Experiment Number : 1

Experiment : RC and RL Transients

Study of Transient Behaviour of RC Circuit.

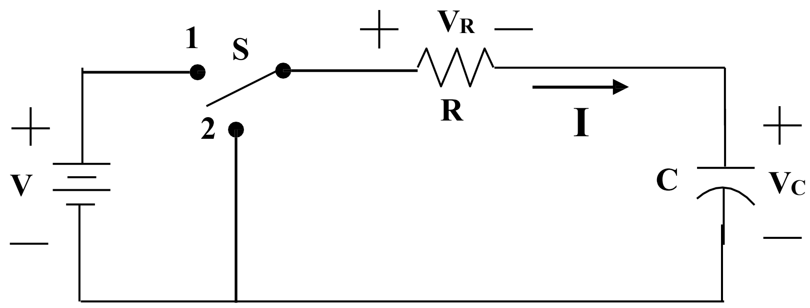
OBJECTIVE:

The objective of this experiment is to study Transient Response of RC circuit with step Input. In this experiment we shall apply a square wave input to an RC circuit separately and observe the respective wave-shapes and determine the time constants.

THEORY:

The transient response is the temporary response that results from a switching operation and disappears with time. The steady state response is that which exists after a long time following any switching operation.

Let us consider an RC circuit shown in figure.



CHARGING PHASE: When the switch is connected to position 1, applying KVL we can write

$$V = Ri + \frac{1}{C}\int i\,dt ------------(1)$$

If the capacitor is initially uncharged, the solution of equation (1) is----

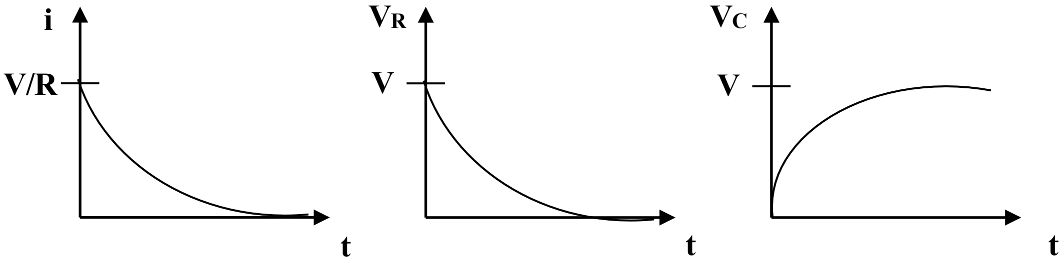
$$i = \frac{V}{R}e^{-\frac{t}{\tau}} ----------------(2)$$

Therefore the voltage across the resistor and capacitor are given by

$$V_R = Ve^{-\frac{t}{\tau}} \text{-----------------}(3)$$

$$V_C = V - V_R = V(1 - e^{-\frac{t}{\tau}}) \text{-------}(4)$$

Where $\tau = RC$ and is called the time constant of the circuit. Equation (2), (3) & (4) are plotted below:



It is seen from the curves that the voltage across the capacitor rises from zero to V volts exponentially and the charging current is maximum at the start i.e. when C is uncharged, then it decreases exponentially and finally ceases to zero when the capacitor voltage becomes V.

DISCHARGING PHASE: When the switch is connected to position 2,applying KVL we can write

$$0 = Ri + \frac{1}{C}\int idt \text{--------------}(5)$$

Since the voltage across the capacitor is now V, the solution of equation (5)

