LIC APPLICATIONS

LABORATORY MANUAL

R19

III / IVB.TECH ECE

I– SEMESTER

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SIR C.R.REDDY COLLEGE OF ENGINEERING
ELURU – 534 007

List of Experiments

Minimum Twelve Experiments to be conducted:

1. Study of OP AMPs – IC 741, IC 555, IC 565, IC 566, IC 1496 – functioning,parameters andSpecifications.
2. OP AMP Applications – Adder, Subtractor, ComparatorCircuits.
3. Integrator and Differentiator Circuits using IC741.
4. Active Filter Applications – LPF, HPF (firstorder)
5. Active Filter Applications – BPF, Band Reject (Wideband) and NotchFilters.
6. IC 741 Oscillator Circuits – Phase Shift and Wien BridgeOscillators.
7. Function Generator using OPAMPs.
8. IC 555 Timer – Monostable OperationCircuit.
9. IC 555 Timer – Astable OperationCircuit.
10. Schmitt Trigger Circuits – using IC 741 and IC555.
11. IC 565 – PLLApplications.
12. IC 566 – VCOApplications.
13. Voltage Regulator using IC723.
14. Three Terminal Voltage Regulators – 7805, 7809,7912.
15. 4 bitDAC using OPAMP.

EXPERIMENTNO:1 **Date:**

STUDY OF OP-AMPS

AIM: To study the pin configurations, specifications & functioning of different integrated circuits used in the practical applications.

APPARATUSREQUIRED:

a) IC µA 741OP-Am
b) NE ISE 555/SE555C
c) VCO IC566
d) Phase Locked Loop NE/SE565
e) IC 723 VoltageRegulator
f) Three Terminal VoltageRegulators

a) µA 741 OP-AMP

Pinconfiguration

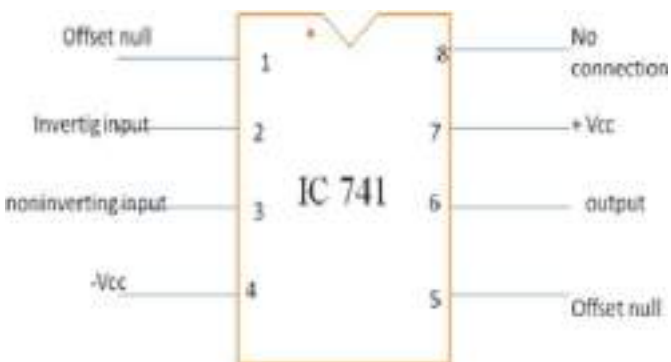


Fig 1.1 Pin diagram forIC741

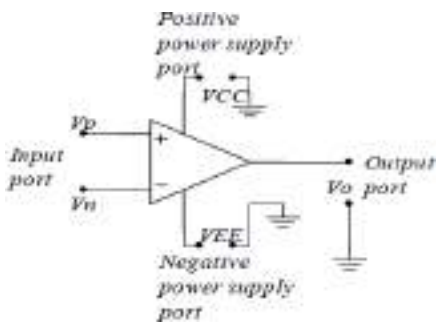


Fig 1.2 Symbol for IC741

The operational amplifier (op-amp) is a voltagecontrolled voltage source with very high gain. It is a five terminal four port active element. The symbol of the op-amp with the associated terminals and ports is shown in Figures.

The power supply voltages *VCC* and *VEE* power the operational amplifier and in general define the output voltage range of the amplifier. The terminals labeled with the "+" and the "-" signs are called non-inverting and inverting respectively. The input voltage Vp and Vn and the output voltage Vo are referenced to ground.

Specifications

1. Supplyvoltage:

µA 741A,µA741, µA741E	±22v
µA741C	±18v

2. Internal powerdissipation

Dippackage	310mw
Differentialinputvoltage	±30v

3.Operating temperature range	
Military(µA 741A, µA741)	-55^0 to $+125^0$ C.
4.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.PSRR	30µV/V.
8.Input resistance	2MΩ.
9.CMRR	90dB.
10. Output resistance	75Ω.
11. Bandwidth	1.0 MHz.
12. Slew rate	0.5 V/µ sec.

Applications of IC 741: Adder, substractor, comparator, filters, oscillators

b) NE / SE 555 TIMER

Pinconfiguration

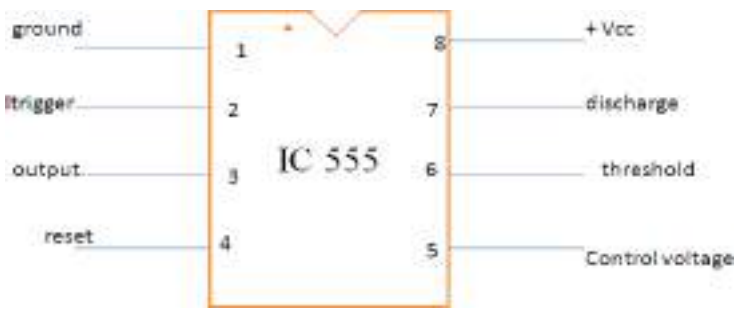


Fig 1.3 Pin diagram for IC 555

One of the most versatile linear ICs is the 555 timer which was first introduced in early 1970 by Signetic Corporation giving the name as SE/NE 555 timer. This IC is a monolithic timing circuit that can produce accurate and highly stable time delays or oscillation. Like other commonly used op-amps, this IC is also very much reliable, easy to use and cheaper in cost. It has a variety of applications including monostable and astable multivibrators**,** dc-dc converters, digital logic probes**,** waveform generators, analog frequency meters and tachometers, temperaturemeasurement and control devices, voltage regulators etc. The timer basically operates in one of the two modes either as a monostable (one-shot) multivibrator or as an astable (free-running) multivibrator.The SE 555 is designed for the operating temperature range from – 55°C to 125° while the NE 555 operates over a temperature range of 0° to70°C.

Specifications:

1. Supplyvoltage	4.5V to 18V
2. Supplycurrent	3mA
3. Outputvoltage(low)	0.1V
4. Outputvoltage(high)	12.5V &3.3V
5. Maximumoperatingfrequency	500kHz
6. Timing	µsec tohours

Applications of IC 555: Multivibrators, Oscillators, generation of PWM

c) IC 566 pinconfiguration

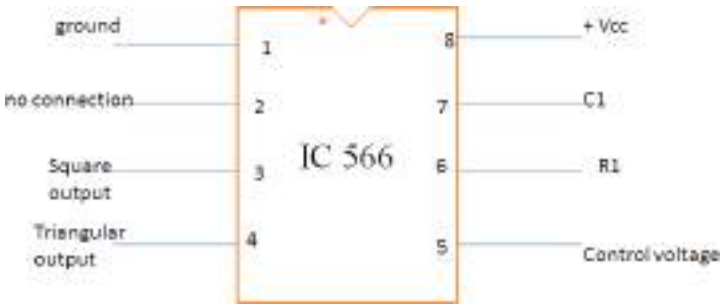


Fig 1.4 Pin diagram for IC 566

The NE/SE566 Function Generator is a voltage-controlled oscillator of exceptional linearity with buffered square wave and triangle wave outputs. The frequency of oscillation is determined by an external resistor and capacitor and the voltage applied to the control terminal. The oscillator can be programmed over a ten-to-one frequency range by proper selection of an external resistance and modulated over a ten-to-one range by the control voltage, with exceptional linearity

Specifications:

1. Operatingsupplyvoltage	12V to24V
2. Operating supplycurrent	12.5mA
3. Inputvoltage	$3V_{p-p}$
4. Operatingtemperature	0 to70^{o}C
5. Powerdissipation	30mw

Applications of VCO: Frequency modulation, Voltage to frequency converter

d) NE / SE 565 PHASE LOCKEDLOOP Pinconfiguration

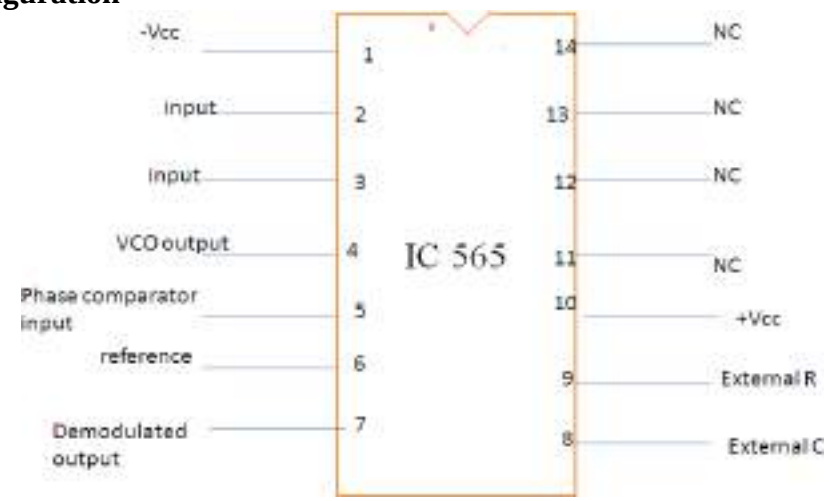


Fig 1.5 Pin diagram for IC 565

Specifications:

1. Maximumsupplyvoltage	26v
2. Input voltage	3v(p-p)
3. Powerdissipation	300mw
4. Operatingtemperaturerange	NE565-0^0 to 700C, SE 565-55to1250C
5. Supplyvoltage	12v
6. Supplycurrent	8mA
7. Outputcurrentsink	1mA
8. Outputcurrent source	10mA

Applications of IC 565: FM demodulation

e) IC 723 VOLTAGE REGULATOR

Pinconfiguration

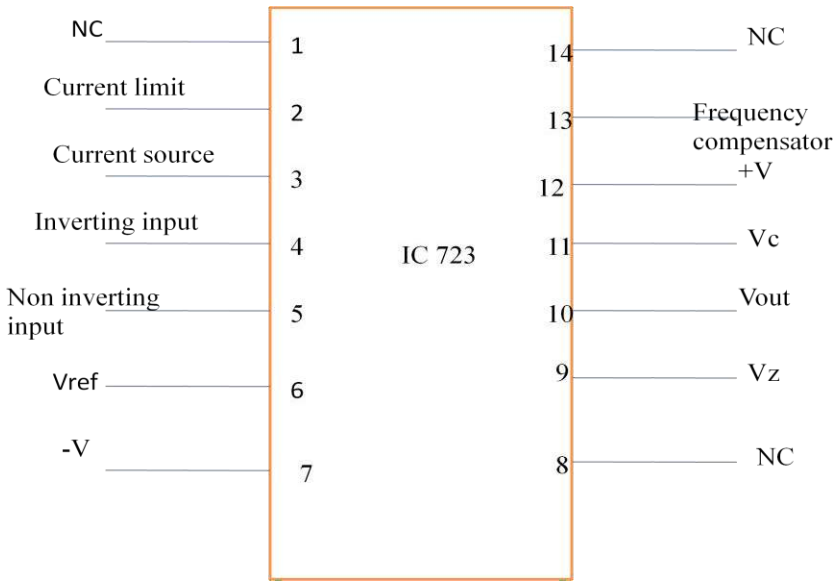


Fig 1.6 Pin diagram for IC 723

The 723 voltage regulator is commonly used for series voltage regulator applications. It can be used as both positive and negative voltage regulator. It has an ability to provide up to 150 mA of current to the load, but this can be increased more than 10A by using power transistors. It also comes with comparatively low standby current drain, and provision is made for either linear or fold-back current limiting. LM723 IC can also be used as a temperature controller, current regulator or shunt regulator and it is available in both Dual-In-Line and Metal Can packages. The input voltage ranges from 9.5 to 40V and it can regulate voltage from 2V to37V.

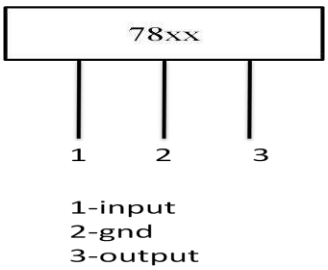
Specifications:

1. Input voltage	40v max
2. Output voltage	2v to 37v
3. Output current	150mA
4. Input regulation	0.02%
5. Load regulation	0.03%
6. Operating temperature	55^0C to125^0C

f) THREE TERMINAL VOLTAGEREGULATORS

i) IC 78XX (Positive VoltageRegulators)

Pinconfiguration

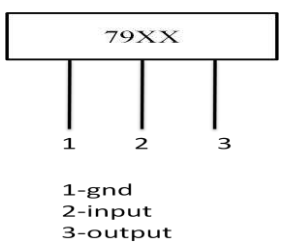


Specifications

1. Inputvoltage	
For 5V to 18Vregulatedoutput	35V.
Up up 24Vregulated output	40V.
2. Internalpower dissipation	internallylimited.
3. Storagetemperaturerange	-65^0 C to 150^0 C.
4. Operating junction Temperature range	
µA7800	-55^0 C to 150^0C.
µA7800C	0^0 C to 125^0C.

ii) IC 79XX (Negative VoltageRegulators)

Pinconfiguration



Specifications:

1. Inputvoltage	
For -5v to -18vregulatedoutput	-35V
For -24vregulatedoutput	-40V
2. Internalpowerdissipation	internallylimited
3. Storagetemperaturerange	-65^o C to 150^oC
4. Operating junction temperaturerange	
µA7800	-55^o C to 150^oC
µA7800C	0^o C to 125^oC

RESULT:

The pin configurations, specifications & functioning of different integrated circuits used in the practical applications have beenstudied

EXPERIMENTNO:2 **Date:**

APPLICATIONS OF OPERATIONAL AMPLIFIER (IC 741)

AIM: To design and study the operation of IC 741 Operational amplifier as

a) Adder
b) Subtractor
c) Comparator

APPARATUS REQUIRED:

1. BreadBoard.
2. FunctionGenerator
3. Cathode RayOscilloscope.
4. DigitalMultimeter.
5. Regulated Power Supply (DualChannel).
6. ConnectingWires.

COMPONENTS REQUIRED:

1. IC 741 :1No
2. Resistor……10kΩ :5No

CIRCUIT DIAGRAMS:

a) ADDER

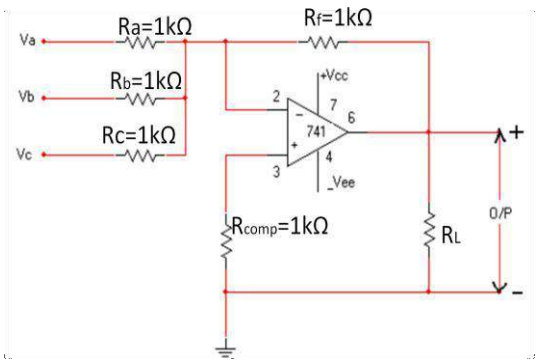


Fig 2.1 adder

b) SUBTRACTOR

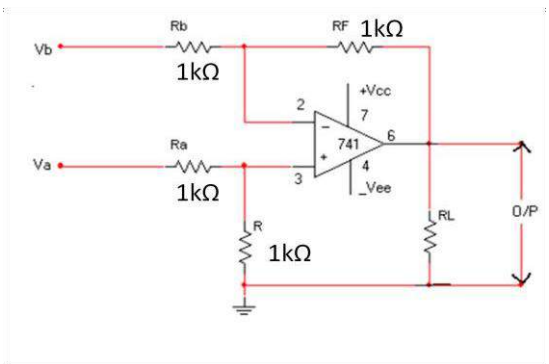


Fig 2.2 subatractor

c) COMPARATOR

i. Non-InvertingComparator

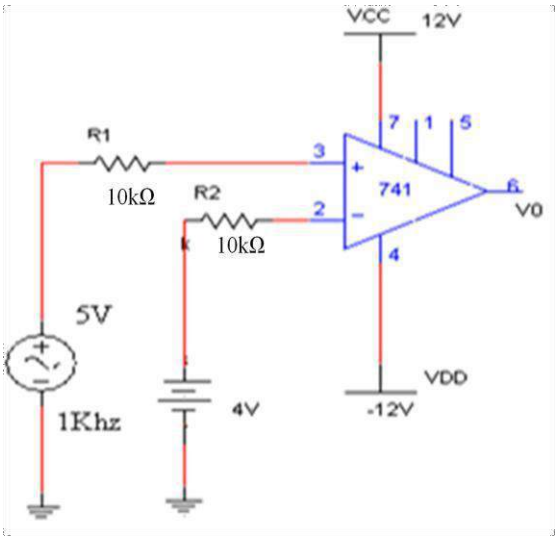


Fig 2.3 comparator

THEORY:

Adder:

A typical summing amplifier (Inverting Adder) with three inputs Va ,Vb&Vc applied at the inverting terminal of IC741 is shown in fig(1). The following analysis is carried out assuming that the Op-Amp is an ideal one, that is AOL = ∞, Ri = ∞ & R0=0; since the input bias current is assumed to be zero, there is no voltage drop across the resistor Rcomp and hence the non inverting input terminal is at ground potential.

Thevoltageatnode„A"iszeroasthenon-invertinginputterminalisgrounded.The nodalequationbyKCL atnode„a"isgivenas

$$\frac{\square_{\square}}{\square_{\square}} + \frac{\square_{\square}}{\square_{\square}} + \frac{\square_{\square}}{\square_{\square}} + \frac{\square_{o}}{\square_{\square}} = o$$

$$\square_o = -\left(\frac{\square_{\square}}{\square_{\square}}\square_{\square} + \frac{\square_{\square}}{\square_{\square}}\square_{\square} + \frac{\square_{\square}}{\square_{\square}}\square_{\square} \right)$$

Case (1):-$R_a=R_b=R_c=R_f$

$$V_0 = - (V_a + V_b + V_c)$$

Case (2):-$R_a=R_b=R_c=3R_f$

$$V_0 = - (V_a + V_b + V_c)/3$$

Subtractor

A typical subtractor with two inputs Va&Vb applied at the non-inverting terminal & Inverting terminal of IC741 respectively is shown in fig(2). The following analysis is carried out assuming that the Op-Amp is an ideal one, that is AOL = ∞, Ri = ∞ & R0=0;

Let Ra = Rb= Rf = R,
V_O= Va –
Vb**COMPARATOR**
:

A comparator is a circuit which compares a signal voltage applied at one input of an op-amp with a known reference voltage at the other input. It is basically an open loop op-amp with output ±Vsat as in the ideal transfer characteristics. It is clear that the change in the output state takes place with an increment in input Vi of only 2mv.This is the uncertainty region where output cannot be directly defined There are basically 2 types of comparators.
1. Non inverting comparatorand.
2. Invertingcomparator.

