of low pass filter and high pass filter produces a high "Quality factor" type filter which has wide pass band.

AIM:- Study and application of PLL IC.

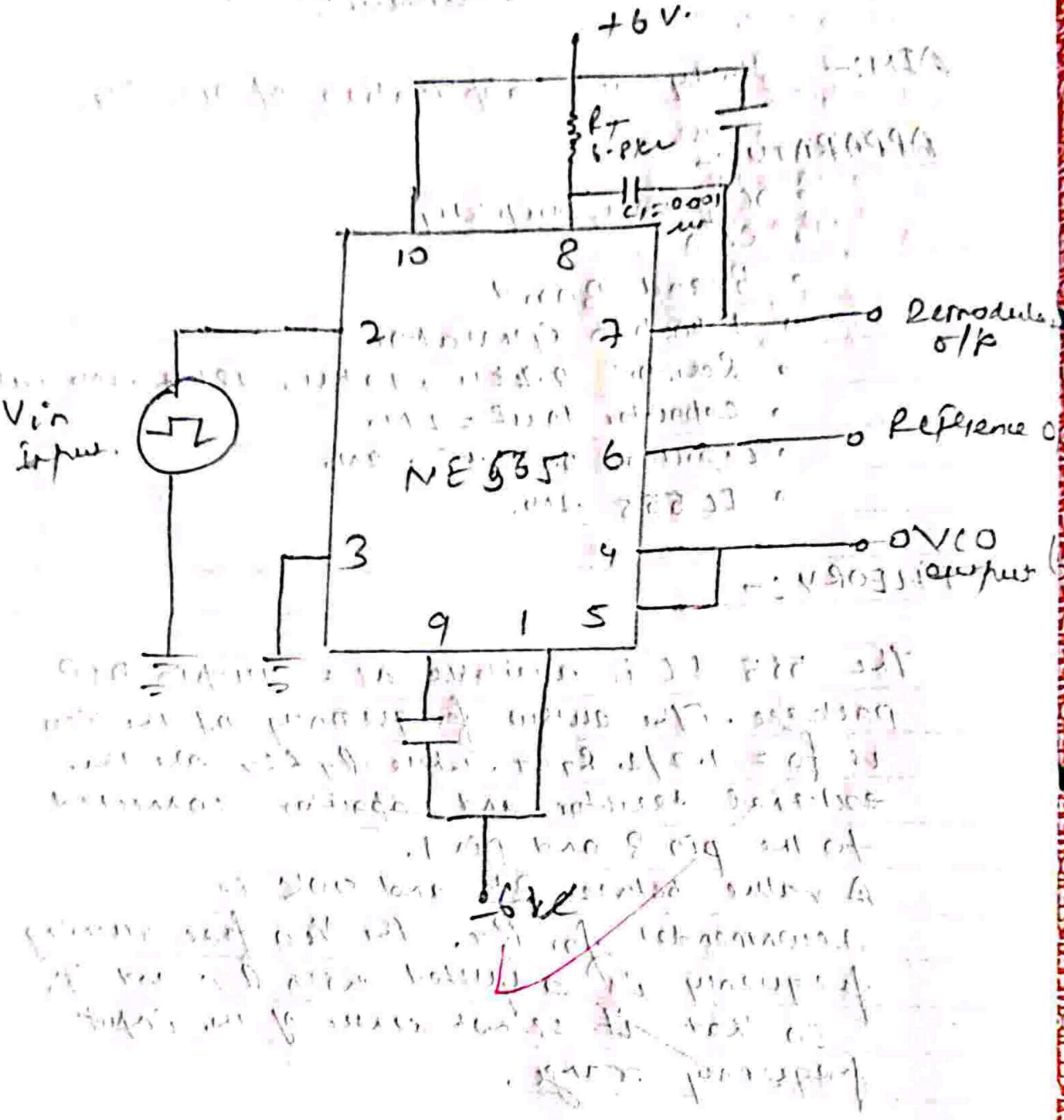
APPARATUS:-

- DC power supply
- CRO
- Bread Board
- Function Generator
- Resistors 2.2kΩ, 10kΩ, 18kΩ - 1No each
- Capacitor 10nF = 1 No
- Capacitor 0.01μF - 2No
- IC 565 - 1No.