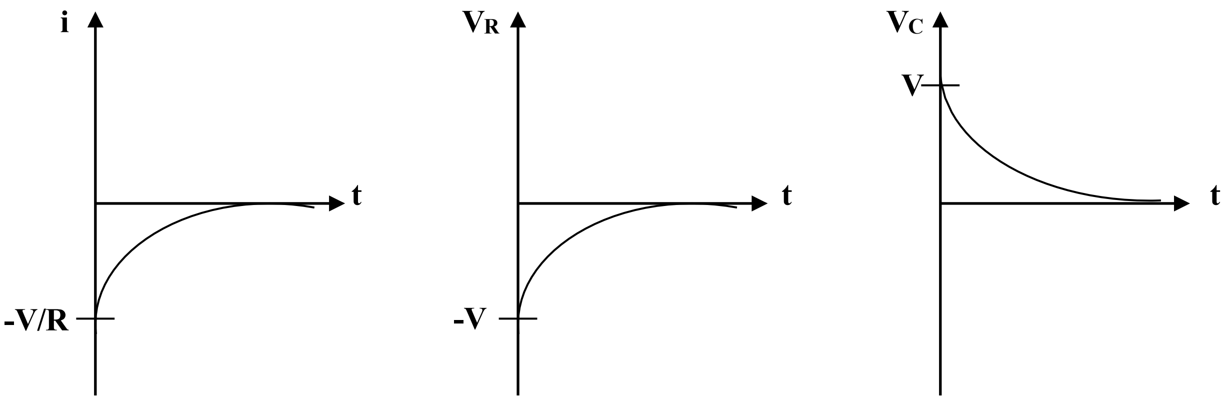
$$i = -\frac{V}{R}e^{-\frac{t}{\tau}} \text{-----------------}(6)$$

is therefore the voltage across the resistor and capacitor are given by

$$V_R = -Ve^{-\frac{t}{\tau}} \text{---------------}(7)$$

$$V_C = Ve^{-\frac{t}{\tau}} \text{-----------------}(8)$$

Equation (6), (7) & (8) are plotted below:



It is seen from the curves that the voltage across the capacitor falls from V to zero volts exponentially. The charging current is maximum at the start i.e. when the switch is just thrown to position 2, then it decreases exponentially and finally ceases to zero when the capacitor voltage becomes zero.

APPARATUS:

- Resistance: 1KΩ
- Capacitance: 1μF
- Oscilloscope and Chords
- Signal Generator and Chords
- Wires
- Bread board

EXPERIMENTAL SETUP:

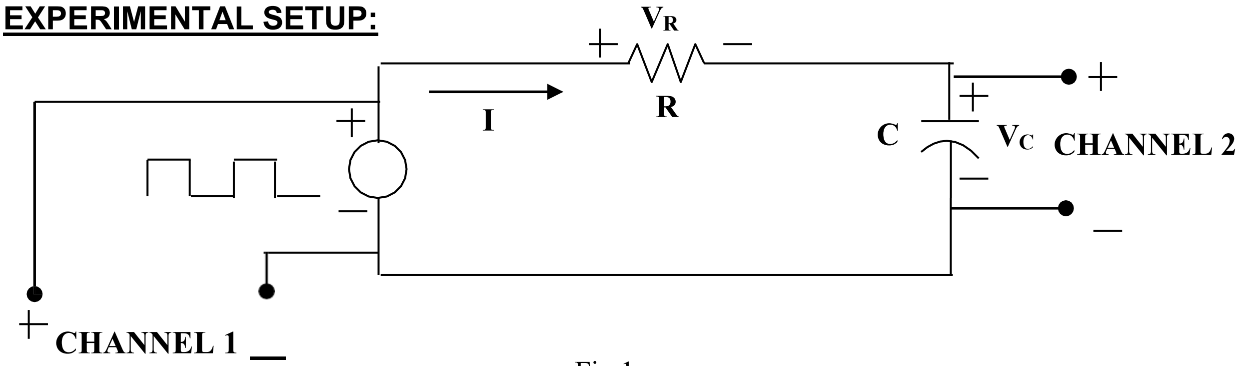


Fig.1

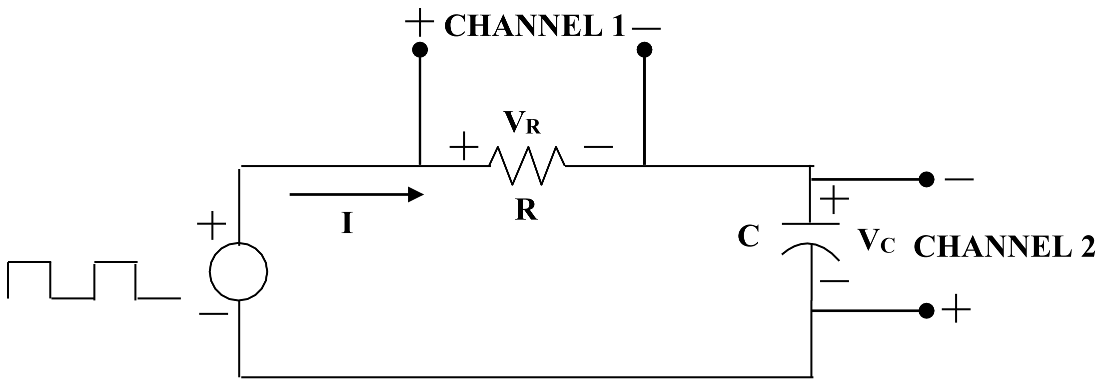


Fig.2

PROCEDURE:

1. Setup the circuit as shown in figure 1.
2. Apply 100Hz square wave from signal generator.
3. Observe the wave shapes at Ch.1 and Ch.2 in DUAL mode and draw them. Find the time constant from the wave shape of V_C.
4. Disconnect Ch.1 and Ch.2 and reconnect them as shown in figure 2.
5. Observe the wave shapes at Ch.1 and Ch.2 (INV.) in DUAL mode and draw them.

REPORT:

1. Draw all the wave shapes on graph paper.

Part B Continued: `Study of Transient Behaviour of RL Circuit.`

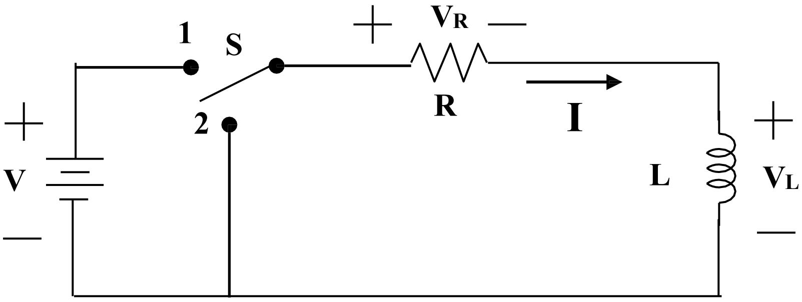
OBJECTIVE:

The objective of this experiment is to study Transient Response of RL circuit with step input. In this experiment we shall apply a square wave input to an RL circuit and observe the wave-shapes and determine the time constant.

THEORY:

The transient response is the temporary response that results from a switching operation and disappears with time. The steady state response is that which exists after a long time following any switching operation.

Let us consider an RL circuit shown in figure.



STORAGE PHASE: When the switch is connected to position 1, applying KVL we can write

$$V = Ri + L\frac{di}{dt} ------------ (1)$$

If the inductor is initially relaxed, the solution of equation (1) is----

$$i = \frac{V}{R}(1 - e^{-\frac{t}{\tau}}) ---------------- (2)$$

$$V_R = V(1 - e^{-\frac{t}{\tau}}) --------------- (3)$$

$$V_L = V - V_R = Ve^{-\frac{t}{\tau}} ------ (4)$$

Therefore the voltage across the resistor and inductor are given by
Where τ = L/R and is called the time constant of the RL circuit. Equations (2), (3) & (4) are plotted below:

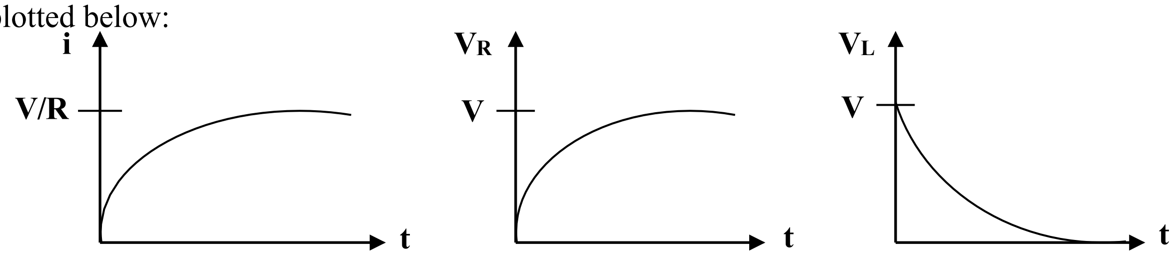


Fig.1

It is seen from the curves that the voltage across the inductor falls from V to zero volts exponentially. The current is zero at the start i.e. when the switch is just thrown to position 1, then it increases exponentially and finally reach to V/R amps when the inductor voltage becomes zero.