PROCEDURE:

Part-I

Adder

1. Connect the Adder circuit as shown in fig.1 with Ra = Rb = Rc = Rf = 10KΩ, RL =100KΩ and R = 250Ω on the CDSboard
2. Switch„ON"thepowersupplyandapply+15Vtopinno.7and-15Vtopinno.4ofthe IC741.
3. Apply the input voltages from the regulated supplies to the corresponding inputs at theinverting Input terminal of IC741 (pinno.2).
3. Connect the Digital Multimeter at the Output terminals (pin no.6), and note downthe Output voltage and verify with theoreticalvalues.
4. Repeat the above steps for different inputvoltages.

Subtractor

1. Connect the subtractor circuit as shown in fig.2 with Ra = R_b = R_f = R = 10KΩ andR_L =100KΩ on the CDS board
2. Switch„ON"thepowersupplyandapply+15Vtopinno.7and-15Vtopinno.4ofthe
3. Apply the input voltages from the regulated supplies to the corresponding inputs at the inverting & non-inverting input terminals of IC741 (pin no.2 & 3respectively).
4. Connect the Digital Multimeter at the Output terminals (pin no.6), and note down the output voltage and verify with theoreticalvalues.
5. Repeat the above steps for different inputvoltages

Part-II

Comparator

1. Connect the comparator circuit as shown infig.3.
2. Connect the 1MHz function generator to the input terminals. Apply 1V signal at non-inverting terminals of the op-ampIC741.
3. Connect the 20MHz C.R.O at the outputterminals.

4. Keep 1V reference voltage at the Inverting terminal of the Op-amp. When Vin is less than the Vref, then output voltage is at –Vsat because of the higher input voltage at negative terminal. Therefore the output voltage is at logic lowlevel
5. Now, Keep –1V reference voltage. When Vrefis less than the Vin, then the output voltage is at +Vsat because of the higher input voltage at positive terminal. Hence, the output voltage is at logic highlevel.
6. Observe and record the output voltage andwaveforms.

OBSERVATIONS
ADDER:

V1(volts)	V2(volts)	Theoretical V0=-(V1+V2)	Practical V0 =-(V1+V2)

SUBTRACTOR:

V1(volts)	V2(volts)	Theoretical V0=(V1-V2)	Practical V0 =(V1-V2)

Observations for comparator:
Input signal
Amplitude = Time period=
Output signal
Amplitude = Time period=

EXPECTED WAVEFORMS FOR COMPARATOR:

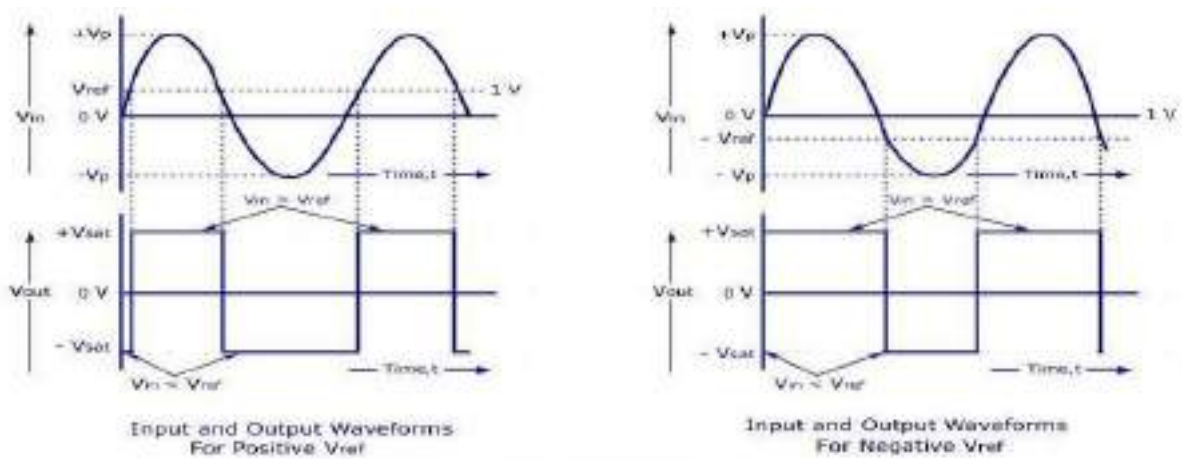


Fig 2.4 output wave form of a non inverting comparator for $+v_{refand-Vref}$

PRECAUTIONS:
1. Make null adjustment before applying the inputsignal.
2. Maintain proper Vcclevels.

Applications of adder and subtractor:
1. Digital signalprocessing
2. Communication

Applications of comparator:
1. Zero crossingdetector
2. Leveldetector
3. Time markergenerator
4. Window detector

RESULT:

Adder and Subtractor are designed using 741 Op – Amp and the experimental results were compared with the theoretical values.

Applied input signal is compared with reference voltages in a comparator using 741 Op – Amp and the corresponding waveforms were noted.

REVIEW QUESTIONS:

1. Draw an Op- amp circuit whose output VO = V1+ V2 – V3–V4.
2. Show that the o/p of an n-input inverting adder is V0 = - (Va +Vb + … +Vn)
3. Draw the circuit of non-inverting adder with 3 inputs and find the o/p VoltageV0.
4. Design a mixed adder forV0=V1+2V2-V3-5V4.
5. Design a subtractor for V0 = Va - 5Vb-2Vc
6. Applications ofcomparator.
7. Applications of adder andsubtractor.

Redraw circuit:

GRAPH

GRAPH

EXPERIMENTNO:3 **Date:**

INTEGRATOR AND DIFFERENTIATOR

AIM: To design, construct and verify the response of

a) Integrator using Op-amp IC741 for sine and square wave inputs at 1 KHzfrequency.
b) Differentiator using Op-amp IC741 for sine and square wave inputs at 1 KHzfrequency.

APPARATUS REQUIRED:

1. Bread Board / CDSBoard.
2. Function Generator(1MHz).
3. Cathode Ray Oscilloscope (20MHz/30MHz)
4. Regulated Power Supply (DualChannel).
5. ConnectingWires.

COMPONENTS REQUIRED:

IC 741	1No
Resistor-------1kΩ	1No
10kΩ	2No
100kΩ	1No
Capacitor-----0,1µf	1No

CIRCUIT DIAGRAMS:

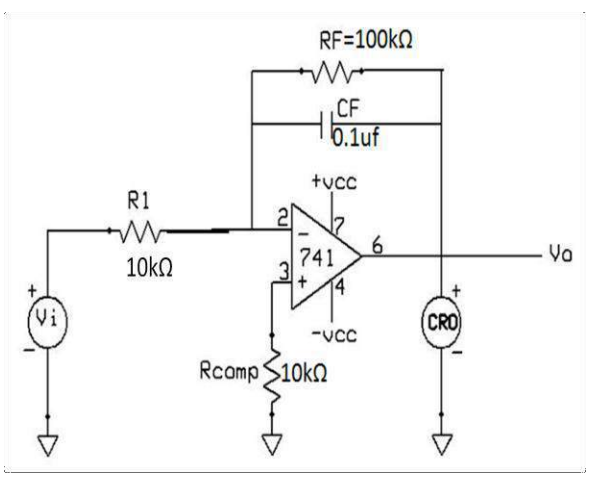


Fig3.1Integrator

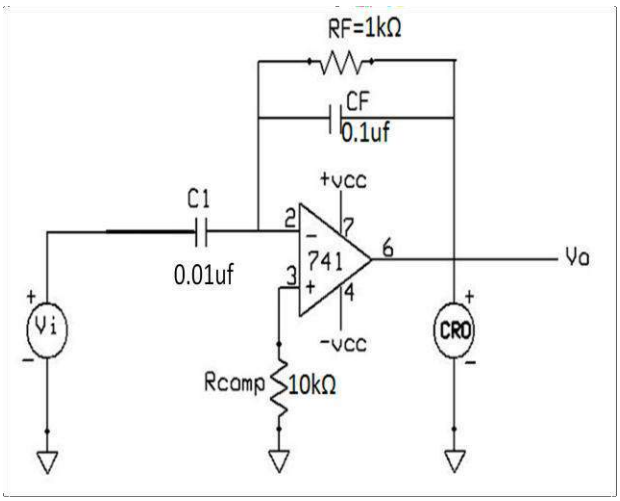


Fig 3.2Differentiator

THEORY:

The integrator

A circuit in which the output voltage waveform is the integration of the input is called integrator**.** $V_0=-1/R_4C_1$

The above equation indicates that the output voltage is directly proportional to the negative

integral of the input voltage and inversely proportional to the time constant R1CF. For Example if the input is a sine wave, the output will be a cosine wave or if the input is a square wave, the output will be a triangularwave.

1. When the input signal frequency is ZERO, the integrator works as an open – loop amplifier. This is because of the capacitor $C_F$acts as an open circuit (X_{CF} =1/ωCF = infinite forf=0).
2. Therefore the ideal integrator becomes unstable & suffers with low frequency noise. To overcome this problem $R_F$is connected across the feedback capacitor C_F. Thus RF limits the low-frequency gain and hence minimizes the variations in the outputvoltage.
3. Frequency f_b at which the gain of the integrator is 0 dB, is givenby

$$f_b = 1/2\pi R1CF$$

4. Both the stability and the low – frequency roll-off problems can be corrected by the addition of a resistors $R_F$in the feedbackpath.

NOTE: The input signal will be integrated properly if the time period T of the input signal is greater than or equal to R_FC_F.

The Differentiator

The differentiator circuit performs the mathematical operation of differentiation. That is the output waveform is the derivative of the input waveform. Therefore

$$V_O = R_f C_1 dVin / dt$$

1. The above equation indicates that the output voltage is directly proportional to the derivative of the input voltage and also proportional to the time constantR_FC_1.
2. For Exampleif the input is a sine wave, the output will be a cosine wave or if the input is a square wave, the output will bespikes.
3. The reactance of the circuit increases with increase in frequency at a rate of 20dB/ decade. This makes the circuit unstable. In other words the gain of an ideal differentiator circuit is direct dependent on input signal frequency. Thereforeat high frequencies (f=∞), the gain of the circuit becomes infinite making the systemunstable.
4. The input impedance XC1 decreases with increase in frequency, which makes the circuit very susceptible to high frequencynoise.
5. The frequency response of the basic differentiator is shown in fig 3.4 In this fig fa is the frequency at which the gain is 0dB.

$$fa=1/2\pi R_FC_1$$

6. Both the stability and the high – frequency noise problem can be corrected by the addition of two components R_1 and C_F as shown in fig 3.2.The frequency response of which is shown in fig 3.4. From f to fa the gain decreases at 40dB/decade. This 40 dB/decade change in gain is caused by the R_1C_1 and $R_FC_F$combinations.

NOTE: The input signal will be differentiated properly if the time period T of the input signal is greater than or equal to $R_F C_1$.

PROCEDURE:

Integrator

1. Connect the circuit as shown in fig 3.1 on thebreadboard.
2. Switch„ON"thepowersupplyandapply+15Vto pinno.7and -15Vto pinno.4ofthe IC741.

3. Apply a sine wave input signal of 2V peak-to-peak amplitude at 1 KHz frequency from the function generator (at pin no.2 of theIC741).
4. Connect the C.R.O at (pin no.6) the outputterminals.
5. Observe and plot the input & output voltagewaveforms.
6. Measure the output voltage (Vo) from the experimentalresults.

Differentiator

1. Connect the circuit as shown in fig 3.2 on thebreadboard.
2. Switch„ON"thepowersupplyandapply+15Vto pinno.7and -15Vto pinno.4ofthe IC741.
3. Apply a sine wave input signal of 2V peak-to-peak amplitude at 1 KHz frequency from the function generator (at pin no.2 of theIC741).
4. Connect the C.R.O at (pin no.6) the outputterminals.
5. Observe and plot the input & output voltagewaveforms.
6. Measure the output voltage (Vo) from the experimentalresults.

EXPECTED WAVEFORMS:

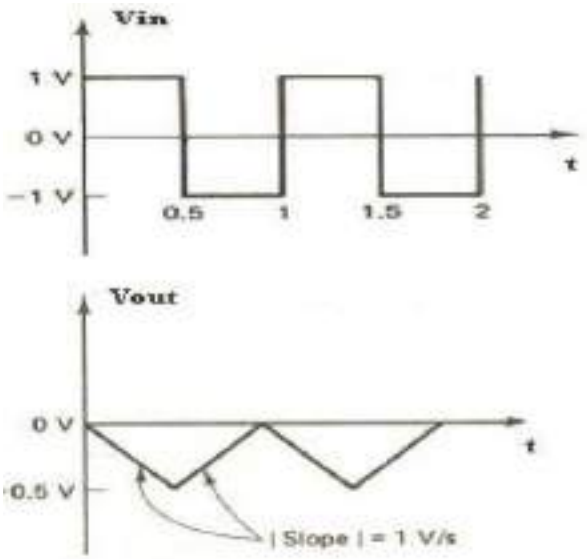


Fig 3.3 Output waveformofIntegrator

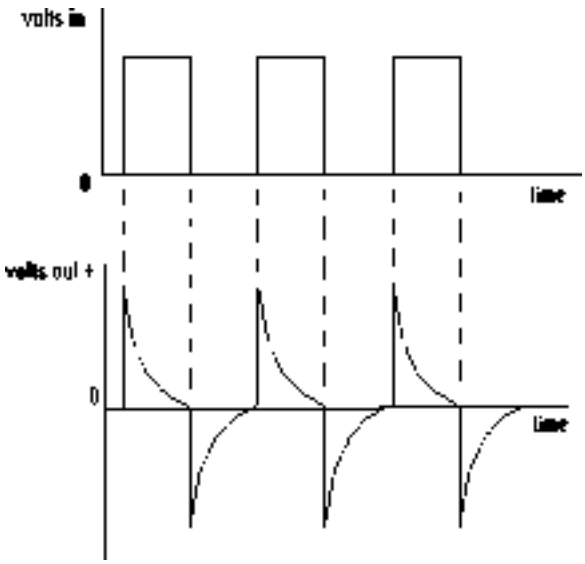


Fig 3.4 Output waveform of Differentiator

Observations forintegrator:

Input signal

Amplitude = Time period=

Output signal

Amplitude = Time period=

Observations for differentiator:

Input signal

Amplitude = Time period=

Output signal

Amplitude = Time period=

Applications of integrator:
1. In the analogcomputers
2. In solving differentialequations
3. In analog to digitalconverters
4. In various signal wave shapingcircuits
5. In ramp generators

Applications of differentiator:
1. In wave shaping circuits
2. as a rate of change detector in FMdemodulators

RESULT: The Integrator & Differentiator circuits were constructed using IC 741 and verified their response for sine & square wave inputs.

REVIEW QUESTIONS:
1. Show that the output of a differentiator is differential ofinput.
2. Show that the output of a integrator is integral ofinput.
3. Mention the difference between practical integrator and idealIntegrator.
4. Explain the frequency response of anintegrator.
5. What type of output waveform is obtained when a triangular wave is applied to integrator circuit and also to Differentiatorcircuit?
6. A low frequency differentiator is desired for a particular application to Perform the operation Vo (t) =-0.001 dvi(t)/dt . Determine the suitable design of differentiator circuit for the periodic signal with a frequency of 1KHz.
7. What are the applications ofintegrator?

Redraw circuit:

GRAPH

GRAPH

EXPERIMENTNO:4 **Date:**

FREQUENCY RESPONSE OF LOW PASS AND HIGH PASS ACTIVE FILTERS

AIM: To design, construct and plot the frequency response of

a) First order low pass filter with cut-off frequency of 5KHz
b) First order high pass filter with a cut-off frequency of 1KHz.

APPARATUS REQUIRED:

1. Bread Board / CDC Board.
2. Function Generator(1MHz).
3. Cathode Ray Oscilloscope (20MHz/30MHz)
4. Regulated Power Supply (DualChannel).
5. ConnectingWires.

COMPONENTS REQUIRED:

IC 741	1No
Resistor-------1kΩ	1No
10kΩ	2No
4.7kΩ	1No
Capacitor-----0.1µf	1No

CIRCUIT DIAGRAMS:

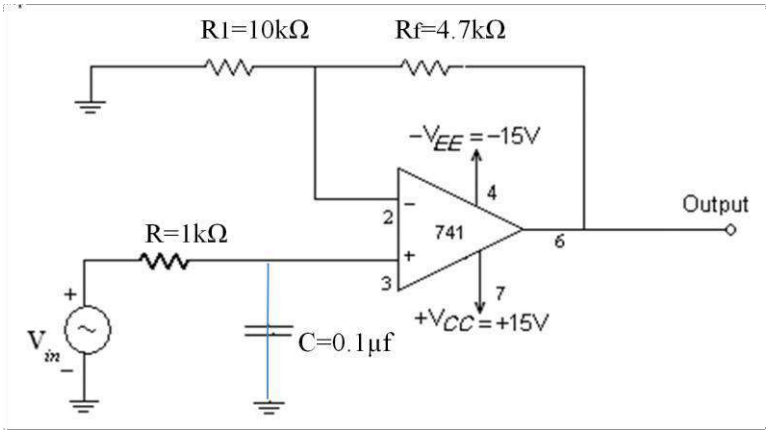


Fig 4.1 Low pass filter

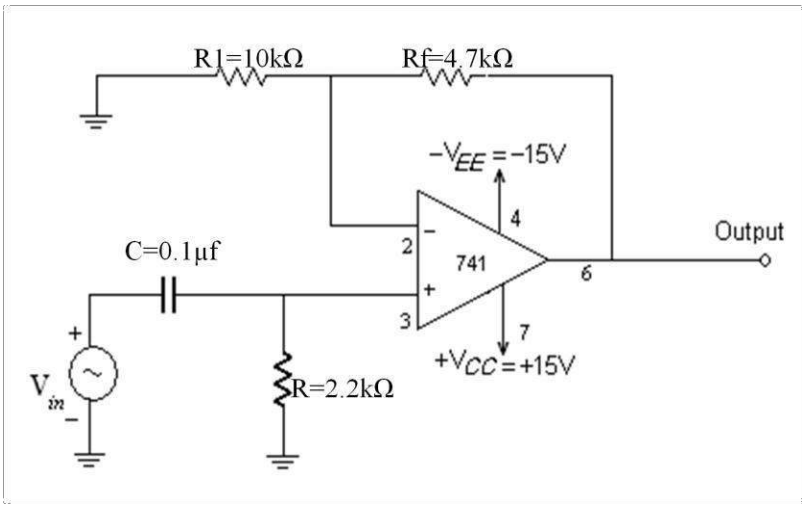


Fig 4.2 High pass filter

THEORY:

A first order filter consists of a single RC network connected to the non-inverting input terminal of the op-Amp as shown in the figure. Resistors R_1& R_f determine the gain of the filter in the pass band. Components R & C determine the cutoff frequency ofthefilter.

