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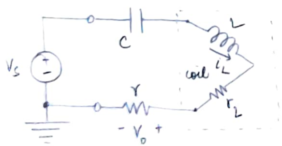

Fig 1.

Series Resonant LRC circuit

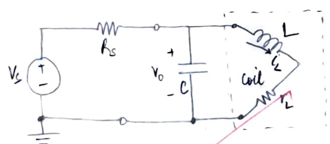

Fig 2.

Parallel Resonant LRC circuit

Experiment-6

(Series and Parallel Resonance)

Objective

→ To study the resonance frequency for both parallel and series RLC circuits.

→ To calculate the Quality Factor (Q) and bandwidth of the circuit.

Apparatus Required

i) Resistors (100Ω and $10k\Omega$)
ii) Inductor (1 mH)
iii) Capacitor ($0.1\mu F$)
iv) DSO

Theory

Resonance is a property that enables one to select a particular freq. out of a signal containing many frequencies.

At the resonant frequency, a series resonant circuit gives the minimum impedance while a parallel resonant circuit gives maximum impedance.

← The circuit configurations are shown in Fig 1. and Fig 2.

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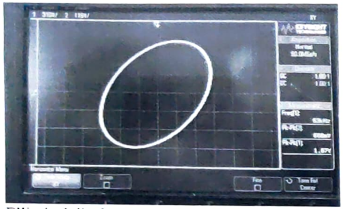
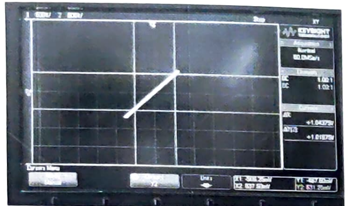


Elliptical display



straight line with 45 degrees

Observations:

A) Series Resonance

Table 1 :

According to formula, $\frac{V_o}{V_{in}} = f_s = \frac{Ch-1}{CH-2}$

$$\boxed{\frac{V_o}{V_{in}} = \frac{r}{r + r_L}}$$

$$\text{slope} = \frac{\Delta Y}{\Delta X} = \frac{1.01875}{1.04375}$$

$$\frac{100}{100 + r_L} = 0.976 \Rightarrow r_L = 2.46\,\Omega$$

Using multimeter, $r_L = 2.62\,\Omega$

experimental r_L	Measured from multimeter r_L
$2.46\,\Omega$	$2.62\,\Omega$

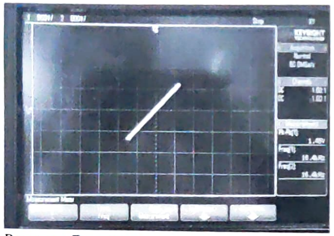
~~ex~~ correct

$$\frac{A_m}{\sqrt{2}} = \frac{0.97}{\sqrt{2}} = 0.69$$

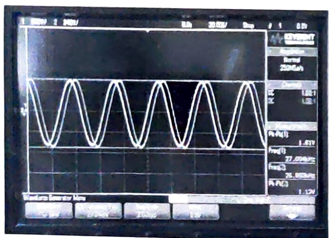
$$\frac{CH\,2}{CH\,1} = 0.69 \Rightarrow CH\text{-}2 = 0.69 \times 500$$

$V_{out} = 345$
(scale factor)

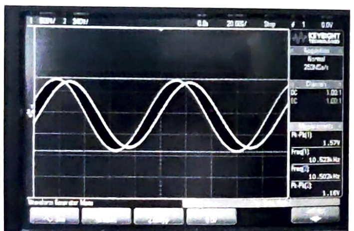
→ Applying V_{in} as 500mV and V_{out} as 345mV.



Resonant Frequency



f(H)



f(L)

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Table 2:

Series Resonance	Resonance Freq. (f_s)	$I_{max} = \frac{1}{r+r_L}$	f_L	f_H
R = 100 Ω L = 1 mH C = 0.1 μF	16.4 KHz	$\frac{1}{100+2.46}$ = 0.00976	10.5 KHz	27.04 KHz

Table 3:

$\boxed{Q = \frac{f_s}{f_2 - f_1}}$ (Practical)

$\boxed{Q = \frac{1}{R}\sqrt{\frac{L}{C}}}$ (Theoretical)

$\boxed{f_s = \frac{1}{2\pi\sqrt{LC}}}$ (Theoretical)