THEORY:-

The 565 IC is available as a 14-pin DIP package. The output frequency of the VCO is $f_0 = 1.2/4 R_1 C_1$. where R_1 & C_1 are the external resistor and capacitor connected to the pin 8 and pin 9.
A value between 2kΩ and 20kΩ is recommended for R_1. The VCO free running frequency is adjusted with R_1 and C_1, so that it is not center of the input frequency range.

Circuit diagram:



PROCEDURE:-

(i) Connect the circuit as shown in fig.

(ii) Measure the free running frequency of Vco at pin 4 with the input signal Vin = zero. Compare it with the calculated value = 1.2/4R+CT.

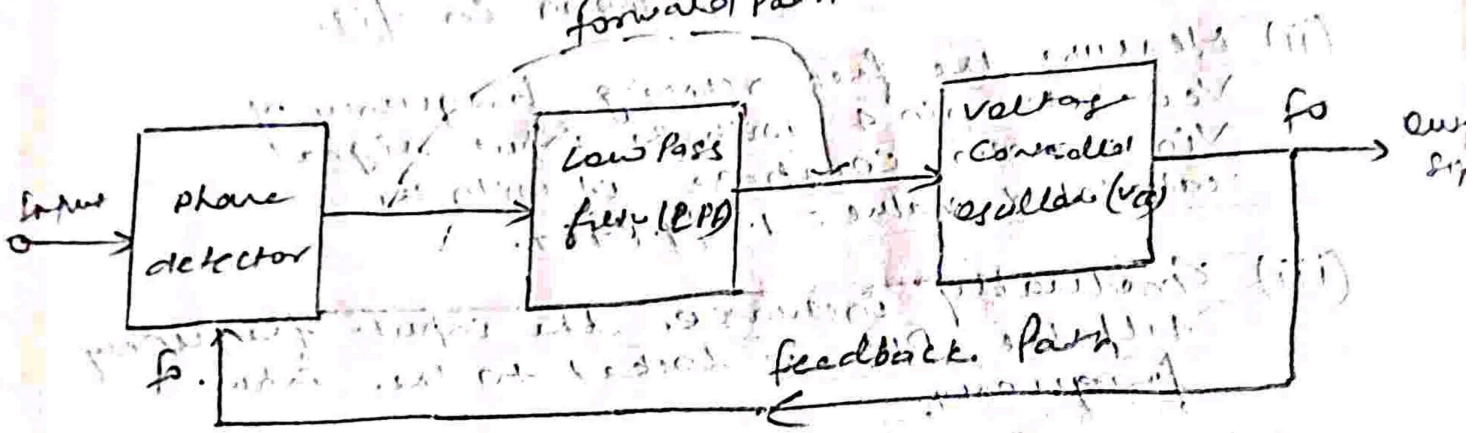
(iii) Gradually increase the input frequency till the PLL is locked to the input frequency.

(iv) This frequency fc1 gives the lower end of the capture range.

(v) If the input frequency is increased further the loop will be in unlocked condition only.

(vi) Now gradually decrease the input frequency till the PLL is again get locked This is the frequency fc2, the upper end of the capture range.
Keep on decreasing the input frequency

PLL Block diagram



A Good Product Page 10

Date Experiment 5
Topic

until the loop is un-locked. This frequency fL gives the lower end of the hard range.

RESULT:-

fo free running frequency.

fL lower locking frequency:

fcL lower capture frequency:

fcH higher capture frequency:

fLH higher locking frequency:

OUTCOME:-

After conducting this experiment, students are able to understand the applications of PLL.

AIM:- Design of Binary Adder and Subtractor.