Low-Pass filter: The circuit of 1st order low-pas filter is shown in fig.1 & its frequency response is as shown in the fig3. The dashed curve in the fig 4.3 indicates the ideal response & solid curve indicates practical filter response. It is not possible to achieve ideal characteristics. However with special design techniques (Higher order filters) it is possible to closely approximate the ideal response. Active filters are typically specified by the voltage transferfunction,

H(s) = V0 (s)/ Vi(s)…… (1) (under steady state conditions)

High Pass Filter: The circuit of 1storder high pass filter is shown in fig.2 & its frequency response is as shown in the fig4.4 the dashed curve in the fig 4.4 indicates the ideal response & solid curve indicates practical filter response. When an input signal is applied to High pass filter, the signals at high frequencies are passed through circuit and signals at low frequencies are rejected. That is the signal which are having frequencies less than the lower cutoff frequency $f_L$are rejected and the signal with frequency greater the lower cut off frequency $f_L$are passed through the circuit. Thatis

1. For f >f_L, Vo(s) /Vi(s) = Maximum and is called as passband.
2. For f <f_L, Vo(s) /vi(s) = 0 and is called as the stopband

PROCEDURE:

1. Connections are made as per the circuitdiagram.
2. Apply sine wave of amplitude $4V_{p-p}$ to the non inverting inputterminal.
3. Values the input signalfrequency.
4. Note down the corresponding outputvoltage.
5. Calculate gain indb.
6. Tabulate thevalues.
7. Plot a graph between frequency andgain.
8. Identify stop band and pass band from thegraph

OBSERVATIONS:

Low Pass Filter

Input signal amplitude:

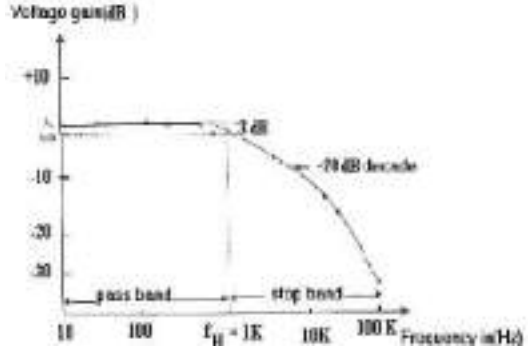
Frequency(Hz)	V_0(V)	Gain =(V0/Vi)	Gain in db= 20log(V0/Vi)

High Pass Filter

Input signal amplitude:

Frequency(Hz)	V_0(V)	Gain =(V0/Vi)	Gain in db= 20log(V0/Vi)

EXPECTED WAVEFORMS:



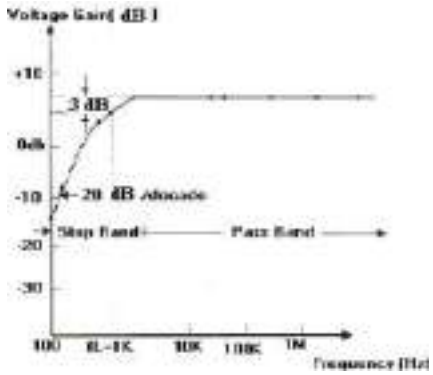


fig 4.3 Frequency response of 1st Order LPF fig 4.4 Frequency response of 1st Order HPF

Applications of filters:

1. In communications systems, use filters to suppress noise, to isolate a single communication from many channels, to prevent spillover of adjacent bands, and to recover the original message signal from modulated signals.

2. In instrumentation systems, engineers use filters to select desired frequency components or eliminate undesired ones. In addition, we can use these filters to limit the bandwidth of analog signals before converting them to digital signals. You also need these filters to convert the digital signals back to analogrepresentations.

3. In audio systems, engineers use filters in crossover networks to send different frequencies to different speakers. In the music industry, record and playback applications require fine control of frequencycomponents.

4. In biomedical systems, filters are used to interface physiological sensors with data logging and diagnosticequipment.

RESULT: The first order LPF & HPF are designed for a chosen cutoff frequency and the frequency response curves were plotted between voltage gain (dB) and frequency (Hz).

REVIEW QUESTIONS:

1. List the advantages of active filters over passivefilter.
2. Derive $f_H$of second orderLPF.
3. Draw the frequency response for ideal and practical of all types offilters.
4. Design a first order low pass filter for 2 KHzfrequency.
5. Draw the ideal and practical frequency response characteristics of high passfilter.
6. What are the applications of LPF andHPF?

Redraw circuit:

SEMILOG

SEMILOG

EXPERIMENTNO:5 **Date:**

FREQUENCY RESPONSE OF BAND PASS AND BAND REJECT ACTIVE FILTERS

AIM: To design, construct and study the frequency response of

a) Band passfilter
b) Band rejectfilter

APPARATUS REQUIRED:

1. Bread Board / CDSBoard.
2. FunctionGenerator
3. Cathode RayOscilloscope
4. Regulated Power Supply (DualChannel).
5. ConnectingWires.

COMPONENTS REQUIRED:

IC 741	1No
Resistor-------1kΩ	1No
10kΩ	2No
4.7kΩ	1No
Capacitor-----0.1µf	1No

CIRCUIT DIAGRAMS: BAND PASS FILTER

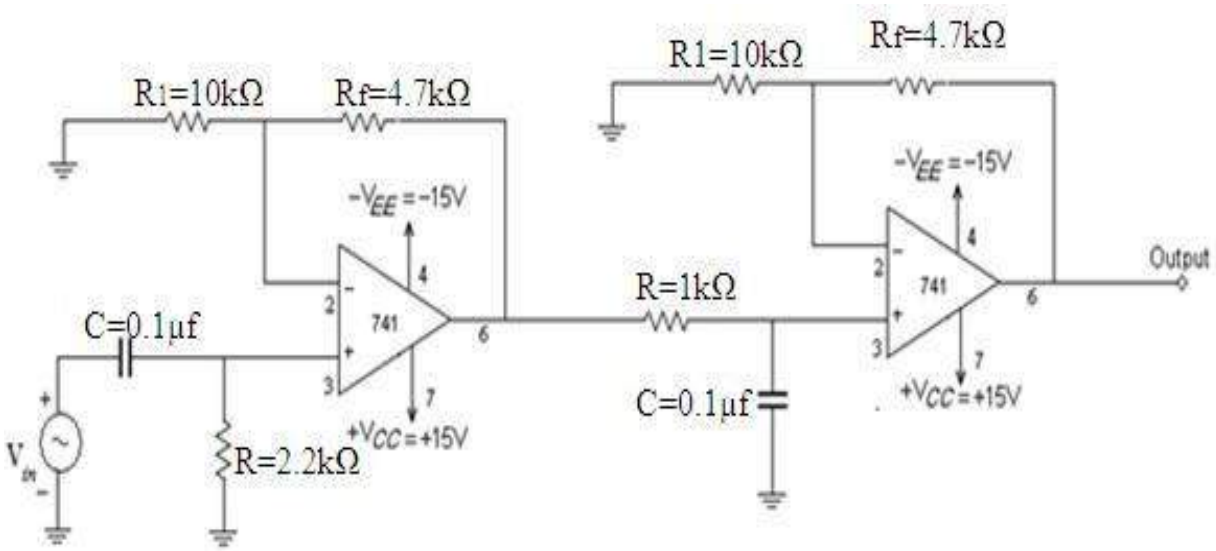


Fig 5.1 Band pass filter

BAND REJECT FILTER

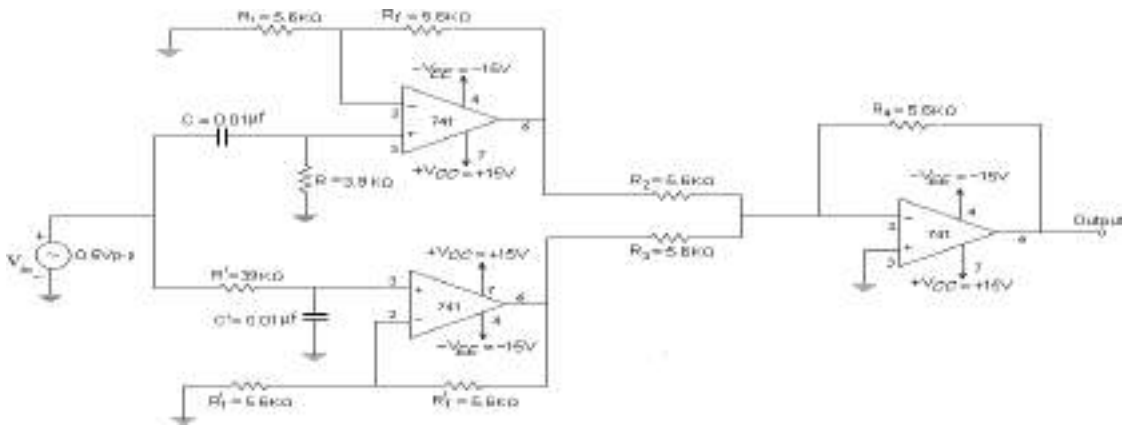


Fig 5.2 Band reject filter

THEORY:
BAND PASS FILTER:

A Band Pass Filter (BPF) has a pass band between the lower cut-off frequency, f_L& the higher cut-off frequency f_H, such that $f_H > f_L$. When the input frequency is zero, the gain of the filter will be zero. As the input signal frequency increases from zero to f_L, the gain will increase at a rate 20dB/decade up to 3dB less than its maximum value. If the input signal frequency increases beyond f_L, the gain will reach its maximum value and remains constant up to high frequencies as shown in the Fig 5.3. When the input signal frequency reaches the higher cut-off frequency, f_H, the gain will fall 3dB less from its maximum value. If the input signal frequency increases beyond f_H, the gain will decreasesto zero at rate of 20dB/decade. After reaching the total pass band region, the gain of the filter is constant up to its designed f_H(high cut offfrequency).

There is a phase shift between input and output voltages of BPF as a function of frequency in its Pass Band region. This filter passes all frequencies equally well i.e.the output and input voltages are equal in amplitude for all frequencies. This highest frequency up to which the input and output amplitudes remain equal is dependent of the unity gain bandwidth of Op – Amp. At this frequency, the phase shift between input and output becomesmaximum.

BAND REJECT FILTER:

A Band Reject Filter (BRF) has a stop band between the cutoff frequencies f_H&f_L such that $f_H < f_L$. When the input signal frequency is zero, the gain of the BPF will be maximum and will remains constant as the input signal frequency increases. At the higher cut off frequency f_H, the gain becomes 3dB less than its maximum value. As the input signal frequency increases beyond f_H, the gain of the filter decreases & becomes zero at the central (f_C) or operating frequency (f_O). After this center frequency f_C, the gain increases to 3dB less than its maximum value at the lower cut-off frequency, f_L. As the input signal frequency increases beyond f_L the gain increases to the maximum value and becomesconstant.

There is a phase shift between input and output voltages of BPF in its “Pass band region”. This filter passes all the frequencies equally well i.e. output and input voltages are equal in (magnitude) amplitude for all frequencies. This highest frequency up to which the input and output amplitude remains equal is dependent on the unity gain bandwidth of the Op- Amp. However at this

frequency, the phase shift between the input and output is maximum.

PROCEDURE:

1. Make the circuit connection as shown infigure.
2. Connect the signal generator to input terminals. And connect the C.R.O at output terminals of the trainer & switch on thetrainer.
3. Apply the input signal frequency from 100Hz to 10KHz.
4. Record the input frequency, Input voltage and Output voltage. Find the gain of the B.P.F using the formula. The gain magnitude in dB is equal to 20 Log (Vo/Vi).

OBSERVATION TABLES: Band Pass Filter:

Input signal amplitude:

Frequency(Hz)	$V_{0(V)}$	Gain =(V0/Vi)	Gain in db= 20log(V0/Vi)

Band Reject Filter:

Input signal amplitude:

Frequency(Hz)	$V_{0(V)}$	Gain =(V0/Vi)	Gain in db= 20log(V0/Vi)

EXPECTED WAVEFORMS:

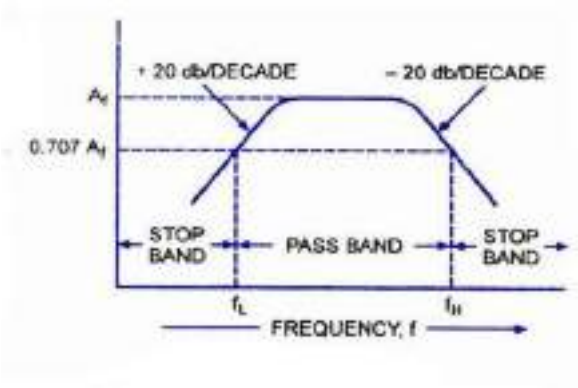


Fig 5.3 frequency response for bandpass filter

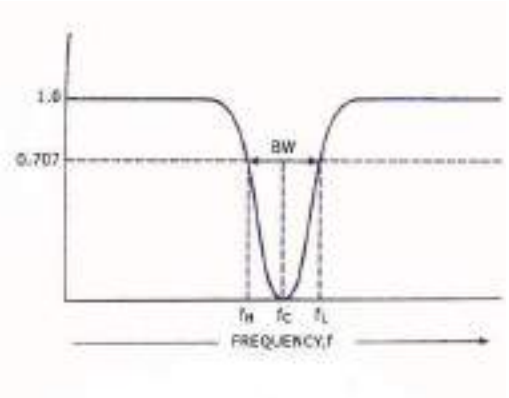


Fig 5.4 frequency response for band rejectfilters

RESULT: The band pass & band reject filters have been designed for chosen f_L, f_H and frequency responses were plotted between voltage gain (in dB) and input frequency.

REVIEW QUESTIONS:

1. Mention the applications of Band passfilters.
2. Mention the differences between wide band and narrow bandfilters.
3. What is all passfilters.
4. Explain why the band pass filter is called multiple feedbackfilter.
5. Define pass band, stop band attenuation band with respect to filterresponse.
6. Define a filter and discuss its generalcharacteristics.
7. Explain the difference between active and passivefilters.
8. What is the difference between narrow band reject filter and wide band rejectfilter?
9. What are the allocations of band pass and band reject filters?
10. Design a band pass filter with an upper cutoff frequency of 3Khz and a lower cut off frequency of1Khz.

Redraw circuit:

SEMILOG

SEMILOG

EXPERIMENTNO:6 **Date:**

IC 741 Oscillator Circuits –RC Phase Shift and Wein Bridge Oscillators.

AIM: To study the Operation of Wein – Bridge Oscillator and RC phase shift oscillator using IC 741 Op-Amp and to determine the frequency of Oscillations.

APPARATUS REQUIRED:

1. CDS Board/ Bread Board
2. Regulated DC power Supply
3. C.R.O
4. Connecting patchchords

COMPONENTS REQUIRED:

IC 741	1No
Resistor-------1kΩ	4No
1.5kΩ	2No
15kΩ	1No
100kΩ	1No
Capacitor-----0.1µf	3No

CIRCUIT DIAGRAM:

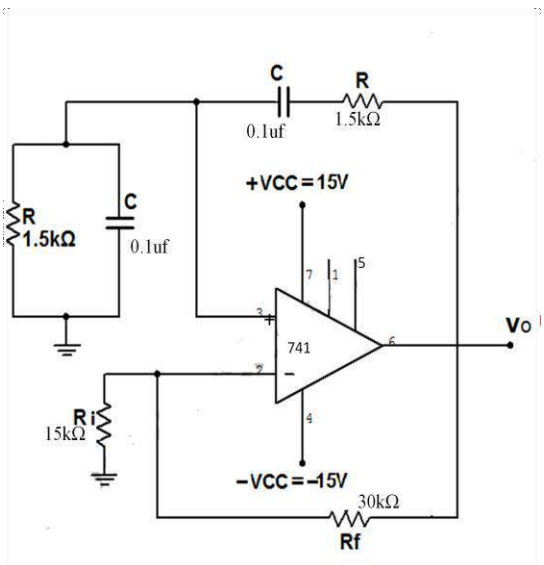


Fig 6.1 Weinbridgeoscillators

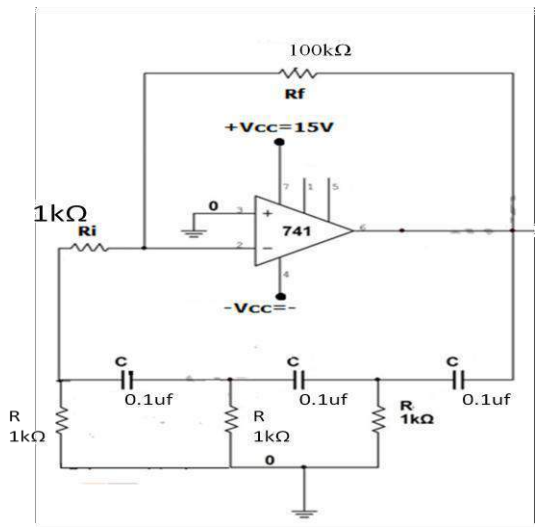


Fig 6.2 RC phase shiftoscillator

THEORY:

Wein bridge oscillator:

The most commonly used audio frequency oscillator is weinbridge oscillator. From the figure shown above it may be noted that the feedback signal in the circuit is connected to the positive terminal so that the Op-Amp is working as a non-inverting amplifier. Therefore the feedback network needs not to provide any phase shift. The circuit can be viewed as a weinbridge

with a series RC network in one arm and a parallel RC network in the adjoining arm. The addition of zero phases around the circuit is achieved by balancing the bridge.
The frequency of the oscillations in Wein Bridge is given by

$$F_0 = 1/ 2\pi RC$$

At F_O, The feedback factor β is equal to 1/3. Therefore for sustained oscillation, the amplifier must have a gain of precisely 3. However from practical point of view, A_V may be slightly less or greater than 3. For $A_V<3$ the oscillations will either die down or fail to start when power is first applied and for $A_V>3$, the oscillations will be growing.