① Bandwidth = $f_H - f_L = 27.04 - 10.5$
$= 16.54$ KHz

② $Q = \frac{16.4}{16.54} = \boxed{0.991} \rightarrow$ measured

③ $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{100}\sqrt{\frac{10^{-3}}{0.1 \times 10^{-6}}} = \boxed{1} \rightarrow$ theoretical

④ $f_s = \frac{1}{2\pi\sqrt{10^{-3} \times 10^{-7}}} = \frac{10^5}{2\pi}$

$= \frac{10^2}{2\pi}$ KHz

$= 15.92$ KHz

Experimental res. freq. (f_s)	Experimental bandwidth	Exp. Q	Theoretical f_s	Theoretical bandwidth	Theoretical Q
16.4 KHz	16.54 KHz	0.991	15.92 KHz	15.92 KHz	1

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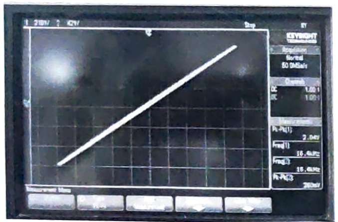
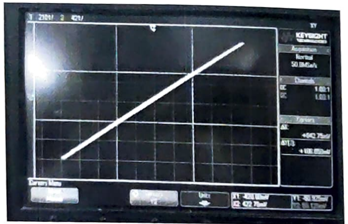


Resonant Frequency



straight line with 45 degrees

B) Parallel Resonance

$f_p = 16.4 \text{ kHz}$

$$\boxed{\frac{V_0}{V_s} = \frac{R_p}{R_s + R_p}}$$

$$\frac{\Delta Y}{\Delta X} = \frac{106.05}{842.75} = 0.1258$$

$$0.1258 = \frac{R_p}{10^4 + R_p} \Rightarrow R_p = 1.4 \text{ k}\Omega$$

$$I_{min} = \frac{1}{R_s + R_p} = \frac{1}{10 + 1.4} = \frac{1}{11.4} = 0.0877 \text{ mA}$$

Parallel Resonance	Res. freq. (f_p)	I_{min}	f_L	f_H
R = 100 Ω, L = 1 mH, C = 0.1 μF	16.4 kHz	0.0877 mA	9.55 kHz	27.88 kHz

Bandwidth $= f_H - f_L = 27.88 - 9.55$
$= 18.33$ kHz

$$Q = \frac{16.4}{18.33} = \boxed{0.894} \rightarrow \text{measured}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \boxed{1} \rightarrow \text{theoretical}$$

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Conclusion

We observe the resonance frequency for both parallel and series RLC circuits. We also calculated quality factor and bandwidth.

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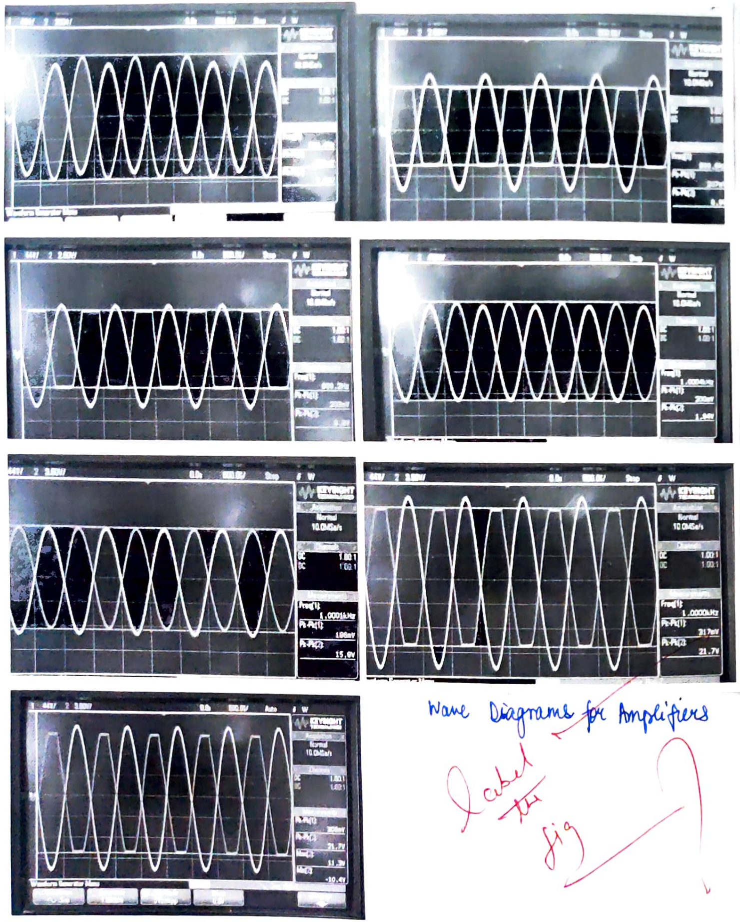