THEORY:-

(Half Adder)

Half adder is a combinational logic circuit with two inputs and two outputs. The half adder ckt is designed to add two single bit binary number A and B. It is the basic building block for addition of two single bit numbers. The circuit has two output carry and sum.

Truth Table :-

Input		Output	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

(Full Adder)

Full adder is developed to overcome the drawback of Half Adder ckt. It can add two one-bit numbers, A and B, and carry C. The full adder is a three input and two output combinational ckt.

Truth Table:

Inputs			Outputs	
A	B	Cin	S	Co
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

(Half Subtractor)

Half subtractor is a combinational ckt with two input and two output.
It produces the different between two binary bits at the input and also produces an output (Borrow). to indicate if a 1 has been borrowed. In the subtraction (A-B), A is called as Minuend bit and B is called as Subtrahend bit.

Truth Table.

Input		Output	
A	B	(A-B)	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

(Full Subtractor)

The disadvantage of a half subtractor is overcome by full subtractor. The full subtractor is a combinational circuit with three inputs A, B, C and two output D and C'. A is the "minuend" produced by the previous stage D is the difference output and C is the borrow output.

Truth Table

Inputs			Outputs	
A	B	C	(A-B-C)	C'
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

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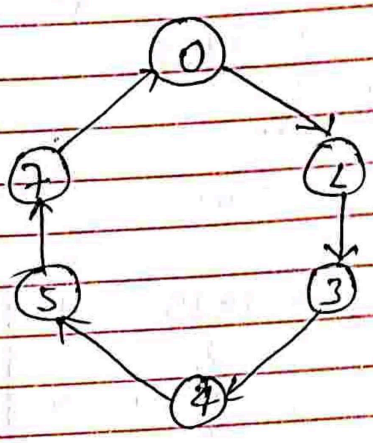
Date : Page : 19

Topic : Experiment - 7

AIM :- Design of Counter.

Problem :- Design synchronous counter for sequence :
$0 \rightarrow 1 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 7 \rightarrow 0$, using T- flip-flop.

Explanation :- for given sequence, state transition diagram as following below



State transition table logic -

Present State	Next State
0	1
1	3
3	5
5	7
7	0

A Gogel Product

Date :

Page : 20

Topic : Experiment 7

State transition table for given sequence :-

Present state				Next state	
Q_3	Q_2	Q_1	$Q_3(t+1)$	$Q_2(t+1)$	$Q_1(t+1)$
0	0	0	0	0	1
0	0	1	0	1	1
0	1	1	1	0	0
1	0	0	1	0	1
1	0	1	1	1	1
1	1	1	0	0	0

T flip-flop :- If value of Q changes either from 0 to 1 or from 1 to 0 then input for T flip-flop is the input value is 0.

Q_t	Q_{t+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

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Date _____ Page 21

Topic Experiment 7.

Input Table of flip-flops.

T_3	T_2	T_1
0	0	L
0	L	0
1	L	L
0	0	L
0	L	0
1	L	L

find value of T_3, T_2, T_1 in terms of Q_3, Q_2, Q_1 using K-map (Karnaugh Map).

T_3 / $Q_3 Q_2 / Q_1$	00	0L	11	10
0	0	0	1	x
L	0	0	L	x

Therefore,
$T_3 = Q_2$.

T_2 / $Q_3 Q_2 Q_1$	00	0L	11	10
0	0	L	L	x
L	0	L	L	x

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Date _____ Page 22

Topic Experiment 7

Therefore, $T_2 = Q_1$

T_1 / $Q_3 Q_2 Q_1$	00	01	11	10
0	1	1	0	x
1	1	1	0	x

Therefore,

$T_1 = Q_2$.

Now, you can design sequential circuit using expressions of K-maps.

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Date : Page : 23

Topic : Experiment - 8

AIM:- Study of Multiplexer and demultiplexer / decoders.