RC phase shift oscillator:

Phase shift oscillator which consists of an Op-Amp as the amplifying stage & three RC cascaded networks as the feedback circuit that provides feedback voltage from the output back to the input of the amplifier. The output is used in inverting mode. Therefore any signal that appears at the inverting terminal is shifted by 180^0 phase shift required for oscillation is provided by the cascaded RC networks. Thus the total phase shift of the cascaded RC networks is exactly 360^0 or 00. Atsomespecificfrequencywhenthephaseshiftofthecascaded RCnetworkisexactly180^0 and the gain of the amplifier is sufficiently large and circuit oscillates at that frequency.

$$\frac{R_f}{R_1} = 29 \quad => \quad R_f = 29R_1$$

Thus the circuit will produce a sinusoidal waveform of frequency f_o if the gain is 29 and the total phase shift around the circuit is exactly 360^0.

PROCEDURE:

Wein bridge oscillator:

1. Connect the circuit as shown in thefigure1.
2. Connect the C.R.O at the output terminals and observe the outputwaveform.
3. Record the output waveform and measure the practical frequency from thewaveform.
4. For different values of R, calculate theoretical frequency using the formula $F_O = 1/ 2\pi RC$ and also measure the frequency of output signal from thewaveform.
5. Compare the theoretical and practical frequencies of the outputsignal.

RC phase shift oscillator:

1. Connect the circuit as shown infigure1.
2. Connect Oscilloscope at output terminals V_0 observe the output sinewave.
3. Record the output waveform and measure the practical frequency of the output waveform.
4. From the given values of R & C calculate theoretical frequency using theformula $f=1/2\pi RC\sqrt{6}$.
5. Compare the theoretical and practicalfrequencies.

Observations for Wein bridge oscillator:

Output signal

Amplitude = Time period=

S.NO	R (in Ohms)	C (in μF)	f theoretical = 1/2∏RC (in Hz)	f practical (in Hz)

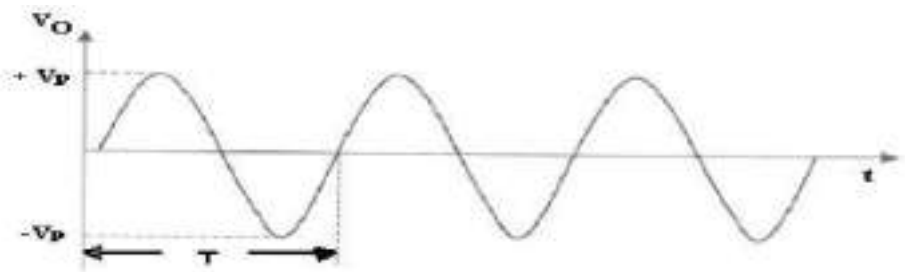
RC phase shift oscillator:

Output signal

Amplitude = Time period=

S.NO	R (in Ohms)	C (in μF)	f theoretical = 1/2∏RC√6 (in Hz)	f practical (in Hz)

EXPECTED WAVEFORMS:



RESULT: Operation of Wein –Bridge and RC phase shift oscillators using IC 741 Op-Amp is studied and frequency of the oscillations is determined.

REVIEW QUESTIONS:

1. State Barkhausen criterion foroscillations.
2. Derive the frequency of oscillations and gain of wein bridgeoscillator.
3. List out different types ofoscillators.
4. What is the phase shift provided by each RC section at the frequency of oscillation?
5. On what factors does the oscillator frequency dependon?
6. What type of feedback does the phase shift RC networkprovide?
7. List out the applications of RC phase shift oscillator and wein bridgeoscillator.
8. Design an RC phase shift oscillator with a frequency of2Khz.

Redraw circuit:

GRAPH

EXPERIMENTNO:7 **Date:**

FUNCTION GENERATOR USING IC 741 OP – AMP

AIM: Study of op-Amp as function generator that produces various specific waveforms for test purpose over a wide range of frequencies.

APPARATUS:

1. Function Generator Trainerkit.
2. C.R.O.
3. DigitalMultimeter.
4. ConnectingWires.

CIRCUIT DIAGRAM:

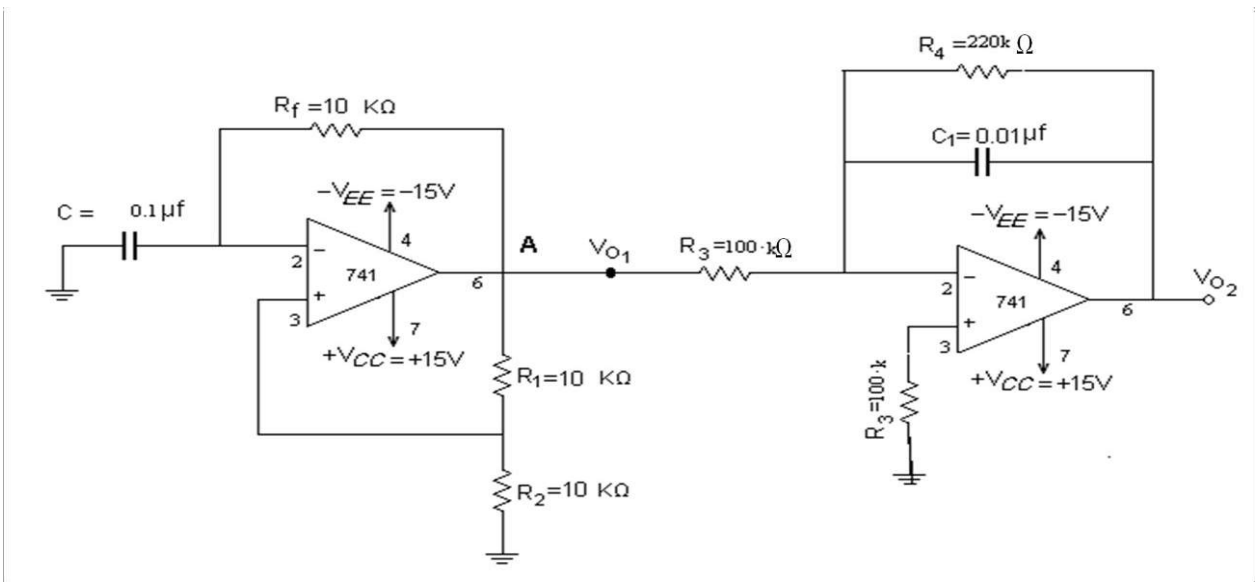


Fig 7.1 Function generator using ic 741 op – amp

THEORY:

Function generator is a signal generator that produces various specific waveforms for test purposes over a wide range of frequencies. In laboratory type function generator generally one of the functions (sine, square & triangle) is generated using dedicated chips or standard circuits and converts it in to required signal.

This consists of

1. Sine wave generator Using IC741.
2. Square wave generator (Astable Multivibrator using IC741)
3. Active integrator using IC741

SQUARE WAVE GENERATOR (ASTABLE MULTIVIBRATOR)

In comparison to sine wave oscillations, square wave signals are generated when the Op-Amp is forced to operate in saturated region. That is the output of the Op-Amp is forced to swing between +Vsat& -Vsat, resulting in square wave output. The circuit arrangement of a square wave generator using IC 741 is shown in fig.

TRIANGULAR WAVEGENERATOR:

The circuit arrangement of a triangular wave generator is shown in Fig.2. A square wave from the square wave generator is fed to the integrator. The RC time constant of the integrator has been chosen in such a way that it is very small value compared to the time period of the incoming square wave. For the basic operation of integrator, it is known that the output of the integrator for a given square wave input is a trianglewave.

PROCEDURE:

1. Connect trainer kit to the 230V AC mains and switch on thesupply.
2. Observe the output of the sine wave generator. If signal is not coming or distorted in shape adjust the gain trim pot provided on the kit until a good signal is obtained. Measure the signal frequency usingOscilloscope.
3. Observe the output of the square wave generator and measure the output signal frequency.
4. Observe the output of the Integrator (triangular wave generator) by varying the input signal frequency (square wave is internally connected to thecircuit).
5. Measure the frequency of the triangular wave usingCRO.

WAVEFORMS:

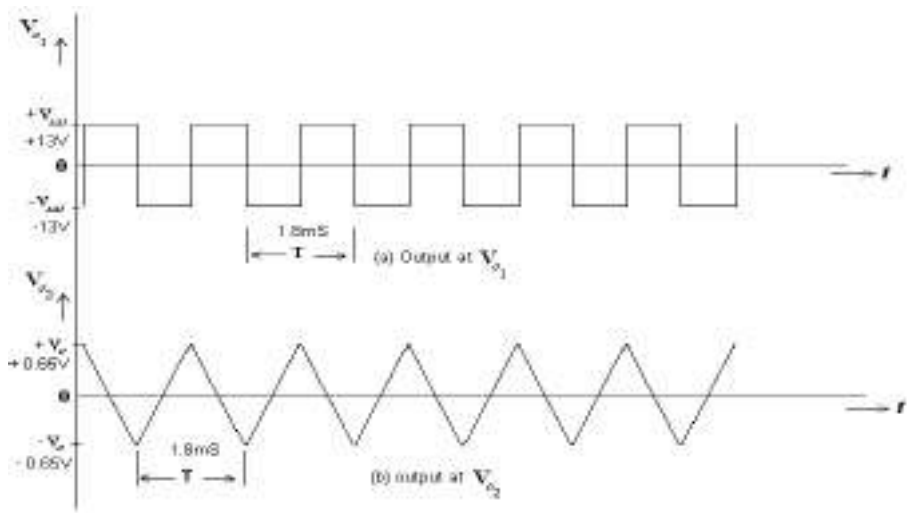


Fig 7.2:expected output waveforms of function generator

Observations:

Square wave Output signal

Amplitude = Time period=

Triangle wave Output signal

Amplitude = Time period=

Applications:
1. square wavegenerators
2. triangular wavegenerators
3. sine wavegenerators

RESULT: Hence studied op-Amp as function generator that produces Sine, square and triangular waveforms for test purpose over a wide range of frequencies.

REVIEW QUESTIONS:

1. WhatarethedifferenttypesoffunctiongeneratorsIC"s?
2. What type of output waveforms is obtained from functiongenerator?
3. What is the advantage of using OP-AMP as anoscillator?
4. Why do we call sine to square wave converter as zero crossingdetectors?
5. What happens when a negative reference voltage is applied at the non-inverting terminal of a square wavegenerator?
6. How do you vary the frequency and amplitude of different waveforms obtained from functiongenerator.
7. What are the applications of functiongenerator?

Redraw circuit:

GRAPH

EXPERIMENTNO:8 **Date:**

MONOSTABLE MULTIVIBRATOR USING 555 TIMER

AIM: To design a Monostable Multivibrator using 555 timer to get 10msec. pulse output.

APPARATUS REQUIRED:

1. C.R.O
2. Regulated DC power Supply
3. Functiongenerator
4. CDS Board/ Bread Board.
5. Connecting patchchords.

COMPONENTS REQUIRED:

IC 555	1No
Resistor-------10kΩ	1No
Capacitor-----0.1µf	1No
0.01µf	1No

CIRCUIT DIAGRAM:

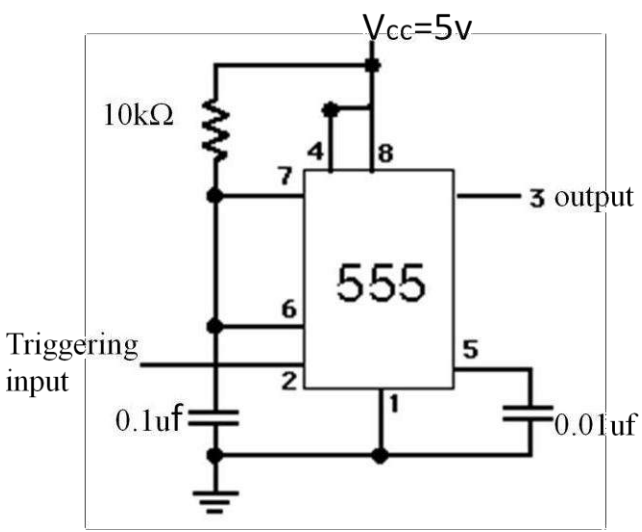


Fig 8.1: circuit diagram of monostable multivibrator

THEORY:

The 555 Timer is used in number of applications; it can be used as monostable, astable multivibrators, DC to DC converters, digital logic probes, analog frequency meters, voltage regulators and time delay circuits.

The IC 555 timer is 8-pin IC and it can operate in free- running (Astable) mode or in one-shot (Monostable) mode. It can produce accurate and highly stable time delays or oscillations. Monostable can also be called as One-shot Multivibarator. Fig 1.2 shows the Pin configuration of

Monostable Multivibrator. When the output is low, the circuit is in stable state, Transistor Q1 is ON and capacitor C is shorted out to ground. However, upon application of a negative trigger pulse to pin-2, transistor Q1 is turned OFF, which releases short circuit across the external capacitoranddrivestheoutputHigh.ThecapacitorCnowstartschargінguptowardVccthrough R. However, when the voltage across the external capacitor equals 2/3 Vcc, the output of comparator1 switches from low to high, which inturn drives the output to its low state. The output, *Q* of the flip flop turns transistor Q1 ON, and hence, capacitor C rapidly discharges through the transistor. The output of the Monostable remains low until a trigger pulse is again applied. Then the cycle repeats. Fig (2) shows the trigger circuit & Fig.3 shows trigger input, output voltage and capacitor voltagewaveforms.

Pulse width of the trigger input must be smaller than the expected pulse width of the output waveforms. Trigger pulse must be a negative going input signal with amplitude larger than 1/3 Vcc. The time during which the output remains high is givenby

$$tp = 1.1RC$$

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

DESIGN:

Step 1: Choose C=1µF.
Step 2: Since in monostable multivibrator, tp=1.1RC. Therefore R= tp / 1.1C
Step 3: Using equations, design the value of R.

PROCEDURE:

1. Connect the 555 timerin Monostable mode as shown infig.8.1
2. Connect the C.R.O at the output terminals & observe theoutput.
3. Apply external trigger at the trigger input terminal (PIN 2) and observe the output of Monostable Multivibrator.
4. Record the trigger input, voltage across the capacitor & output waveforms andmeasure
5. The output pulse width. Verify results with the sample output waveforms as shown infig
6. Calculate the time period of pulse (tp =1.1RC) theoretically & compare it with practical values.

OBSERVATION TABLE:

S.No	Theoritical value of o/p pulse width (in m.sec) □□= 1.1 □□	Practical value of output pulse width(in m.sec

EXPECTED WAVEFORMS:

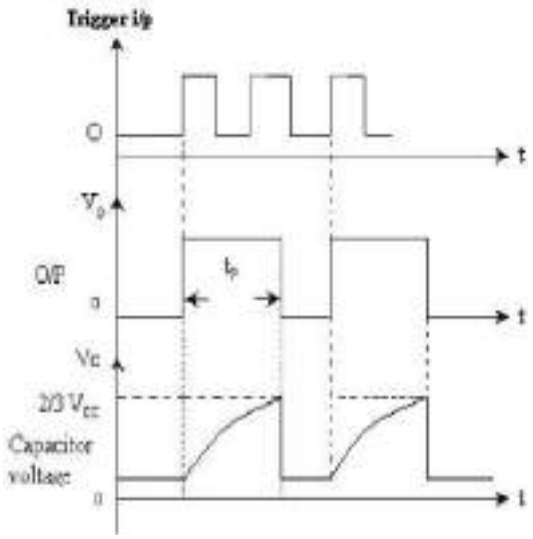


Fig8.2: expected waveforms of monostable multivibrator

Observations:

Trigger input

Amplitude = Time period=

Square wave Output signal

Amplitude = Time period=

Triangle wave Output signal

Amplitude = Time period=

Applications:

1. Frequencydivider
2. Pulse widthmodulation
3. Linear rampgenerator
4. Missing pulsedetector

RESULT: Hence designed & studied 555 timer as a Monostable multivibrator and also theoretical & Practical of time period values of the output waveform are compared.

REVIEW QUESTIONS:

1. List the important features of the 555Timer.
2. Define Dutycycle.
3. Consider the Monostable multivibrator with R=3KΩ and C=0.0068μF. Determine the pulse width.
4. What is the function of control input (pin5) of 555timers?
5. List the applications of 555 timers in Monostable mode.
6. Why do we use negative trigger for Monostableoperation?
7. Explain the trigger circuit used for Monostablemultivibrator?
8. What are the applications of Monostablemultivibrator?

Redraw circuit:

GRAPH

EXPERIMENTNO:9 **Date:**

ASTABLE MULTIVIBRATOR USING 555 TIMER

AIM: To design an Astable Multivibrator using IC 555 timer to generate a square wave of 6.9 KHz with 52.38 % Duty Cycle.

APPARATUS:

1. C.R.O
2. Functiongenerator
3. Regulated DC power Supply
4. CDS Board/ Bread Board.
5. Connecting patchchords.

COMPONENTS REQUIRED:

IC 555	1No
Resistor-------2.2kΩ	1No
3.3kΩ	1No
Capacitor-----0.1µf	1No
0.01µf	1No

CIRCUIT DIAGRAM:

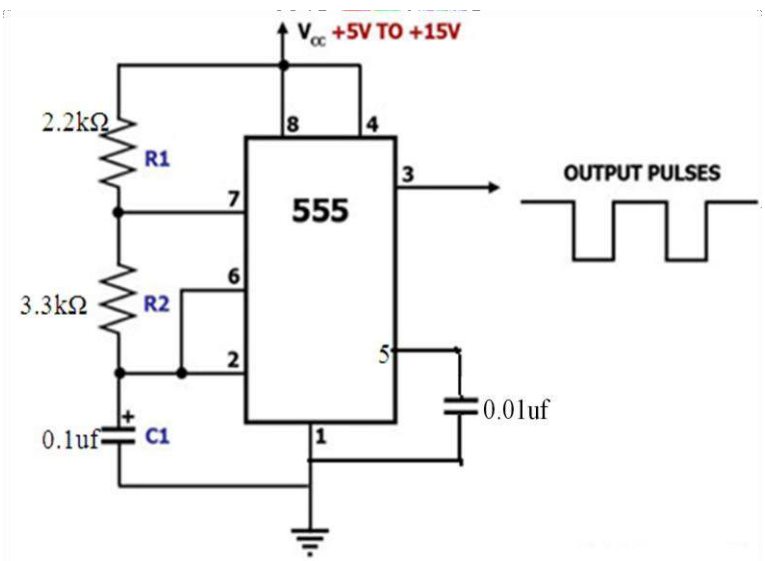


fig 9.1: circuit diagram for astable multivibrator

THEORY:

The 555 Timer is used in number of applications; it can be used as monostable, astable multivibrators, DC to DC converters, digital logic probes, analogy frequency meters, voltage regulators and time delay circuits. The IC 555 timer is 8-pin IC and it can operate in free-running (Astable) mode or in one-shot (Monostable) mode. The pin configuration of NE 555 Timer is as shown fig (1). It can produce accurate and highly stable time delays or oscillations.