DECAY PHASE: When the switch is connected to position 2,applying KVL we can write

$$0 = Ri + L\frac{di}{dt} -------------(5)$$

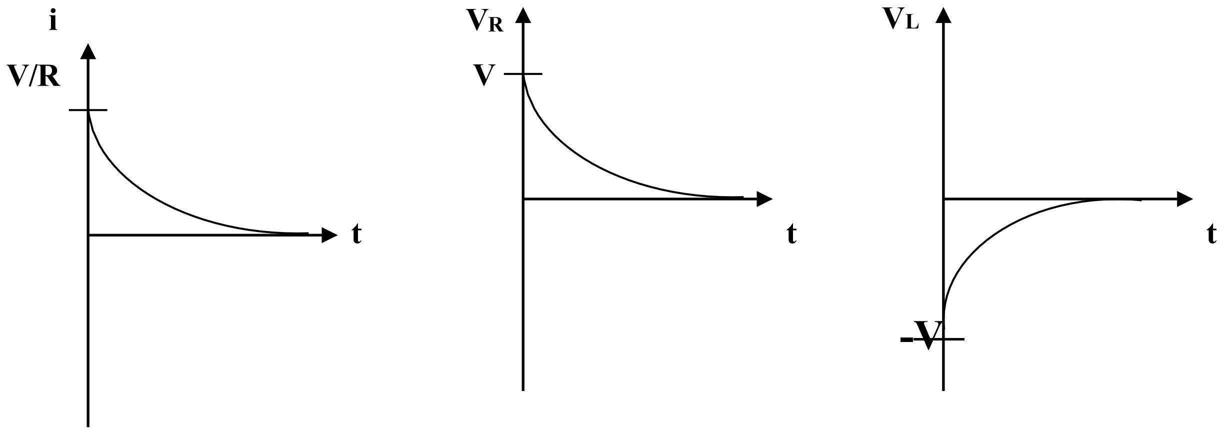
the solution of equation (5) is
Therefore the voltage across the resistor and inductor are given by

$$i = \frac{V}{R} e^{-\frac{t}{\tau}} --------------(6)$$

$$V_R = Ve^{-\frac{t}{\tau}} --------------(7)$$

$$V_L = -Ve^{-\frac{t}{\tau}} --------------(8)$$

Equations (6), (7) & (8) are plotted below:



It is seen from the curves that the voltage across the inductor rises from -V to zero volts exponentially. The current is maximum at the start i.e. when the switch is just thrown to position 2, then it decreases exponentially and finally ceases to zero when the inductor voltage becomes zero.

APPARATUS:

- Resistance:460 Ω
- Inductance: 2.7mH
- Oscilloscope and Chords
- Signal Generator and Chords
- Wires
- Bread Board

EXPERIMENTAL SETUP:

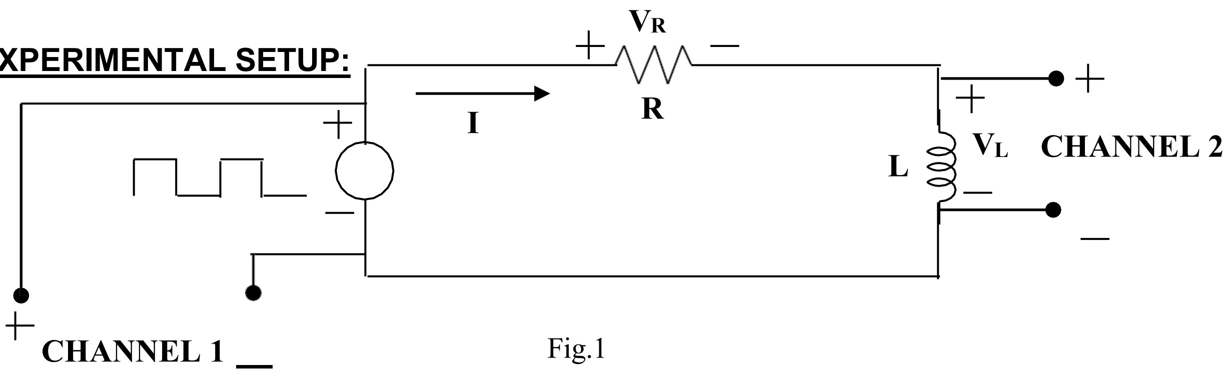


Fig.1

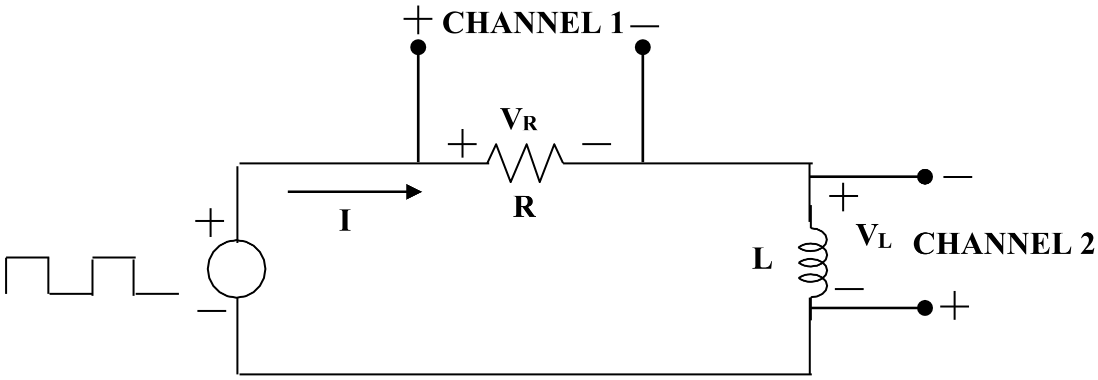


Fig.2

PROCEDURE:

6. Setup the circuit as shown in figure 1.
7. Apply 14 kHz square wave from signal generator.
8. Observe the wave shapes at Ch.1 and Ch.2 in DUAL mode and draw them. Find the time constant from the wave shape of V_L.
9. Disconnect Ch.1 and Ch.2 and reconnect them as shown in figure 2.
10. Observe the wave shapes at Ch.1 and Ch.2 (INV.) in DUAL mode and draw them.

REPORT:

2. Draw all the wave shapes on graph paper.

EXPERIMENT NO.: 2

NAME OF THE EXPERIMENT: STUDY OF COMMON EMITTER AMPLIFIER.

OBJECTIVE: To know the effect of the frequency on the gain of a common emitter amplifier and also to measure the input impedance, output impedance and phase relation ships of a CE amplifier.

EQUIPMENTS:

- (i) n-p-n transistor C828 one piece
- (ii) 10k,100K potentiometer one piece each
- (iv)resistors 100Ω ,470Ω, 560Ω,5KΩ,33KΩ
- (v)capacitors 10μF,10μF,47μF
- (vi) multimeter one piece
- (vii)bread board one piece
- (vii)power supply one piece
- (viii)signal generator one piece
- (ix)oscilloscope one piece

CIRCUIT DIAGRAM:

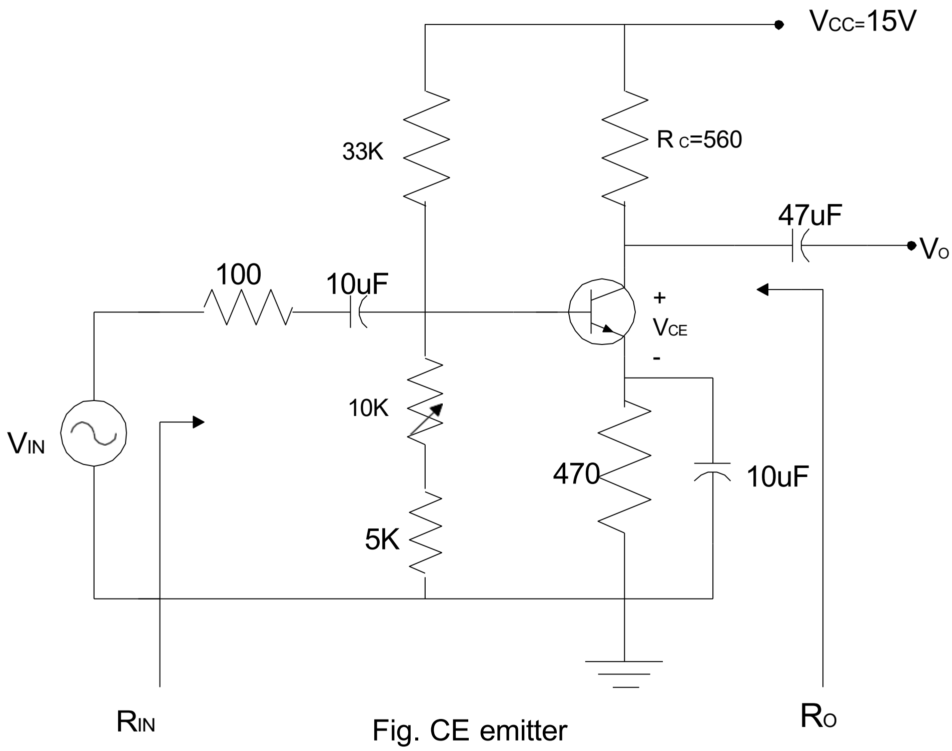


Fig. CE emitter

PROCEDURE:

1. Construct the circuit as shown in fig. adjust 10K potentiometer until V_{CE} is approximately equal to $V_{CC}/2$ by multimeter.
2. Set the signal generator frequency at 5KHz. Ch.2 is connected to V_O . Increase input signal until output is not distorted. Connect V_{IN} to ch.1. Measure peak value of both V_{in} and V_O .

3. Set the oscilloscope in dual mode . Observe the phase relationship between input and output.
4. Connect the 100KΩ potentiometer from V_O to ground. Adjust the 100 KΩ potentiometer until V_O is half the open circuit value. Measure the output impedance from potentiometer.
5. Disconnect ch.2 and connect ch.1 across 100Ω and measure peak value.
6. Disconnect the bypass capacitor and observe the effect on gain.
7. Reconstruct the circuit as shown in fig. Set the signal frequency at 50 Hz. Measure the input and output.
8. Repeat step 7 for frequency 100Hz, 200Hz, 500Hz,800Hz,1KHz,2KHz etc until higher cutoff frequency is found ensuring input remain constant for all steps.
9. Observe the phase relationships between input and output below lower cutoff and higher cutoff frequency.

REPORT:

1. Plot the gain in dB as a function of frequency in a semi-log paper.
2. From the graph paper determine the lower cutoff frequency , higher cutoff frequency and midband gain for this common emitter amplifier.
3. What is the input impedance, output impedance and phase relationship between input and output for CE amplifier and comment on them ?
4. What is the function of bypass capacitor and dc blocking capacitor.?
5. What is the advantage and disadvantage of common emitter amplifier ?.
6. How can frequency response be improved in CE amplifier for what cost ?.

Experiment Number: 3

STUDY OF CHARACTERISTIC OF SERIES RESONANCE AND RC FILTER CIRCUIT

Part A: Series Resonance

Theory: A series resonant circuit containing R, L and C are in series and is said to be in resonance when the total reactance is zero. Since the capacitive reactance and the inductive reactance are of opposite sign so a series circuit will be in resonance when X_L is equal to X_C in magnitude. Thus for series resonance,

$$X_L = X_C$$

$$2\pi f L = \frac{1}{2\pi f C}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Where, f is the resonance frequency. Thus series resonance can be obtained by adjusting L, C or f. In this experiment we will vary C to obtain the resonance condition. It is obvious that at the resonance the power factor of the combined load will be unity, and the total impedance is the value of the resistance R and will be minimum so that current is maximum. This is the criterion, which will use to detect the resonance condition.