Wave Diagrams for Amplifiers

label the fig

Experiment - 7
(Voltage amplifiers using Op-Amp)

Objective:

To study the behaviours and limitations of voltage amplifiers using an operational amplifier (Op-Amp) by analysing inverting & non-inverting amplifier circuits.

Apparatus Required

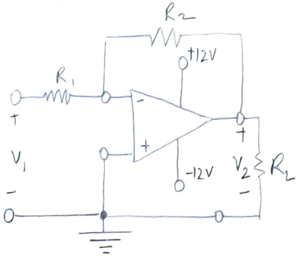
- Breadboard & connecting wire
- OPAMP IC-741
- Resistors
- Capacitors
- DC Power supply
- DSO

Theory

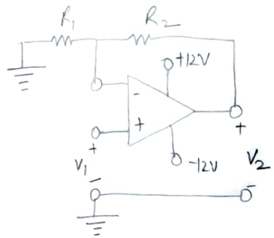
- Voltage Amplifier:
An Ideal voltage amplifier generates an output voltage proportional to the input voltage, irrespective of the load connected. The amplification factor is determined by circuit components.

- Inverting Amplifier:
The voltage gain $A_V = -\frac{R_2}{R_1}$
The output voltage is inverted relative to the input.

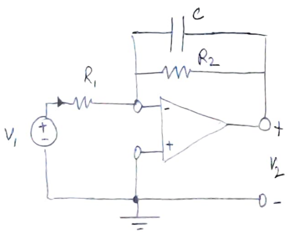
Circuit Diagrams:



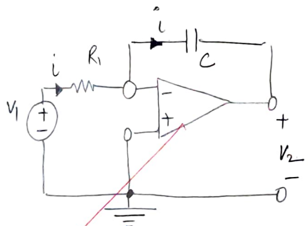
Inverting Amplifier



Non-Inverting Amplifier



Practical Integrator



Ideal Integrator

- Non-inverting amplifier:
  The voltage gain is given by $A_{vm} = 1 + \frac{R_2}{R_1}$

  The output voltage maintains the same phase as the input.

- Frequency Response:
  The gain in decibels: $G_v = 20 \log_{10} A_{vm}$

- Integrator Circuit:

  The output of an integrator follows: $V_2 = -\frac{1}{CR_2}\int v_1\,dt$

  For a sinusoidal input, the gain is $A = \frac{1}{wCR_1}$.

  A sq. wave input results in a triangular output.

Observations

A) Inverting Amplifier

R_2	V_1	V_2	A_v	Theor. $A_v = R_2/R_1$
10 KΩ	200mV	1.94V	9.7	-10
82 KΩ	196mV	15.9V	81.122	-82

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R_L	Pk-Pk(1) (V_0-)	Pk-Pk(2) (V_0+)	I_0(min)	I_0(max)
330Ω	−10.4V	11.3V	−0.0315A	0.0342 A
220Ω	−10.4V	11.3V	−0.0472 A	0.051 A
100Ω	−10.4V	11.3V	−0.104 A	0.113 A

B) Non-Inverting Amplifier

$R_2 = 18K\Omega$

Freq.	V_1	V_2	A_{vm}	$G_v = 20\log_{10} A_{vm}$	Theor. $A_{vm} = 1 + \frac{R_2}{R_1}$
0.1	0.2V	2.04V	10.2	20.172	10
0.2	0.2V	2.04V	10.2	20.172	10
0.5	0.2V	2.06V	10.3	20.256	10
1	0.2V	2.04V	10.2	20.172	10
2	0.2V	2.06V	10.3	20.256	10
5	0.2V	2.03V	10.15	20.129	10
10	0.2V	2V	10	20	10
20	0.2V	1.96V	9.8	19.824	10
50	0.2V	1.68V	8.4	18.485	10
100	0.2V	1.15V	5.75	15.193	10
200	0.2V	650mV	3.25	10.237	10
500	0.2V	269mV	1.345	2.574	10