Astable Multivibrator often called a free-running Multivibrator. External Trigger input is not required to operate the 555 as an Astable Configuration. However, the time during which the output is either high or low is determined by two external components Resistor & Capacitor. Fig shows the 555 as Astable Multivibrator. Initially, when the output is high, capacitor C starts charging towards Vcc through resistor Ra and Rb. As soon as voltage across the capacitor equals to 2/3 Vcc, comparator-1 triggers the flip-flop, and the output is low. Now capacitor discharges through Rb and transistor Q1. When the voltage across capacitor C equals to 1/3Vcc, comparator-2"s output triggers the flip-flop, and the output goes high. Then the cycle repeats. The output voltage waveforms are as shown in fig (3).In this way capacitor periodically charges and discharges between 2/3Vcc and 1/3Vccrespectively.

The time during which the capacitor charges from 1/3Vcc to 2/3 Vcc is equal to the ON time of the timer (i.e. the output is HIGH) and is given by

$$tc = 0.69(R_1+R_2)C$$

The time during which the capacitor discharges from 2/3 Vcc to 1/3Vcc is equal to the OFF time of the timer, during which the output is LOW and is given by

$$td = 0.69(R_2)C$$

The total time period of the output is the sum of charging time(tc)and discharging time(td) and is given by

$$T = tc + td = 0.69(R_1 + 2R_2)\ C$$

Therefore the frequency of oscillations of Astable multivibrator is given by

$$F = 1/T = 1.45/ (R_1 + 2R_2)\ C$$

DUTY CYCLE:

This term is in conjunction with Astable Multivibrator. The duty cycle is the ratio of the ON time, tc during which the output is high to the total time period T. It is generally expressed as a percentage.

Duty cycle, $D = (T_{ON} /T_{ON}+ T_{OFF}) = tc /T = (R_1 + R_2) / (R_1 + 2R_2)$

DESIGN:

Step1: Choose C=0.01 µF

Step2: using the formula, $F = 1.45/ (R_1 + 2R_2)\ C$, Get a relation between R_1& R_2.

Step3: Consider the expression for duty cycle, $D= (T_{ON} /T_{ON}+ T_{OFF}) = (R_1 + R_2) / (R_1 +2R_2)$ & obtain a relation between R_1& R_2.

Step4: Using the relations between R_1& R_2., obtained in step2 & step3, solve for R_1& R_2.

PROCEDURE:

1. Connect the IC 555 timer in Astable mode as shown infig.
2. Connect the C.R.O at the output terminal (pin 3) and observe theoutput.
3. Record the waveforms at pin3, across the capacitor & compare them with the sample output waveforms as shown in fig(3)
4. Measure the charging time (tc), discharging time (td) and total time period/ Frequency from the outputwaveform.
5. Calculate tc, td, time period (T), frequency (f) of the square wave output and percentage duty cycletheoretically.
6. Compare the theoretical values charging time (tc), discharging time (td) total time period/ Frequency & % Duty cycle with the practicalvalues.

OBSERVATION TABLE:

S.NO	Theoretical Values					Practical Values				
	t_c (m.sec)	t_d (m.sec)	T (m.sec)	f (in Hz)	D	t_c (m.sec)	t_d (m.sec)	T (m.sec)	F (inHz)	D

EXPECTED WAVEFORMS:

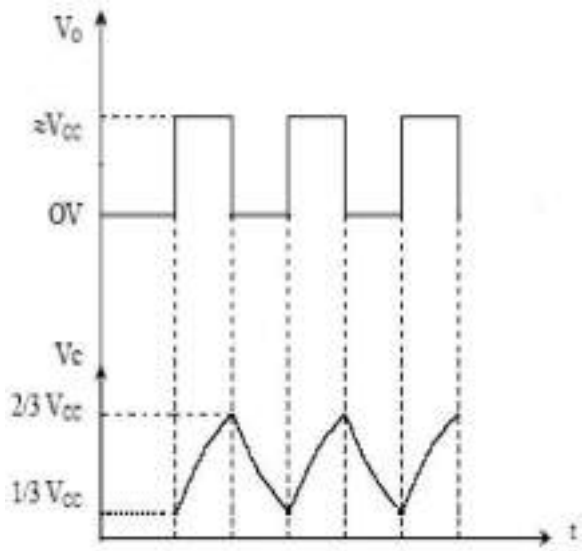


Fig 9.2: expected output waveforms of astable multivibrator

Observations:

Square wave Output signal

Amplitude = Time period=

Triangle wave Output signal

Amplitude = Time period=

Applications:

1. square wavegenerator
2. Voltage controlledoscillator
3. FSK(frequency shift keying)generator

RESULT: Hence designed & studied IC 555 timer as an Astable multivibrator and also calculated the frequency of oscillations & time period of output waveform.

REVIEW QUESTIONS:

1. List the important features of the IC555 Timer. 2. Define Dutycycle.
2. What are the modes of operation of Timer and explain the difference between two operating modes of the 555Timer.
3. Consider the Astable multivibrator with R1=10KΩ,R2=200KΩ and C=0.1μF.Determine
   a) Frequency b) Dutycycle.
4. Design an Astable 555 timer circuit to produce a 2kHz square wave with a dutycycle of

70%.

5. What is the function of control input (pin5) of 555timer?
6. Compare thetime period „T" of the Astable multivibrator using IC555 timer&op-amp IC741.
7. Why do we connect pin 4 of IC 555 timer to supply pin when it is notused.
8. List out the applications of astblemultivibrator.

Redraw Circuit:

GRAPH

EXPERIMENTNO:10 **Date:**

Schmitt Trigger Circuits – using IC 741 and IC 555

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

APPARATUS REQUIRED:

1. FunctionGenerator
2. Regulated DC power Supply
3. Dual ChannelOscilloscope(CRO)
4. DigitalMultimeter
5. CDS Board / BreadBoard
6. Connectingwires

COMPONENTS REQUIRED:

IC 555	1No
Resistor-------10kΩ	1No
1kΩ	2No
100kΩ	2No
Capacitor-----0.1µf	1No
0.01µf	1No

CIRCUIT DIAGRAMS:

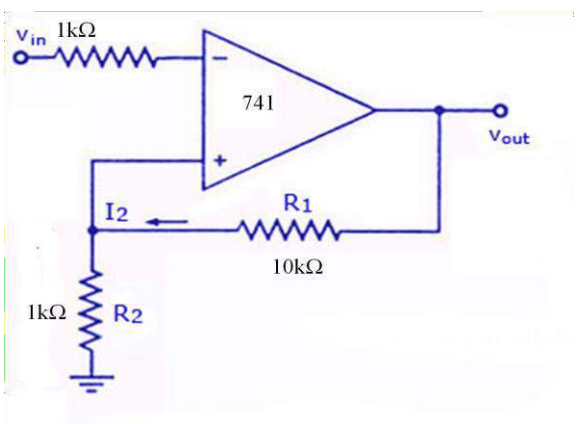


Fig 10.1: circuit diagram of schmitt trigger using IC741

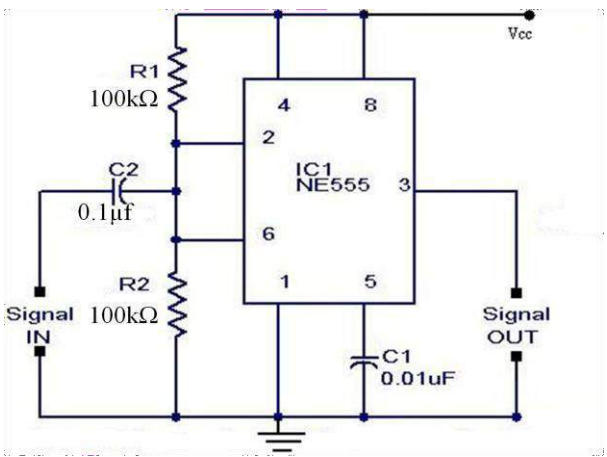


Fig 10.2: circuit diagram of schmitt trigger using IC555

THEORY:

In Schmitt Trigger two internal comparators are tied together and externally biased at VCC/2 through R_1& R_2. 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 waveoutput.

PROCEDURE for IC 741

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

PROCEDURE for IC 555:

1. Connect the circuit as shown in fig(10.2).
2. Apply the input sine wave 5V (P-P) using function generator at 1KHZfrequency.
3. Observe the output waveform at Pin No:3.

INPUT AND OUTPUT WAVE FORMS OF SCHMITTH TRIGGER:

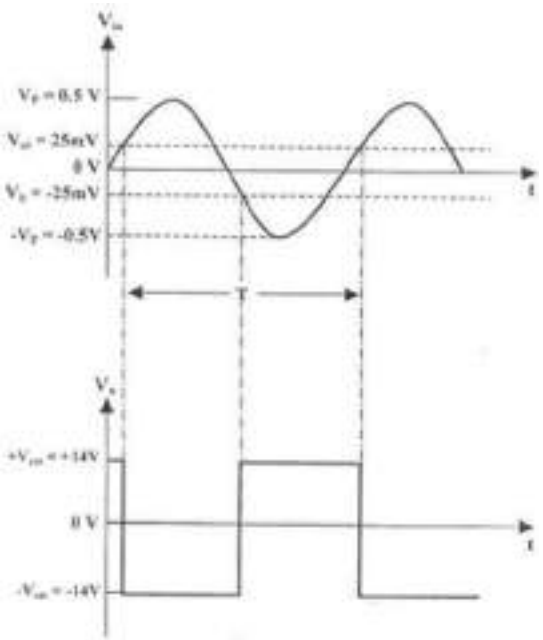


Fig 10.3: expected input and output waveforms of Schmitt trigger

Observations for Schmitt trigger using IC 741:

Input signal

Amplitude = Time period=

Output signal

Amplitude = Time period=

Observations for Schmitt trigger using IC 555:

Input signal

Amplitude = Time period=

Output signal

Amplitude = Time period=

Applications:

1. on/offcontrollers
2. Used as acomparator

RESULT: Hence constructed and studied Schmitt trigger using IC 741 and IC 555

REVIEW QUESTIONS:

1. How can a comparator be converted to Schmitttrigger
2. What do you mean by the Phenomenon hysteresis orbacklash?
3. Why do we short pin 2 and pin 6 of IC 555 timer for Schmitt triggeroperation.
4. Why do we connect pin 4 of 555 timer toVcc.
5. Why do we call Schmitt trigger as square wavegenerator.
6. How do you vary the duty cycle of the outputwaveform?
7. What are the applications of Schmitttrigger?
8. Design a Schmitt trigger with an UTP =3V and LTP=5V and an input voltage of10v.

Redraw Circuit:

GRAPH

GRAPH

EXPERIMENTNO:11 **Date:**

PHASE LOCKED LOOP (PLL) USING IC 565

AIM: To calculate free running frequency, capture range and lock range of PLL System.

APPARATUS REQUIRED:

1. C.R.O
2. FunctionGenerator
3. DC powersupply
4. CDS board / BreadBoard
5. Connectingwires

COMPONENTS REQUIRED:

1.	LM 565IC		: 1No
2.	Resistors	10K	:1No
		680Ω	:2No
3.	Capacitors	0.1µ F	: 1No
		1µ F	: 1No
		0.01µ F	: 1No

CIRCUIT DIAGRAM:

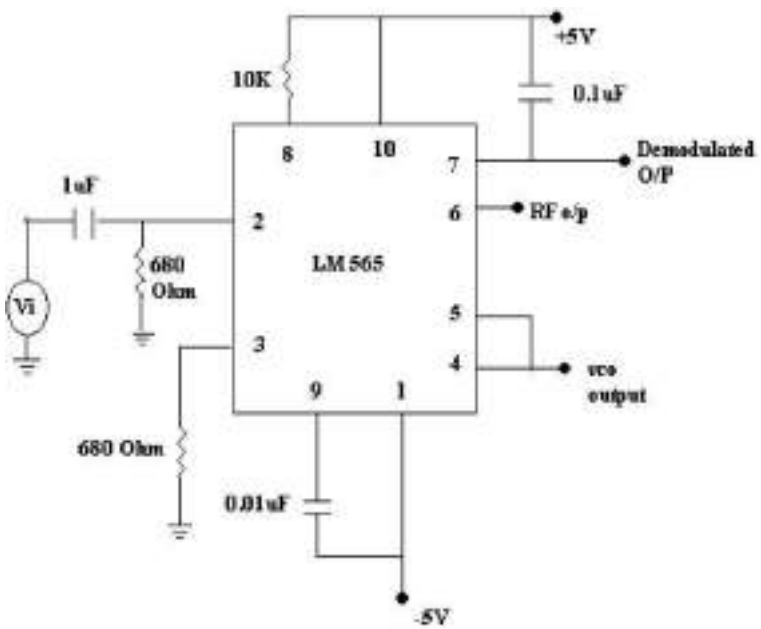


Fig 11.1:circuit diagram of PLL using IC 565

THEORY:

The fig.11.1 shows the phase-locked loop (PLL) in its basic form. The PLL consists of i) a phase detector ii) a low pass filter and iii) a voltage controlled oscillator as shown.

The phase detector, or comparator compares the input frequency f_{IN} with the feedback frequency f_{OUT}. The output of the phase detector is proportional to the phase difference between f_{IN} and fout. The output voltage of a phase detector is a dc voltage and therefore is often referred to as the error voltage. The output of the phase detector is then applied to the low-pass filter, which removes the high-frequency noise and produces a dc level. This dc level, in turn, is the input to the voltage-controlled oscillator (VCO). The filter also helps in establishing the dynamic characteristics of the PLL circuit. The output frequency of the VCO is directly proportional to the input dc level. The VCO frequency is compared with the input frequencies and adjusted until it is equal to the input frequencies. In short, the phase-locked loop goes through three states: free running, capture, and phaselock.

Before the input is applied, the phase-locked loop is in the free-running state. Once the input frequency is applied, the VCO frequency starts to change and the phase-locked loop is said to be in the capture mode. The VCO frequency continues to change until it equals the input frequency, and the phase-locked state. When phase locked, the loop tracks any change in the input frequency through its repetitive action.

Lock Range: The range of frequencies over which the PLL can maintain lock with incoming signal is called the " Lock Range" or "Track Range"

FL= 8f0/V where V= + V –(–V), where f0 is free running frequency. Capture range: The range of frequencies over which the PLL can acquire lock with an input signal is called the capturerange.

PROCEDURE:

1. Apply +5v to pin 10 and –5v to pin 1 ofLM565
2. Connect R1= 10KΩ resistor from pin 8 to10 and C1 =0.01μ F capacitor from pin 9 to1.
3. Connect 680Ω resistor from pin 2 & pin 3 toground.
4. Connect pin 4(VCO o/p) to CRO and measure its frequency. This frequency is called the free running frequency,fo.
5. Calculate f0 theoretically using the formula f0 = 1.2 /4R1C1 and compare it with practicalvalue.
6. Connect the circuit as shown infig.
7. Apply square wave at the input with amplitude of 2Vpp and also connect it to channel 1 ofCRO.
8. Connect pin 4(VCO o/p) to channel 2 ofCRO.
9. Vary the input signal frequency in steps and measure its corresponding o/p frequency.
10. Find the lock range and capture range from the obtaineddata.

TABULAR COLUMN:

S.No	Input frequency in HZ	Output frequency inHZ	$F_{c \text{ in HZ}}$	F_L in HZ

Applications:
1. Frequencymultiplier
2. Frequencysynthesizer
3. FMdemodulator
4. FSKdemodulator
5. AM detection
6. Frequencytranslation

RESULT: Free running frequency, lock range and capture range of PLL are measured practically and compared with theoretical values.

REVIEW QUESTIONS:
1. Define lockrange
2. Define capturerange
3. What is the basic operating frequency ofVCO
4. What is meant by phasedetector
5. What are the types of phasedetector
6. Calculate lock range and capture range with basic operating frequency of 2khz and a cut of frequency of1khz

Redraw Circuit:

EXPERIMENTNO:12 **Date:**

VOLTAGE CONTROLLED OSCILLATOR (IC 566)

AIM: To construct and study the voltage controlled oscillator-using IC 566.

APPARATUS REQUIRED:

1. FunctionGenerator.
2. C.R.O.
3. CDS Board/ BreadBoard
4. Connecting Patchchords.

COMPONENTS REQUIRED:

IC 566		1No
Resistor	10kΩ	1No
	1.5kΩ	1No
	20kΩ	1No
Capacitor	1µf	1No
	0.1µf	1No
	0.01µf	1No

CIRCUIT DIAGRAM:

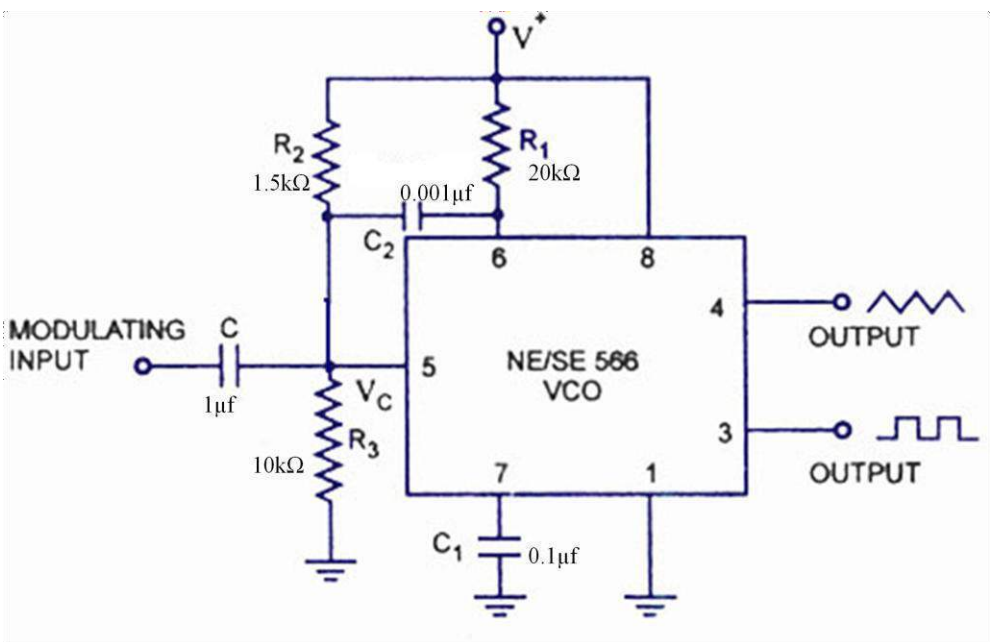


Fig 12.1: circuit diagram of VCO using IC 566

THOERY:

Fig.12.1 shows the circuit diagram of VCO. This arrangement R1C1 combination determines the free running frequency and the control voltage Vc at terminal 5 is sent by the voltage divider formed with R2 and R3. The initial voltage Vc at terminal is

$\frac{3}{4}V_{cc} \leq V_c \leq V_{cc}$ Where +V is the total supplyvoltage.