THEORY:-

(MULTIPLEXER)

Multiplexer means many into one. A multiplexer is circuit used to select and route any one of the several input signals to a single output. A simple example is a single pole multi-position switch..

Multiplexer can handle two type of data.
i.e Analog and Digital.

for analog application, multiplexers are built using relays and transistor switches.

for digital application they are built from standard logic gates.

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Date : Page : 74

Topic : Experiment 8

The multiplexer used for digital applications, also called digital multiplexer, is a circuit with many input but only one output.

By applying control signals (also known as select signals), we can steer any input to the output.

Some of the common types of multiplexer are 2 to 1, 4 to 1, 8-to-1 and 16-to-1 etc. multiplexer.

Application of multiplexer.

Multiplexer are used in various fields where multiple data need to be transmitted using a single line.

Following are some of the applications of multiplexer.

- Communication System -
  It is a set of system that enable communication like transmission system, relay and tributary station and communication network.

- Telephone Network -
  In telephone network, multiple audio signals are integrated on a single for transmission with the help of multiplexers.

- Computer Memory :-
  Multiplexers are used to implement huge amount of memory into the computer and the same time reduces the number of copper lines required to connect the other parts of computer.

- Transmission from the computer system of a satellite -
  Multiplexer can be used for the transmission of data signals from the computer system of a satellite or spacecraft, etc.

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Date : Page : 26

Topic : Experiment - 8

(DEMULTIPLEXER.)

Demultiplexer means one to many. A demultiplexer is a circuit with one input and many output.

By applying control signal, we can steer any input to the output.

Eg of demultiplexer as 1 to 2, 1 to 4, 1 to 8, 1 to 16 etc.

Applications of demultiplexer.

It is used to connect a single source to multiple destinations.

The main application area of demultiplexer is communication system, where multiplexers are used.

Most of the communication system are bidirectional (i.e they function in both ways: transmitting and receiving signals).

Hence, for most of the application, the multiplexer work in syn. demultiplexer are also used for reconstruction of parallel data and ALU circuit.

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Date : Page : 27

Topic : Experiment - 9

AIM:- Implementation of combinational logic circuits.

THEORY:-

The implementation of boolean function using decoders was already discussed in the experiment's.

The same approach is applicable in the case ROM, since ROM is the device that includes both a decoder and OR gates within the same chip.

The blowing off of appropriate fuses or opening the links is referred to as programming.

The designer needs only to specify a ROM program table that provides information for the required pairs in the ROM.

Example : Find the squares of 3-bit Number.

Solution: This example has already discussed and implemented with the classical method in chapter-5

There are 3 input variables and six output functions.
To implement with ROM a, 2³ × 6 ROM or 8×6 ROM is required.

Decimal	X Y Z	Decimal	A B C D E F
0	0 0 0	0	0 0 0 0 0 0
1	0 0 1	1	0 0 0 0 0 1
2	0 1 0	4	0 0 0 1 0 0
3	0 1 1	9	0 0 1 0 0 1
4	1 0 0	16	0 1 0 0 0 0
5	1 0 1	25	0 1 1 0 0 1
6	1 1 0	36	1 0 0 1 0 0
7	1 1 1	49	1 1 0 0 0 1

AIM :- Study of DAC and ADC

Background :-

Digital-to Analog converters (DACs) and analog-to-digital converters (ADC) are important building blocks which interface sensors (Eg. temperature, pressure, light, sound, counting speed or car) to digital systems such as microcontrollers or PCs.

(Digital to Analog converter)

Addition of digital inputs (0 or 1) where say 1 corresponds to 5 volts give rise to analog output, which can be added with different weights considering their place in binary number. But this type of circuit has a disadvantage of requirement of huge number of accurate resistors for high number of bits. Eg. 8 bit converter requires eight resistor ranging from some value R to 128 R.

(Analog-to-digital converter)

Analog to digital converter is for conversion of analog input (any physical quantity such as temp) to digital output in binary form. (which can be read by computer) and further it can be converted to binary decimal format.