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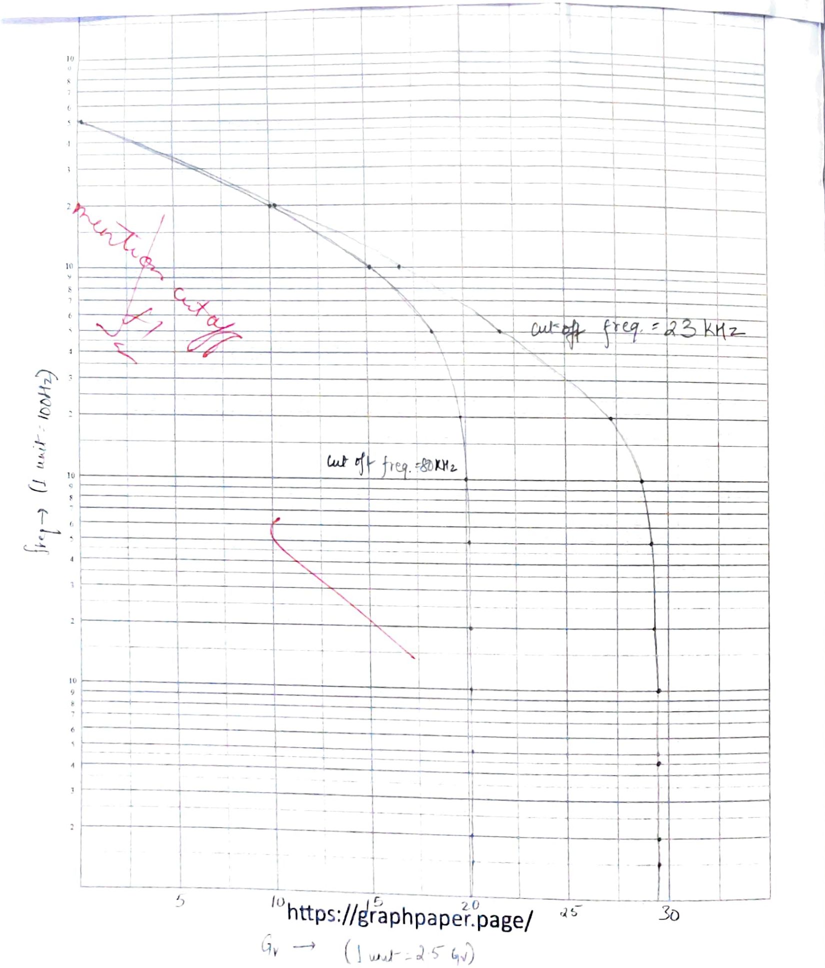

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To find cut-off frequency :-

$A_m = 10$

$$\frac{V_o}{V_i \rightarrow 0.2V} = \frac{A_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7.07$$

$V_o = 7.07 \times 0.2 = 1.4V$

We find $V_o = 1.4V$ at $f = 80\,KHz$ $\therefore$ $f_c = 80\,KHz$

$R_2 = 56\,K\Omega$

Freq.	v_1	v_2	A_{vm}	G_v	Theor. A_{vm}
0.1	0.2V	5.98V	29.9	29.513	29
0.2	0.2V	5.98V	29.9	29.513	29
0.5	0.2V	5.98V	29.9	29.513	29
1	0.2V	5.98V	29.9	29.513	29
2	0.2V	5.93V	29.65	29.44	29
5	0.2V	5.78V	28.9	29.218	29
10	0.2V	5.48V	27.4	28.755	29
20	0.2V	4.59V	22.95	27.215	29
50	0.2V	2.49V	12.45	21.903	29
100	0.2V	1.4V	7	16.902	29
200	0.2V	660mV	3.3	10.37	29
500	0.2V	204mV	1.02	0.172	29

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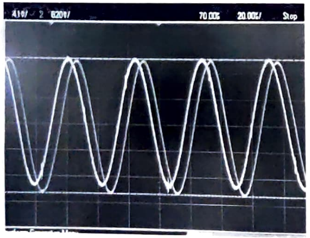