PROCEDURE:

1. Connect the circuit as shown infig.
2. Switch on the power supply of 12V DC & observe square wave output at pin no.3 & triangular wave output at pinno.4.
3. Keep the product of R1 C1 asconstant.
4. By varying the control voltage Vc, between ¾(Vcc) and Vcc observe the outputfrequency.

WAVEFORMS:

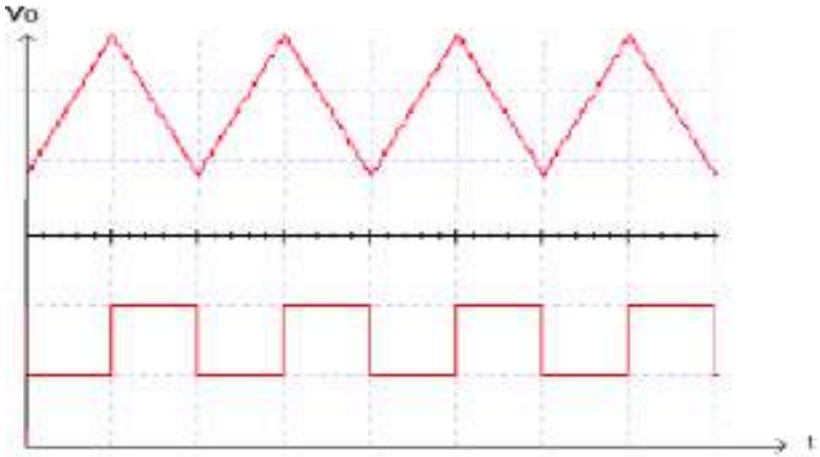


Fig 12.2: expected output waveforms of VCO

Observations:

Square wave Output signal

Amplitude = Time period=

Triangle wave Output signal

Amplitude = Time period=

Applications:

1. Functiongenerators,
2. The production of electronic music, to generate variabletones,
3. Phase-lockedloops,
4. Frequency synthesizers used in communicationequipment.

RESULT: Voltage controlled oscillator-using IC 566 is constructed and the frequency of oscillations is estimated. Also observed the variations in the output signal frequency in accordance with the modulating or control voltage, Vc.

REVIEW QUESTIONS:

1. Mention the applications of voltage-controlledoscillator.
2. How do you vary the VCOfrequency?
3. Why it is called as Voltage controlledoscillator.
4. Draw the internal block diagram of IC 566 andexplain.
5. Derive f0 of the voltage-controlledoscillator.
6. What is the voltage to frequency conversion factor Kv of IC566?
7. Give the pin configuration of IC 566 and explain eachpin.
8. list out the applications ofVCO.

Redraw Circuit:

GRAPH

EXPERIMENTNO:13 **Date:**

VOLTAGE REGULATOR USING IC 723

AIM: a) To construct and study low and high voltage regulators using IC 723. b) To find the %regulation of low and high voltageregulators.

APPARATUS REQUIRED:

1. Oscilloscope.
2. DigitalMultimeter.
3. Connecting patchchords.
4. CDS Board / BreadBoard
5. Regulated Power Supply

COMPONENTS REQUIRED:

1.	IC 723	: 1No.
3.	Resistors ---- 2.2KΩ	:2No.
	3.3kΩ,30kΩ,330kΩ	:1No.
4.	Capacitors ---- 100pF	:1No.
	0.1 µF	:1No.

CIRCUIT DIAGRAMS:

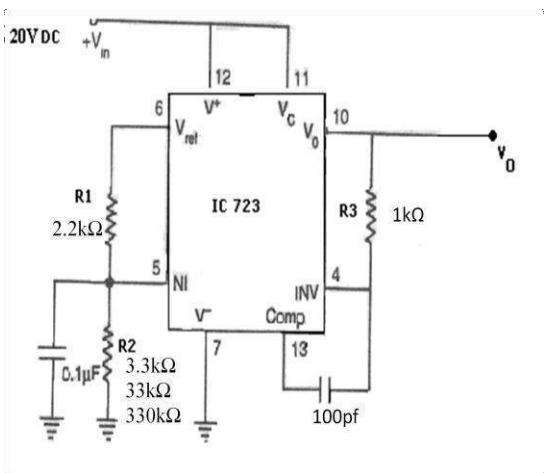


Fig 13.1:circuit diagram oflowvoltageregulator

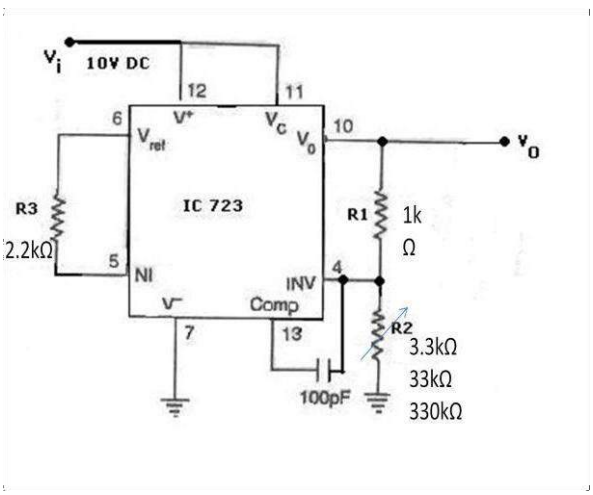


Fig 13.2:circuit diagram of high voltageregulator

Theory:

The IC 723 is a monolithic integrated circuit voltage regulator featuring high ripple rejection, excellent input and load regulation & excellent temperature stability etc. It consists of a temperature compensating reference voltage amplifier, an error amplifier, 150mA output transistor and an adjustable output current limiter.

The basic low voltage regulator type 723 circuit is shown in figure.1.The unregulated input voltage is 24V and the regulated output voltage is varied from 0.2V to 7.5V by varyingthe value of

R2. A stabilizing capacitor (C1) of 100pF is connected between frequency compensation terminal and inverting (INV) terminal. External NPN pass transistor is added to the basic 723-regulator circuit to increase its load current capability. For intermediate output voltages the following formula can be used

$$Vout = (R_2/R_1+R_2)\ Vref$$

The basic high voltage regulator type 723 circuit is shown in figure.2.The output voltage can be regulated from 7 to 37Volts for an input voltage range from 9.5 to 40Volts.

PROCEDURE:

LOW VOLTAGE REGULATOR

1. Connect the circuit diagram as shown infigure.13.1.
2. Apply the unregulated voltage to the 723 IC and note down the regulator outputvoltage.
3. Calculate the line regulation of the regulator using theformula

$$\text{Line Regulation} = \Delta V_O / \Delta V_i$$

4. By varying 10K potentiometer at the load section and note down the regulator output voltage.
5. Calculate the Load regulation of the regulator using theformula

$$\text{Load Regulation} == \Delta V_O / \Delta I_L$$

6. Also calculate the Percentage of load regulation using theformula

$$\frac{E_1 - E_2}{E_1} * 100$$

7. Where E_1 = Output voltage without load &E_2= Output voltage withload.

HIGH VOLTAGE REGULATOR

1. Connect the circuit diagram as shown in figure13.2
2. Apply the unregulated voltage to the 723 IC and note down the regulator outputvoltage.
3. Calculate the line regulation of the regulator using theformula

$$\text{Line Regulation} = \Delta V_O / \Delta V_i$$

5. By varying 10K potentiometer at the load section and note down the regulator output Voltage.
6. Calculate the Load regulation of the regulator using theformula

$$\text{Load Regulation} = \Delta V_O / \Delta I_L$$

6. Also calculate the Percentage of load regulation using theformula

$$\frac{E_1 - E_2}{E_1} * 100$$

7. Where E1 = Output voltage without load & E2 = Output voltage withload.

OBSERVATION TABLE:

i) FOR LOW VOLTAGE REGULATOR

LINE REGULATION: (R_L is constant)

S.No	Unregulated DCinput,V_i in volts	regulated DC input,V_o in volts		
		3.3kΩ	33kΩ	330kΩ

LOAD REGULATION: (Vi is Constant)

S.No	Load resistance,R_L in Ohms	regulated DC input,V_o in volts		

OBSERVATION TABLE:

i) FOR HIGH VOLTAGE REGULATOR

LINE REGULATION: (R_L is constant)

S.No	Unregulated DC input,V_i in volts	regulated DC input,V_o in volts		
		3.3kΩ	33kΩ	330kΩ

LOAD REGULATION: (Vi is Constant)

S.No	Load resistance,R_L in Ohms	regulated DC input,V_o in volts		

EXPECTED WAVE FORMS

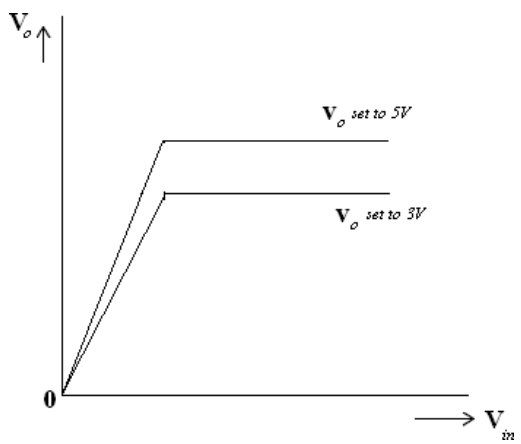


Fig 13.3:expectedlineregulationwaveform

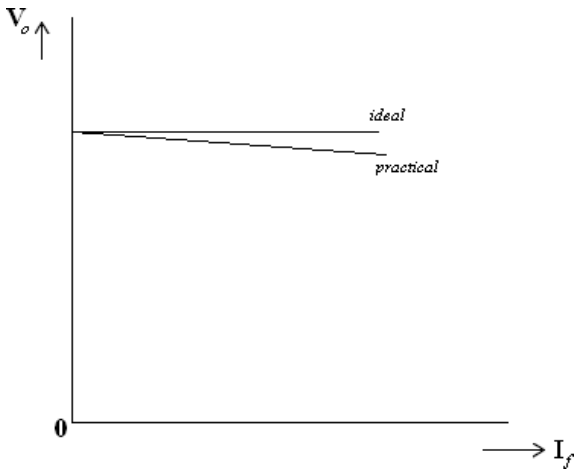


Fig 13.4:expected load regulationwaveform

Applications:

1. Low currentconsumption
2. Overvoltage/ Short-circuitprotection
3. Reverse polarityprotection
4. Over temperatureprotection
5. Loadprotection

RESULT: Low and high voltage regulators using IC 723 were constructed and studied. Also the line and load regulations of the low & high voltage regulators are verified.

REVIEW QUESTIONS:

1. What is the function of a voltageregulator?
2. What is a voltage reference? Why is itneeded?
3. Draw the functional block diagram of 723 regulators andexplain.
4. Design a high voltage and low voltage regulator using IC723.
5. Define line and load regulation of aregulator.
6. List the features of a voltage regulator IC723.
7. List the different types of IC voltageregulators.
8. What are the applications of voltageregulator?

Redraw Circuit:

GRAPH

GRAPH

EXPERIMENTNO:14 **Date:**

THREE TERMINAL VOLTAGE REGULATORS

AIM: a) To construct and study the 3-terminal fixed voltage regulator using IC 78XX and 79XX series.

b) To find line regulation and load regulation of the IC regulator.

APPARATUS REQUIRED:

1. Multimeter
2. Regulated DC Dual Powersupply
3. CDS Board / BreadBoard
4. Connecting patchChords

COMPONENTS REQUIRED:

IC"s

7805	:1No
7812	:1No
7809	:1No

CIRCUIT DIAGRAM:

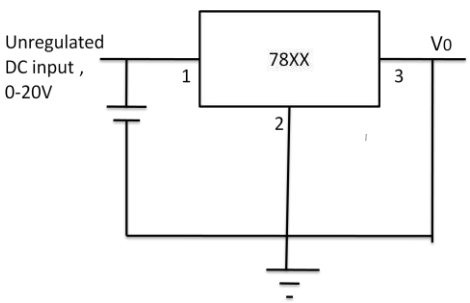


Fig 14.1circuit diagram of Fixed PositiveVoltage regulator

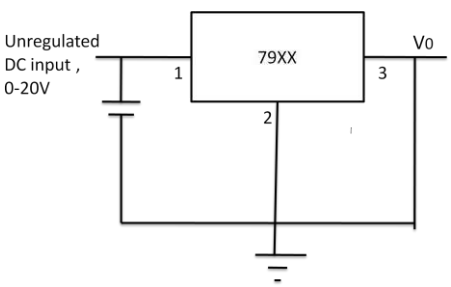


Fig 14.2circuit diagram of Fixed negative Voltageregulator

PROCEDURE:

For fixed positive voltage regulator (78XX):

1. Connect the circuit diagram as shown infigure.14.1
2. Apply the unregulated voltage to the IC 78XX and note down the regulator output voltage, vary input voltage from 7V to 20V and record the outputvoltages
3. Calculate the line regulation of the regulator using theformula

$$\text{Line Regulation} = \Delta V_O / \Delta V_i$$

5. By varying the load resistance R**L** note down the regulator output voltage.
6. Calculate the Load regulation of the regulator using theformula

$$\text{Load Regulation} == \Delta V_O / \Delta I_L$$

For fixed negative voltage regulator (79XX):

1. Connect the circuit diagram as shown infigure.2.
2. Apply the unregulated voltage to the IC 79XX and note down the regulator output voltage, vary input voltage from 7V to 20V and record the outputvoltages
3. Calculate the line regulation of the regulator using theformula

$$\text{Line Regulation} = \Delta V_O / \Delta V_i$$

4. By varying the load resistance R**L** note down the regulator outputvoltage.

5. Calculate the Load regulation of the regulator using theformula

$$\text{Load Regulation} == \Delta V_O / \Delta I_L$$

OBSERVATION TABLES:
FOR POSITIVE VOLTAGE REGULATOR
LINE REGULATION: **(RL is constant)**

S.No	Unregulated DC input, V_i in volts	regulated DC input, V_o in volts		
		5V	9V	12V

EXPECTED WAVE FORMS:

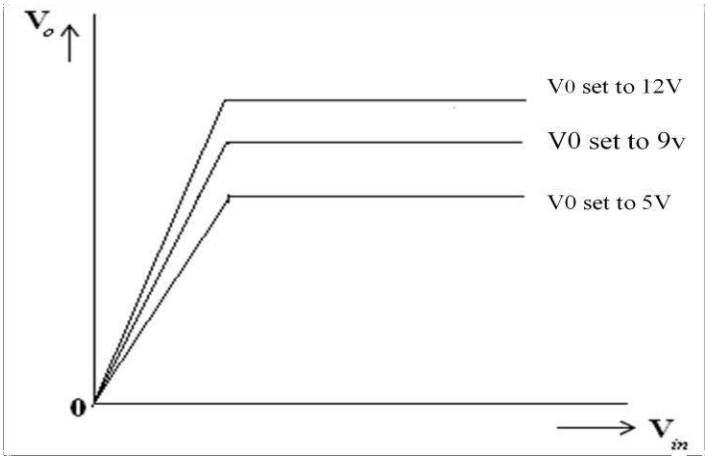


Fig 14.3:expected output waveforms Line regulation for 78xx

RESULT: Hence constructed and studied the 3-terminal fixed voltage regulator using IC 78XX and 79XX series & also the line regulation and load regulation of them are verified.

REVIEW QUESTIONS:

1. Define line and loadregulation.
2. Mention the application of voltageregulator.
3. List the types of voltageregulator.
4. Listthedifferenttypesof3-terminalvoltage regulatorIC's?
5. Draw and explain the internal block diagram of 3- terminal regulatorIC.
6. What is the difference between a +ve and a –ve voltageregulator.
7. Compare three terminal voltage regulators with 723 voltageregulator.
8. List the features of IC voltageregulators.

Redraw Circuit:

GRAPH

EXPERIMENTNO:15 **Date:**

DIGITAL TO ANALOG (D/A) CONVERTERS

AIM: To obtain analog output voltages for the digital input data using 4-bit R-2R ladder type D/A converter.

APPARATUS REQUIRED:

1. 4 – Bit D/A converter (R-2R) TrainerKit.
2. Multimeter.

COMPONENTS REQUIRED:

IC 741		1No
Resistor	10kΩ	3No
	22kΩ	6No

CIRCUIT DIAGRAM:

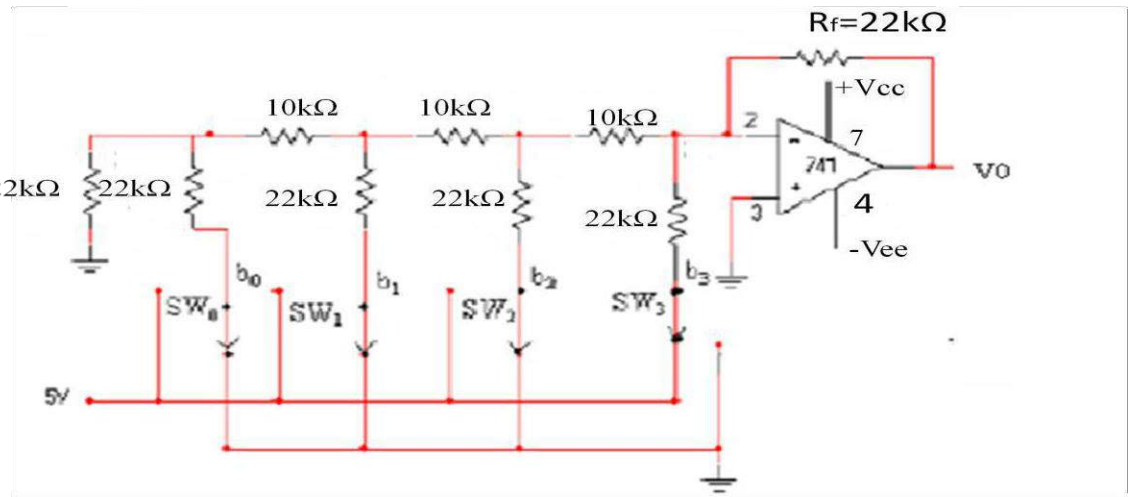


Fig 15.1: circuit diagram of D/A converter

PROCEDURE:

1. Connect the trainer to the mains and switch on the powersupply.
2. Measure the supply voltages of the circuit as +12V &-12V.
3. Calculate theoretically Vo for all digital Input data usingformula.

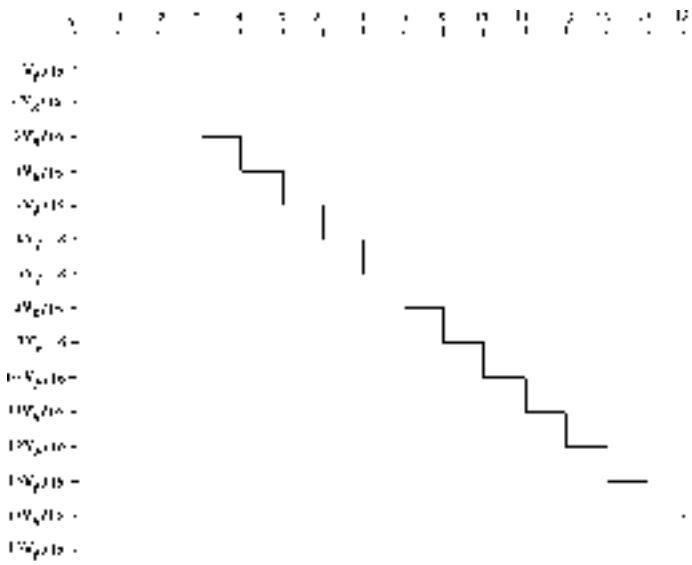
$$V_o = -R_f\left(\frac{b_0}{R} + \frac{2b_1}{R} + \frac{4b_2}{R} + \frac{8b_3}{R}\right)$$

4. In this experiment Rf = 22kΩ & R=10kΩ.
5. Note down Output voltages for different combinations of digital inputs and compare it with theoreticalvalues.

OBSERVATION TABLE:

Digital Input Data				Theoretical Value of the output, V_o (in volts)	Practical Value of the output, V_o (in volts)
b1	b2	b3	b4		
0	0	0	0		
0	0	0	1		
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1		
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1		
1	1	1	0		
1	1	1	1		

Model graph:



Applications:

1. Audio

   Most modern audio signals are stored in digital form (for example MP3sand CDs) and in Order to be heard through speakers they must be converted into an analog signal.

2. Video

   Video signals from a digital source, such as a computer, must be converted to analog form If they are to be displayed on an analog monitor.

RESULT: Obtained analog output voltages for the given digital input data using 4- bit R-2R ladder network D/A converter.

REVIEW QUESTIONS:

1. Derive the expression for the output voltage V0 of R-2R type D/Aconverter.
2. What are the advantages of R-2R type D/Aconverter?
3. Compare R-2R Type with weighted resistor type D/Aconverter.
4. Mention the applications of D/Aconverters.
5. Define the terms full-scale voltage and one least-significant bit for D/Aconverter.
6. Determine the output voltage for the following input digital words when 4-bitD/A converter with Vr=10V,Rf=10KΩ is considered
   i) 0001 ii) 0110 iii)1010
7. What is the difference between Inverted R-2R and Non-Inverted R-2R type D/A converter?
8. What are the applications of D/Aconverter?

Redraw Circuit:

GRAPH

Projects to be implemented:

Automatic StreetLight

1. Introduction:

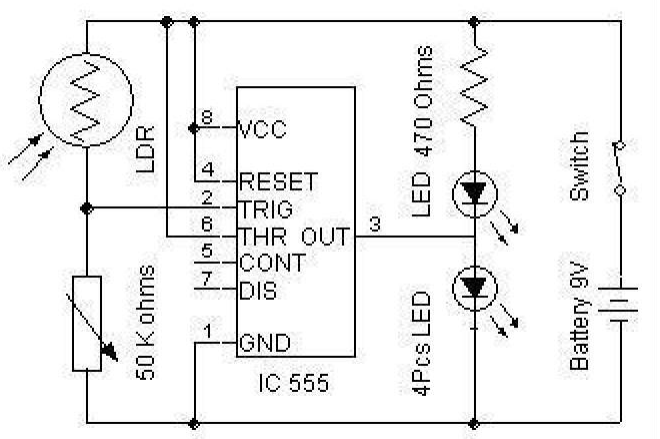
Needs no manual operation for switching ON and OFF. When there is a need of light itautomatically switches ON. When darkness rises to a certain level then sensor circuit gets activatedand switches ON and when there is other source of light i.e.daytime, the street light gets OFF.

The sensitiveness of the street light can also be adjusted. In our project we have used four L.E.Das a symbol of street lamp, but for high power switching one can connect Relay (electromagneticswitch) at the output of pin 3 of I.C 555 that will make easy to turn ON/OFF any electricalappliances that are connected throughrelay.

Principle:

This circuit uses a popular timer I.C 555. I.C 555 is connected as comparator with pin-6 connectedwith positive rail, the output goes high(1) when the trigger pin 2 is at lower then 1/3rd level of thesupply voltage. Conversely the output goes low (0) when it is above 1/3rd level. So small changeinthe voltage of pin-2 is enough to change the level of output (pin-3) from 1 to 0 and 0 to 1. Theoutput has only two states high and low and can not remain in any intermediate stage. It is poweredby a 6V battery for portable use. The circuit is economic in power consumption. Pin 4, 6 and 8 isconnected to the positive supply and pin 1 is grounded. To detect the present of an object we haveused LDR and a source oflight.

LDR is a special type of resistance whose value depends on the brightness of the light which isfalling on it. It has resistance of about 1 mega ohm when in total darkness, but a resistance of onlyabout 5k ohms when brightness illuminated. It responds to a large part of light spectrum. We havemade a potential divider circuit with LDR and 100K variable resistance connected in series. Weknow that voltage is directly proportional to conductance so more voltage we will get from thisdivider when LDR is getting light and low voltage in darkness. This divided voltage is given to pin2 of IC 555. Variable resistance is so adjusted that it crosses potential of 1/3rd in brightness andfallbelow 1/3rd in darkness.Sensitiveness can be adjusted by this variable resistance. As soon asLDR gets dark the voltage of pin 2 drops 1/3rd of the supply voltage and pin 3 gets high and LEDor buzzer which is connected to the output getsactivated.



Circuit Diagram of Automatic Street Light

Component used :

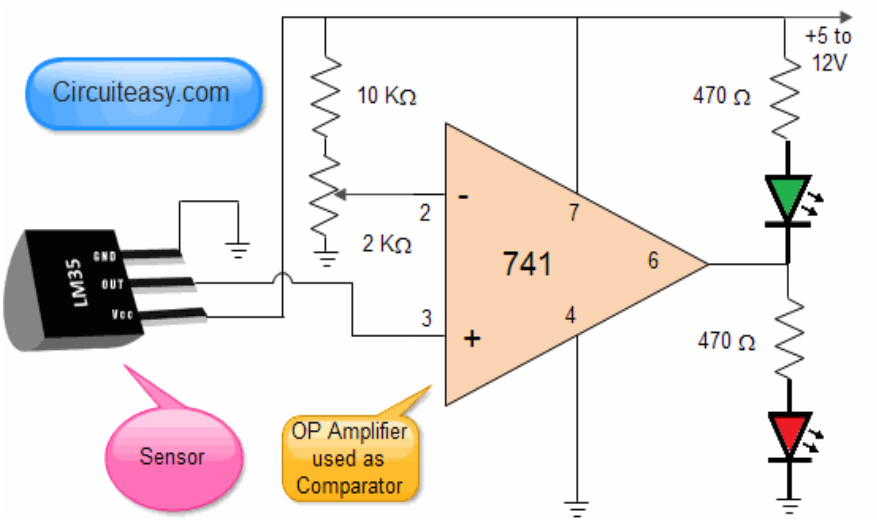
1. 9v Battery withstrip
2. Switch
3. L.D.R (Light DependingResistance)
4. I.C NE555 withBase
5. L.E.D (Light Emitting Diode) 3 to 6 pieces.
6. Variable Resistance of 47 KΩ
7. P.C.B (Printed Circuit Board of 555 or Vero board.

2. TemperatureSensor

This project uses IC LM35 as a sensor for detecting accurate centigrade temperature. Linearitydefines how well over a range of temperature a sensor"s output consistently changes. Unlikethermistor, Linearity of a precision IC Sensors are very good of 0.5°C accuracy and has widetemperature range. its output voltage is linearly proportional to the Celsius (Centigrade) temperature.

The LM35 is rated to operate over a -55° to +150°C temperature range.It draws only 60 µA from itssupply, it has very low self-heating, less than 0.1°C in still air. LM35 Operates from 4 to 30 volts.

Output of IC is 10mv/degree centigrade for eg if the output of sensor is 280 mV then temperature is 28degree C. so by using a Digital multimeter we can easily calculate the degree temperature. For triggerpoint you should set the voltage of pin 2 of IC 741 by using preset or potentiometer.Our aim of this project is not to construct a thermometer but to activate or deactivate a device at aparticular margin temperature. For simplicity we have used 2 LED for indication of both low (Green)and high (Red)temperature.



Circuit Diagram of temperature sensor

Working: The output of IC2 increases in proportion to the temperature by 10 mV per degree. Thisvarying voltage is feed to a comparator IC 741 (OP Amplifier). OP Amplifier are among the mostwidely used electronic devices today.The op-amp is one type of differential amplifier. It has two inputinverting (-) and non-inverting (+) and one output pin. We have used IC741 as non-inverting amplifierwhich means pin 3 is the input and the output is not reversed. This circuit amplifies the differencebetween its input terminals.

As a comparator, Bistable output of an op amplifier is as follows :-

$$V_{\mathbf{out}} = \begin{cases} V_{\mathrm{S}+} & \text{if } V_1 > V_2, \\ V_{\mathrm{S}-} & \text{if } V_1 < V_2, \\ 0 & \text{if } V_1 = V_2, \end{cases}$$

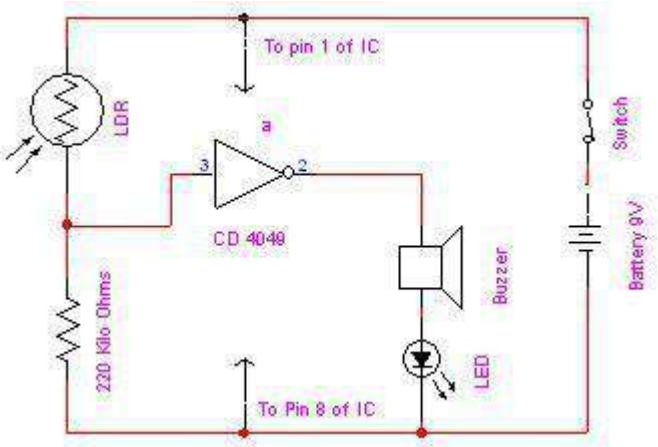
Partlist:
ICLM35,ICLM741
Resistance:10KOhms,470Ohms-
2PcsPreset orP.O.T of 2KOhms
LED-
2pcs(RedandGreen)9VBatterywithSnapSwitch
,wire

**By making this Temperature Sensor Project, student will be capable of making many similar project i.e Automatic room heater controller, determine hotness of Tea or Coffee to avoid burning your tongue, Automatic Fan Controlleretc.*

You may also be Interested in our experiment: Making a Digital Thermometer.

3. ElectronicEye

Electronic eye has much use in this electronic age, also Known as magic eye. It can be used as anautomatic guest indicator at the door, if fitted on the bottom of the door entrance. Once it is installed atthe door there is no need to install a call bell. It can also be used at homes or in banks as a burglaralarm. Fix the LDR to the wooden door or a locker to be protected in such a manner that when anybodytries to open it, a shadow falls on the LDR and the circuit gets activated and produce a pleasant soundthrough the buzzer.This electronic eye circuit uses NOT gate from CMOS I.C CD 4049. CD 4049contains six independent NOT gate in one package; we have used one only. NOT gate output goeshigh(1) when the input pin 3 is at lower then 1/3rd level of the supply voltage, conversely the outputgoes low (0) when it is above 1/3rd level. So small change in the voltage of pin-2 is enough to changethe level of output (pin-3) from 1 to 0 and 0 to 1. The output has only two states high and low and cannot remain in any intermediate stage. It is powered by a 9V battery for portable use. The circuit iseconomical in power consumption. Pin 1 is connected to the positive supply and pin 8 is grounded.To detect the present of an object we have used LDR and a source of light. LDR is a special type ofresistance whose value depends on the brightness of the light that is falling on it. It has resistance ofabout 1 mega ohm when in total darkness, but a resistance of only about 5k ohms when brightnessilluminated. It responds to a large part of light spectrum.We have made a potential divider circuit withLDR and 220 KΩ resistance connected in series. We know that voltage is directly proportional toconductance so more voltage we will get from this divider when LDR is getting light and low voltagein darkness. This divided voltage is given to input of NOT gate.As soon as LDR gets dark the voltageof input not gate drops 1/3rd of the supply voltage and pin 2 gets high and LED or buzzer which isconnected to the output gets activated. Advantage of using Logic gate is that data can be easily send toother digital interface device ieone can easily fed data to computer using parallel port or for furtherprocessing.

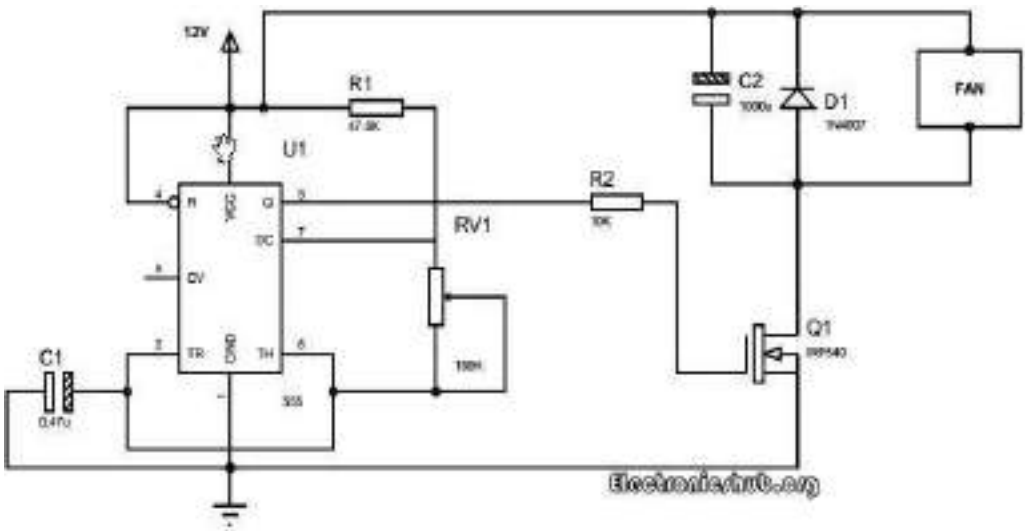


Circuit Diagram of Electronic Eye

4. PWM Based DC FanController:

We use DC fans in many systems in our day to day life. For example, CPU fans, fume extinguishers and many more appliances which we make use of are operated by DC. Most of the times we will have a need to adjust the speed of the motors to our requirement. Although some systems have an automatic adjustment system for fan speed, not all systems possess this functionality. So, we will have to adjust the speed of our fan ourselves occasionally.To adjust the speed of our fan manually, there are multiple ways to do that. We can adjust the speed by using a resistance in series with the motor. This is the simplest of all ways but it is not usually preferred because if we want to use any devices like microcontrollers or any other digital equipment for automating our DC fan speed, then this method will not work in general. A more efficient way to proceed is by using pulse width modulation technique to manage the speed of our DCmotor.

Circuit Diagram of PWM Based DC Fan Controller:



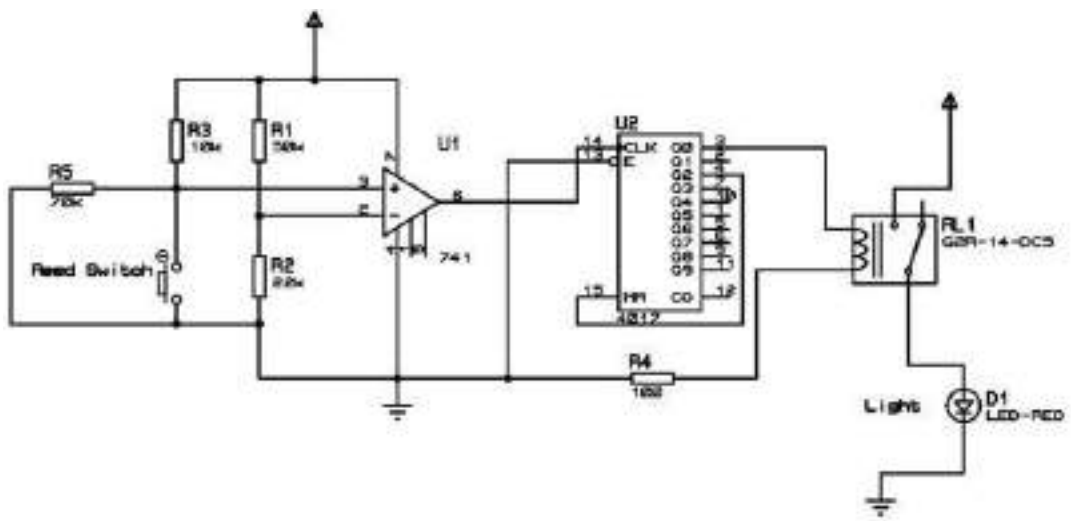
In this circuit, the DC motor is operated by a 555 integrated circuit. The IC 555 in this circuit is being operated in astable mode. In this mode, the circuit can be used as a pulse width modulator with a few small adjustments to the circuit. The frequencyof operation of the circuit is provided by the passive parameters of resistances and capacitances attached to it. The resistance between pin-7 and pin-8, the resistance between pin-6 and pin-7 and the capacitance between pin-2 and the ground govern the frequency of operation and duty cycle of the ic555 in astable mode. The duty cycleisgovernedbytheresistorwhichisinbetweenpin-6andpin-7oftheIC555timer.So,by

taking advantage of the circuits working, we can change the 555 astable multivibrator into a pulse width modulator by using a variable resistor instead of a constant resistor in between pin-6 and pin-7.One of the best things about this circuit is that we can make it work as an astable multivibrator with little hardware and by little cost which can save both the cost involved in making it as well as the space on the printed circuit board is saved. if we want a sophisticated pulse width modulator which works more accurately and which can have more adjusting capabilities, then it is better to use a microcontroller based pulse width modulator than the one which we are using now. However, the circuit or the application for which we are using a pulse width modulator is not so sensitive and hence does not demand so much of accuracy. In such a case, the circuit which we are using with a bare IC 555 is better as it saves our monetary as well as space resources in building the circuit.Theduty cycle of the circuit can be changed by changing the resistance between pin-7 and pin-6. If we increase the duty cycle, the speed of the motor increases and if we decrease the duty cycle, the speed of the motordecreases.