Resultant Graph

To find cut-off frequency:-

$$\frac{V_0}{V_{in}} = \frac{A_m}{\sqrt{2}} = \frac{29}{\sqrt{2}}$$

$$V_0 = \frac{29}{\sqrt{2}} \times 0.2 = 4.101V$$

We find $V_0 = 4.101V$ at $f = 23\,KHz$, $\therefore f_c = 23\,KHz$

Result

The experiment successfully demonstrated the behaviour of inverting and non-inverting amplifiers and verified their theoretical gain values. The frequency response of the non-inverting amplifier followed a low pass nature. The integrator circuit behaved as expected for sinusoidal and sq. wave inputs.

Conclusion

Through this experiment, we learnt about the properties of Op-Amps. The inverting amplifiers demonstrated phase inversion, while the non-inverting amplifier maintained phase consistency with input. Therefore, we were able to study the behaviour and limitations of voltage amplification using Op-Amps.

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c) Integrator Circuit

Waveshape	V_{1p}	V_{2p}	V_{2p}/V_{1p}	$T/4CR_1$ or $1/\omega CR_1$
Square	377mV	540mV	1.43	3.98
Sine	800mV	3.18V	3.975	3.98

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March/19/25

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Mini Project - 1
(DC Power Supply)

Objective

To design & construct a DC Power Supply that converts high voltage AC into regulated DC voltage using a step-down transformer, bridge rectifier, filter capacitor and voltage regulator ICs. The purpose is to provide a constant DC output voltage regardless of variations in input voltage or load conditions.

Apparatus Required

- AC Power Source
- Step down Transformer
- Bridge Rectifier
- Filter capacitor
- Voltage Regulator IC's: IC 7805, IC 7905
- Breadboard & connecting wires
- Multimeter
- Oscilloscope
- LED's (for load testing)

Theory

A DC power supply is essential for electronic circuits requiring stable voltage. The conversion process involves:

- Step-down Transformer: Reduces the high-voltage AC to a lower AC voltage suitable for rectification.
- Bridge Rectifier: Converts AC signal into pulsating DC using diodes

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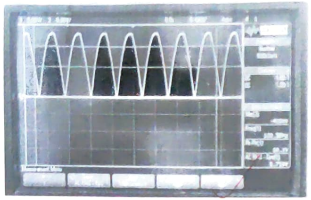
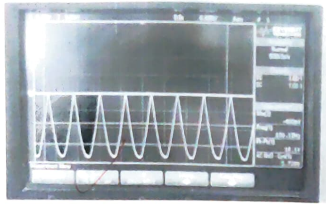
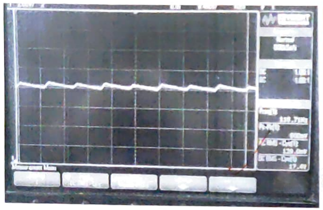
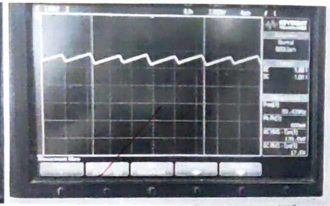




voltage across the rectifier o/p

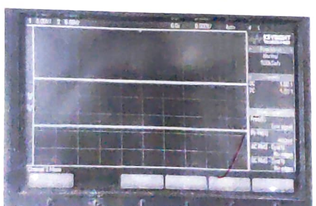




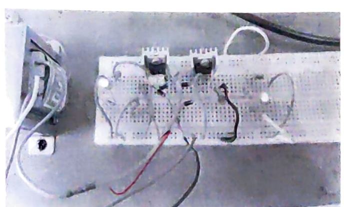
voltage across the filter o/p

voltage across the regulator 7805 o/p

voltage across the regulator 7905 o/p



Graph obtained on connecting LEDs as load across regulator o/p



Snap of circuit

arranged in a bridge configuration.

- Filter Capacitor: Smoothens the pulsating DC by reducing ripples, providing a more stable DC output.
- Voltage Regulator ICs: Ensures a constant output voltage

Observations:

- Voltage across rectifier (o/p): (AC-RMS)

  Across +ve: 5.719 V

  Across -ve: 5.728 V

- Voltage across filter (o/p): (DC-RMS)

  Across +ve: 17.4V

  Across -ve: 17.6V

- Voltage across regulator 7805 o/p: No edges (Graph is a st. line)
- Voltage across regulator 7905 o/p: No edges (Graph is a st. line)

Results:

- The circuit succesfully converted 220V AC to 12V DC.
- Voltage regulator provided a stable output, almost equal to +5V and -5V DC.
- LEDs connected to the regulator output lit up

Conclusion:

The experiment demonstrated the working of a DC power supply including voltage step-down, rectification, filtering & regulation.