5. Automatic Washroom Light Switch

We turn On the lights in our washroom when we enter it and turn them off when we leave. Wesometimes forget to turn Off the lights after leaving the washroom. This may lead to powerwastage and also the lifetime of the lights may decrease. To avoid these problems, we are going tomake a circuit which automatically turns On the lights when a person enters the washroom and itautomatically turns it Off when he leaves it.By automating this, there are many advantages like,the person need not care to turn On the light always when he is using the washroom. The circuitwhich we are doing does it automatically for that person. Also, the person need not turn it off afterusing the washroom. There is no fear that he forgets to turn it Off. The circuit is also designed toconsume lesser power so that the circuit can be used in any household or public washroomswithout worrying about the powerbills.

Automatic Washroom Light Switch Circuit Diagram:

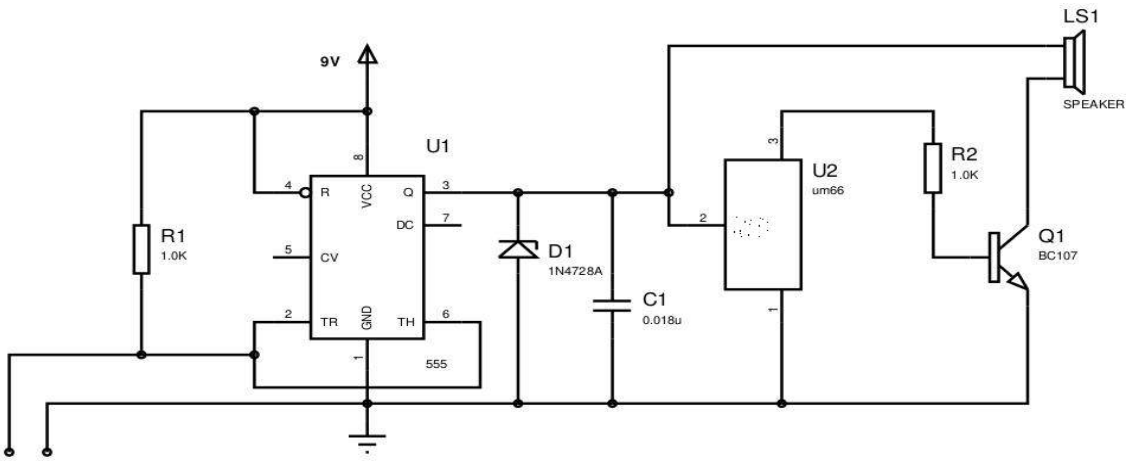


The operation of the circuit is as follows. When the door of the washroom is opened and closed,the circuit turns switches On the light using a relay. When the door opens and closes for the secondtime, the circuit turns Off the light by turning off the relay.The element which is used to detect theopening and closing of the door is a reed switch. There are two types of reed switches. We areusing the one which will be closed in normal state and open when there is a magnetic field nearby.A reed switch electrically is just a relay kind of component but unlike a relay which activates whena coil voltage is supplied, the reed switch activates when a magnetic field is detected in thevicinity. The circuit is given a power supply of 9V. The pin-16 of IC 4017 is given 9V. The pin-8of 4017 is given to ground.The circuit uses IC 741 op-amp as a comparator arranged such that itsoutput is high by default when the door is closed. The circuit is attached to the door

framewhereas

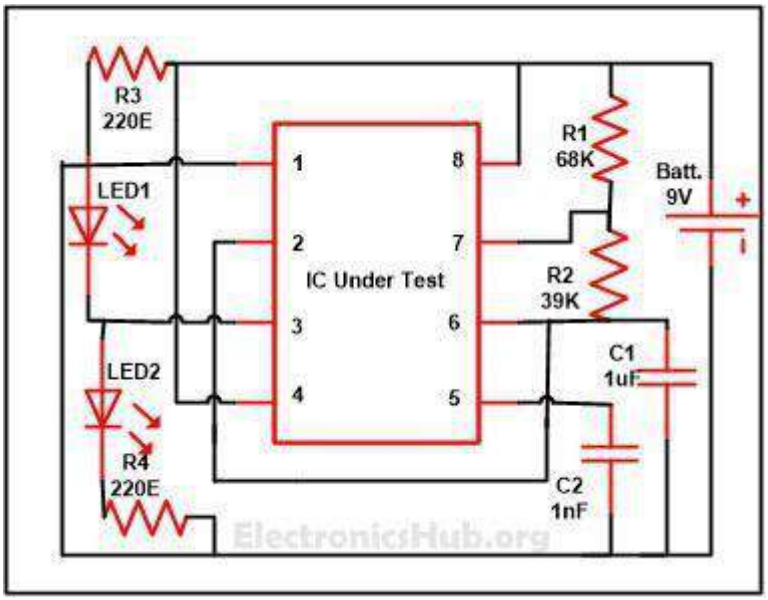
a permanent magnet is attached to the door in such a way that it comes closer to the reed switchwhen it is closed. The IC 4017 is made to alternate between each door open and door close. Whenthe door is opened and closed for one time, the circuit turns On the relay and the the Light turnsON. When the door is opened and closed for the next time, the circuit turns Off the relay and thelight turns off. The IC 4017 is capable of counting uptonine counts but we are restricting it tocount only two and reset back. The ability of this IC to adjust the count value as desired helped usin this project to use it as a one bit counter.When the door is closed, the reed switch opens andhence the op-amp output which is the 6th pin of IC 741 is HIGH. When the door is closed, the pin-6 of IC 741 is turned Off. When the dooris closed back, it triggers the IC 4017 decade counter andhence the relay toggles ON and OFF for each door open and closeoperation.

6. Circuit Diagram of ContinuityTester:



There are many circuit testers already designed but this comes with an improvement that when the circuit detects the connection, it makes a melodious sound which is pleasing to hear instead of the irritating buzzer sound which is intolerable to hear. That too, this circuit does it using integrated circuits wherever possible in an efficient manner so that the hardware is kept to a minimum and the circuit size is also reduced.The circuit uses the 555 IC timer in buffer mode. The output of the 555 IC is a DC voltage when the circuit probes detects the connection shorted. This output is given to a music generating IC which is UM66. This music generating integrating circuit is then given the input from the output of the IC 555. The output is high only when the circuit detects the probes are shorted. If not, the output is kept low. The music which is generated by the integrated circuit um66 can he heard through the loudspeaker. The loudspeaker used is a mini 8 ohms loudspeaker. The circuit can be conveniently assembled onto a printed circuit board so that it comes handy whenever we need to test a circuit for continuity or short circuits. A battery power supply can be used for powering this circuit as the circuit is made to consume very little power due to which using a battery based power supply is ideal as the batteries will last longer maintaining the portability of the circuit.

7. 555 Timer IC Testing SimpleCircuit:



555 Timer IC Testing Circuit

Components used in this Circuit:

- IC-NE555
- R1-68K
- R2-39K
- R3,R4-20E
- C1-1uF/25V
- C2-1nF
- LED1,LED2

This simple 555 IC testing-circuit tests your entire 555 timer IC, so before using your IC check immediately that your IC is good or bad by checking it. This can be done by checking the IC that is it is oscillating or not. Or you can use this circuit in some other circuits also to troubleshoot the proper working of 555 IC.This tester will rapidly tell you if the timer is functional or not. Important feature of this circuit is it will tell 555 timer is shorted or it is not oscillating. Assemble the circuit properly as shown in circuitdiagram.

How to Check the 555 Timer IC:

First of all insert the IC in socket very carefully so that no pin of 555 timer get damage. Now to see the result, switch on the power supply. If your 555 timer is working properly, both the LED1 and LED2 will glow. And any of the LEDs is off or both LED1 and LED2 are not glowing means your 555 timer IC is faulty.

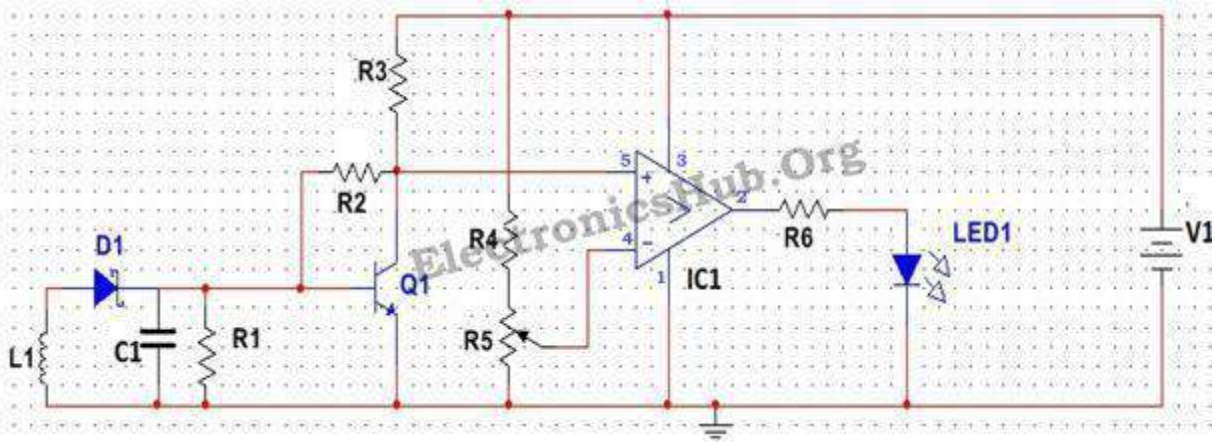
Working of 555 Timer IC Circuit:

In this circuit, we have used the NE555 IC as an astable multivibrator and when power is provided to circuit, the LEDs will start blinking which will show that the IC is working. The blinking rate of LEDs can be changed by increasing or decreasing the values of resistor R1 and R2 and capacitor C1.You can calculate the time duration with the help of formula given below:

$$T = 0.7(R1+2R2)*C1 \text{ in seconds.}$$

As soon as power supply is provided, C1 will start charging through R1and R2.When the voltage across C1 rises above 2/ 3 of supply voltage, the internal Flip Flop toggles. As a result, pin 7 becomes low and C1 starts discharging. When the voltage across C1 goes below 1/ 3 of supply voltage, the internal Flip Flop resets and pin 7 goes high. The C1 again starts charging. All this will happen only when your IC is in good condition. According to the frequency as set with the help of resistor R1, R2 and capacitor C1 charging and discharging take place and LED1 and LED2 will flash accordingly. From these observations, we can conclude that IC NE555 is faulty or not.

8. Circuit Diagram of Cell PhoneDetector:



Circuit Diagram of Cell Phone PhoneDetector

Circuit Components:

- V1 =12V
- L1 =10uH
- R1 =100Ohms
- C1 =100nF
- R2 =100K
- R3 =3K
- Q1 =BC547
- R4 = 200Ohms
- R5 = 100Ohms
- IC1=LM339
- R6 = 10 Ohms
- LED = BlueLED

Cell Phone Detector Circuit Design:

Detector Circuit Design:

The detector circuit consists of an inductor, diode, a capacitor and a resistor. Here an inductor value of 10uH is chosen. A Schottky diode BAT54 is chosen as the detector diode, whichcan

rectify low frequency AC signal. The filter capacitor chosen in a 100nF ceramic capacitor, used to filter out AC ripples. A load resistor of 100 Ohms is used.

Amplifier Circuit Design:

Here a simple BJT BC547 is used in common emitter mode. Since the output signal is of low value, the emitter resistor is not required in this case. The collector resistor value is determined by the value of battery voltage, collector emitter voltage and collector current. Now the battery voltage is chosen to be 12 V (since maximum open source collector emitter voltage for BC 547 is 45V), operating point collector emitter voltage is 5 V and collector current is 2 mA. This gives a collector resistor of approx 3 K. Thus a 3 K resistor is used as Rc. The input resistor is used to provide bias to the transistor and should be of larger value, so as to prevent the flow of maximum current. Here we chose a resistor value of 100K.

Comparator circuit Design:

Here LM339 is used as comparator. The reference voltage is set at the inverting terminal using a potential divider arrangement. Since output voltage from the amplifier is quite low, the reference voltage is set low of the order of 4V. This is achieved by selecting a resistor of 200 Ohms and a potentiometer of 330 Ohms. An output resistor of value 10 Ohms is used as a current limiting resistor.

Mobile Phone Tracking Circuit Operation:

In normal condition, when there is no RF signal, the voltage across the diode will be negligible. Even though this voltage is amplified by the transistor amplifier, yet the output voltage is less than the reference voltage, which is applied to the inverting terminal of the comparator. Since the voltage at non inverting terminal of the OPAMP is less than the voltage at the inverting terminal, the output of the OPAMP is low logic signal.Now when a mobile phone is present near the signal, a voltage is induced in the choke and the signal is demodulated by the diode. This input voltage is amplified by the common emitter transistor. The output voltage is such that it is more than the referenceoutputvoltage.TheoutputoftheOPAMPisthusalogichighsignalandtheLEDstarts

glowing, to indicate the presence of a mobile phone. The circuit has to be placed centimeters away from the object to be detected.

9. Battery Voltage State Indicator using741

Hereisasimplecircuitusingop-amp741called"Batteryvoltagestateindicator"usedto indicatewhetherthebatteryischargedornot.Thecircuitshowsthreestateofbatteryvoltage i.e.charged,dischargedandnormalusingthreedifferentcolorLEDs(LED_1,LED_2 andLED_3).

Circuit Description of Battery Voltage State Indicator: The circuit of battery voltage stateindicator is build around very popular and low costs op-amp IC 741. This circuit uses two op-amps in comparator mode, which compare the battery voltage with references voltage. Thebatteryvoltageisconnectedto$E$(pin2ofIC_1 andpin3ofIC_2)asshowincircuitdiagram,whichfurthercompareswithreferencevoltageE_1 andE_2.

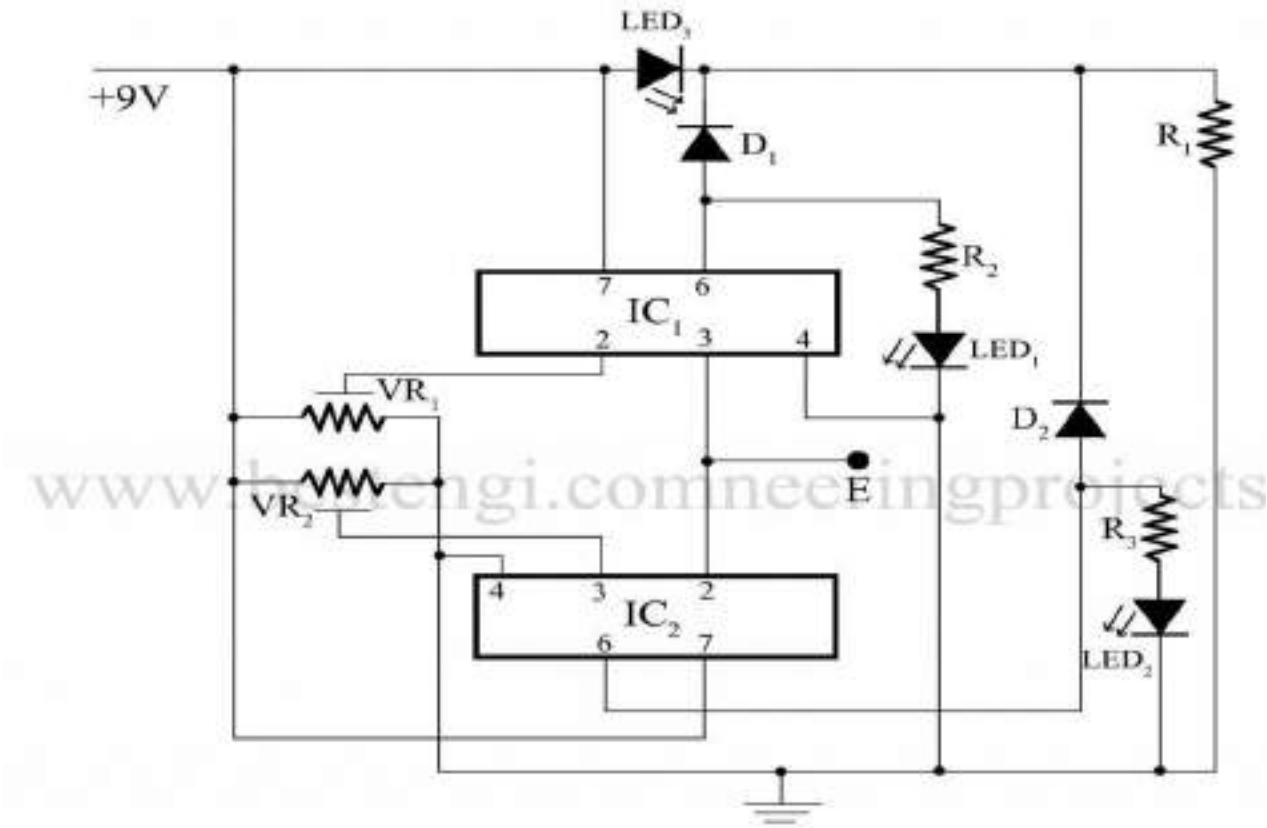


Figure 1: Circuit Diagram of Battery Voltage State Indicator Using Op amp 741

Ifthebatteryvoltageislessthen11V,LED_2 glow,similarlyifbatteryvoltageis11Vto13VLED_3 glowandifthebatteryvoltageisgreaterthan13VLED_1 glow.

ThevariableresistorsVR_1 andVR_2 issoadjustedthatthevoltagebetweenpin2ofIC_1 and

earthis13Vandvoltagebetweenpin3ofIC_3 andearthI11V.

Resistor (all ¼-watt, ± 5%Carbon)

$R_1 – R_3$ = 2.7 KΩ, VR_1, VR_2 = 22KΩ

Semiconductors

IC_1, IC_3 = 741, D_1, D_2 = 1N4148, LED_1 = Red LED, LED_2 = Orange LED, LED_3 = Green LED