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Mini Project-2

Objective

- Construct & study the performance characteristics of a push-pull audio amplifier using NPN (CL-100) & PNP (CK-100) transistors.
- Measure the audible freq. range for input signals from a funcⁿ generator & compare it with standard audible range (20Hz-20KHz)

Apparatus Required

NPN Transistors, PNP Transistors, Function Generator, DC Power Supply, Microphone, DSO, wires, Resistors & other passive components, Loudspeaker

Theory

A push-pull amplifier is a type of power amplifier designed to amplify signals with high efficiency and low distortion. It uses 2 complementary transistors (NPN and PNP) that operate in anti-phase to amplify alternate halves of the input signal.

Observation

Input Sine wave	Audible Frequency Range		Compare it with standard audible range
Function Generator	Min.	Max.	
Sine wave	24Hz	14KHz	20Hz-20KHz

Results

- The amplifier successfully reproduced sound within a freq. range close to the standard audible range.
- Using microphone as input, the amplified sound was audible through the loudspeaker, confirming proper operation of the circuit.

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Mini Project-3

Objective

To design and implement a wash basin tap control system using an IR sensor and 555 timer IC. The system aims to automate the opening and closing of a water tap based on the direcⁿ of a user's hand, thereby conserving water.

Apparatus Required

IR Sensor Module, 555 Timer IC, connecting Wires, Breadboard
Resistors (1KΩ, 470Ω, variable resistor (10KΩ potentiometer)
Capacitors (0.01μF, 1000μF)
LEDs
Diode (1N4007)
Power Supply (+5V DC)

Theory

The system uses an IR sensor to detect the presence of a hand near the tap. When the IR sensor detects an obstacle (hand), it sends a signal to the 555 Timer IC configured in monostable mode. The timer generates an output pulse that activates the solenoid valve, allowing water to flow for a specific duration determined by RC network. The ON time duration (T_{ON}) is calculated using the formula -

$$T_{ON} = R_{eff} \cdot C \cdot \ln(3)$$

where, R_{eff} = Effective resistance in the circuit.
C : Capacitance Value

By adjusting the resistance & capacitance values, the duraⁿ for which the solenoid valve remains open can be controlled.

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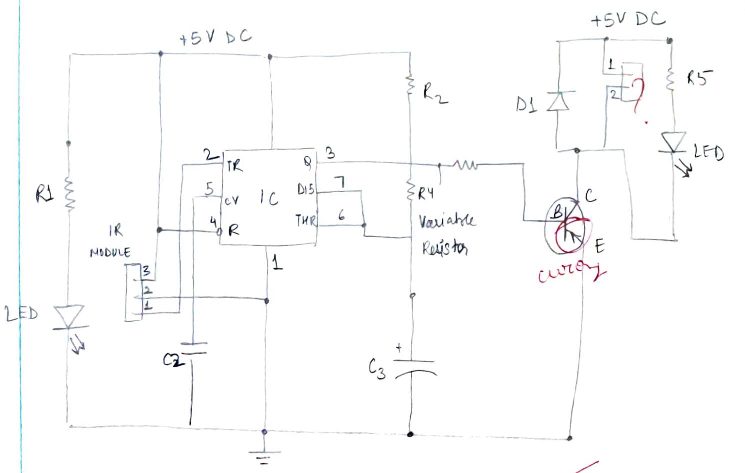

Circuit Diagram

Observations

S. No	Capacitor (C_3) value	Charging cycle resistor value	ON Time duration (Theor.)	ON Time duration (Prac.)	Mode of 555 Timer IC
For given values	1000 μF	1k	1.098 s	1.2 s	Monostable
Set the circuit to get ON time as 5 sec	1000 μF	4.55k	5 s	5.53 s	Monostable

Theoretical calculation of ON Time = $R_{eff} \times C \times \ln(3)$

$= 1000 \times 1000 \times 10^{-6} \times \ln 3 = 1.098$

Calculation of R : $5 = R\,(1000 \times 10^{-6} \times 1.098)$

$R = \dfrac{5 \times 10^{-3}}{1.098} = 4.55 \times 10^{3}$

Conclusion

The project succesfully demonstrates an automatic water tap control system using an IR sensor and 555 Timer IC. By adjusting the RC network, the ON time duration of water flow can be customized as required. The system is effective in reducing water wastage and provides a hands-free operation, enhancing hygiene.

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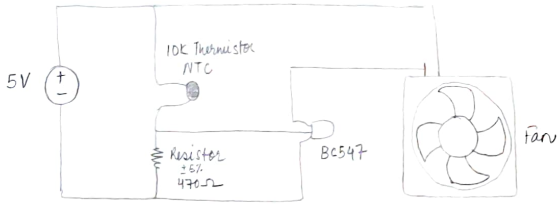


Circuit Diagram

Mini Project -5

Objective
To design & implement a simple DC fan using NTC to regulate fan's speed based on temperature changes.

Apparatus Required
DC supply, NTC Thermistor, Resistors, NPN transistors, DC fan/motor, Multimeter, breadboard, connecting wires

Theory
$\beta = \frac{I_c}{I_B}$ β (current gain of transistor) I_c (collector current) I_B (base current)

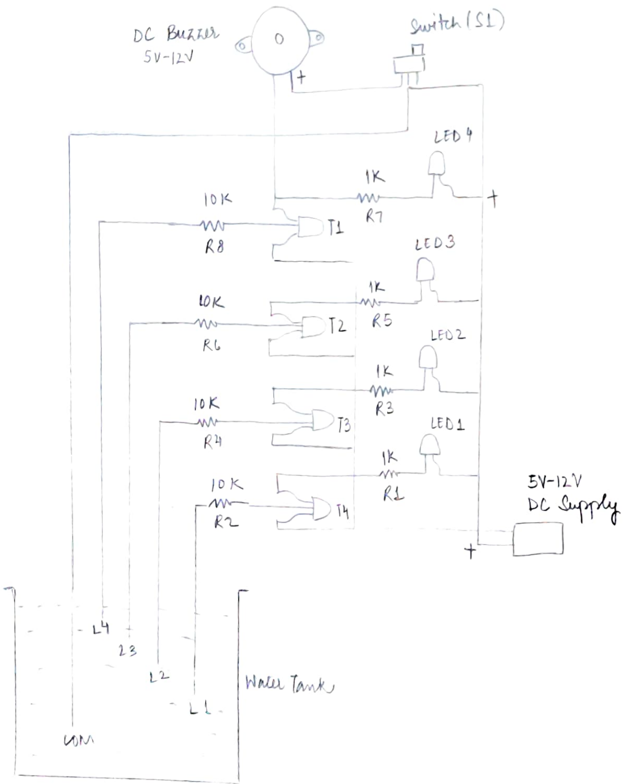
Motor Power = V (across motor terminal) X I_c

Observations

Motor	V_{BE}	I_B	I_c	V(Across motor terminal)	Motor Power
ON	0.833V	1.78mA	106.4mA	4.73V	503.27×10^{-3}W

$\beta = I_c / I_B = 59.77$

Conclusion
The designed circuit successfully controls the speed of a DC fan or motor based on temp. variations. The use of an NTC Thermistor allows for automatic adjustment of speed without manual Intervention.



Circuit Diagram

Mini Project - 6

Objective

To design and construct a simple water level indicator circuit with a buzzer that alerts the user when tank is full.

Apparatus Required

BC547 NPN Transistors, Resistors, LEDs, DC Buzzer, DC Power Supply, Breadboard, Multimeter, Jumper Wires.

Theory

A BC547 transistor acts as a switch. When the base terminal receives a voltage above 0.7V (via water contact), current flows from collector to emitter, turning on the connected LED or buzzer.

At the maximum level, the buzzer sounds an alert.

Observations

Indicator LED	V_{BE} (Manual)	V_{BE} (Water Tank)
ON	0.692V	0.677V
OFF	0V	0.03V

Conclusion

The project demonstrates how BC547 transistors can be used to create a simple indicator. It provides visual alerts through LEDs for different levels and an audible alarm via a buzzer when the tank is full. This setup helps prevent overflow and ensures efficient water usage.