Circuit Diagram

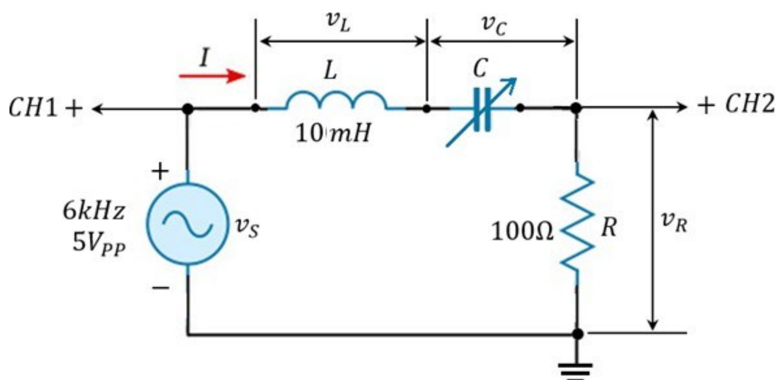


Figure 1

Equipment

1. Resistor : 100 Ω
2. Decade inductance box
3. Decade capacitance box
4. Voltmeter
5. Oscilloscope
6. Signal generator
7. Breadboard

Procedure

1. Complete the RLC circuit by setting 100Ω resistance, 10mH inductance and 30nF capacitance as shown in Figure 1.
2. Select the function generator in sinewave 5 V_{PP}, 6.0 kHz the across the RLC resonator circuit and measure the input voltage by using channel 1 of the oscilloscope. Connect the channel 2 of the oscilloscope to measure the current in the circuit by measuring the voltage across the 100 Ω resistance.
3. Observe the wave-shape in both channels separately by selecting the oscilloscope in dual mode. Measure the values of the series current I by measuring the voltage v_R and the phase difference between v_R and input voltage v_S.
4. Also measure the voltage across, inductor and capacitor.
5. Increase the capacitance gradually 10nF steps until 120nF. Repeat the measurements of steps 3 and 4 for different capacitor settings. At each step, adjust the signal generator output so that v_S remains constant. Record all the measurement in Table-1.

Table-1: $f = 6.0$ kHz and $R = 100\Omega$

Obs.	v_i (Vpp)	C (nF)	v_R (Vpp)	v_L (Vpp)	v_C (Vpp)	$I = v_R/100$ (mA)	Phase (Degrees)
1	5	30					
2	5	40					
3	5	50					
4	5	60					
5	5	70					
6	5	80					
7	5	90					
8	5	100					
9	5	110					
10	5	120					

Report 1.

Plot and the following curves in semi-Log graph

1. I versus C
2. Phase versus C
3. v_L, v_C, and v_R versus C

Part B: FREQUENCY RESPONSE OF RC FILTER

THEORY:

Low Pass Filter: An ideal low pass filter passes all signals below its cutoff frequency with zero attenuation but blocks all signals above that frequency. A simple first order RC low pass filter is shown in Figure 2(a). The transfer function of this filter is given by:

$$T(j\omega) = \frac{v_O}{v_i} = \frac{1}{1 + j\omega CR}$$

The corner or cutoff frequency ω_C is defined as the frequency where the magnitude of the transfer function is $1/\sqrt{2}$ times the maximum value. For this low pass filter, cut off frequency,

$$\omega_C = 1/(RC)$$

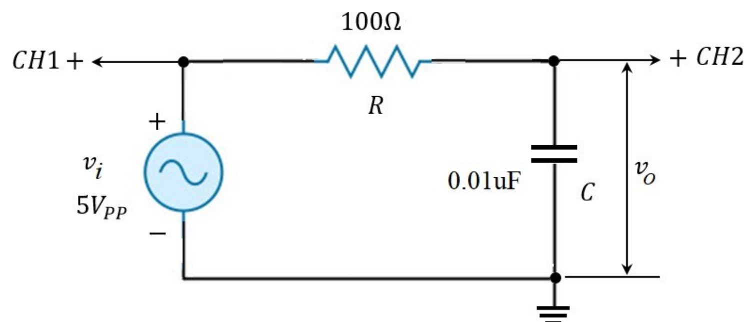


Figure 2(a): RC low pass filter

High Pass Filter: An ideal high pass filter blocks all signals below its cutoff frequency but passes all signals above cut off with no attenuation. A simple first order RC high pass filter is shown in Figure 2(a). The transfer function of this filter is given by:

$$T(j\omega) = \frac{v_O}{v_i} = \frac{j\omega CR}{1 + j\omega CR}$$

For this high- pass filter, cut off frequency,

$$\omega_C = 1/(RC)$$

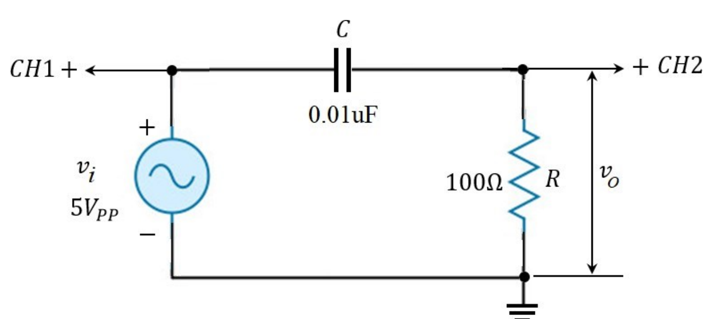


Figure 2(a): RC high pass filter

EQUIPMENT USED

1. Resistor 100 Ω
2. Capacitors 0.01 μF
3. Oscilloscope
4. Signal Generator

Procedure:

1. Construct the circuit as shown in Figure 2(a). Connect v_i to Channel 1 and v_O to Channel 2 of the oscilloscope. Set the input starting frequency to 100 Hz and $v_i = 5\ Vpp$. Measure the peak to peak voltage of v_O and phase angle between v_i and v_O and record in the Table-2 and Table-3 for low pass and high pass filters respectively.
2. Gradually increase the frequency up to 200kHz, record the value of v_O and phase angle in the Table-2. Remember to adjust the signal generator amplitude so that v_i remains constant.
3. Now construct the circuit of Figure 2(b) and repeat steps 1 and 2.

Table-2: For Low pass filter, $R = 100\Omega$ and $C = 0.1\mu F$

Obs.	f (kHz)	v_i (Vpp)	v_O (Vpp)	Practical $\lvert T \rvert$ (dB)	Theoretical $\lvert T \rvert$ (dB)	Phase (Degrees)
1	0.3	5				
2	0.6	5				
3	1.2	5				
4	1.6	5				
5	1.8	5				
6	3.0	5				
7	6.0	5				
8	15.0	5				
9	30.5	5				
10	50.0	5				

Table-2: For high pass filter, $R = 100\Omega$ and $C = 0.1\mu F$

Obs.	f (kHz)	v_i (Vpp)	v_O (Vpp)	Practical $\lvert T \rvert$ (dB)	Theoretical $\lvert T \rvert$ (dB)	Phase (Degrees)
1	0.3	5				
2	0.6	5				
3	1.2	5				
4	1.6	5				
5	1.8	5				
6	3.0	5				
7	6.0	5				
8	15.0	5				
9	30.5	5				
10	50.0	5				

REPORT

1. Determine the theoretical corner frequencies of low pass and high pass filters.
2. Plot the magnitude of the transfer function verses frequency curves on a log graph paper. Determine the corner frequencies from the graphs and compare these with the theoretical values.
3. Plot the magnitude of the phase angle verses frequency curves on a log graph paper and find the angle at corner frequencies from the graph directly.

Experiment No.- 4

SECOND ORDER ACTIVE FILTER DESIGN

Objective: The objective of this experiment is to investigate the characteristics of three different types of active filter namely

i) Low pass filter
ii) High pass filter

Introduction: A filter is a frequency sensitive circuit. It passes some frequencies, but blocks or attenuates others. In this experiment you will build the above two different types of filters and plot a response curve for each type. In these experiments Sallen-Key filter topology is used. The cut-off frequency and gain of filter can be calculate as:

$$f_C = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

$$\frac{R_3}{R_4} = 0.586$$

(Ex. $R_3 = 5.86k, R_4 = 10k$)
(Ex. $R_3 = 33k, R_4 = 56k$)

Instruments and Components Required

Instruments:
Power supply, Signal generator, Oscilloscope

Components:
741 Operational amplifier – 1 pc
0.01μF – 2 pcs
33kΩ resistor – 1 pc
56kΩ resistor – 1 pc
1kΩ resistor – 2 pcs
2.2kΩ resistor – 2 pcs

<u>ACTIVE LOW PASS FILTER:</u>

Theory:

$$|A_v|_{dB} = \frac{1.586}{\sqrt{1 + (f/f_C)^4}}$$

Procedure:

1. Construct the circuit as shown in Figure 1.

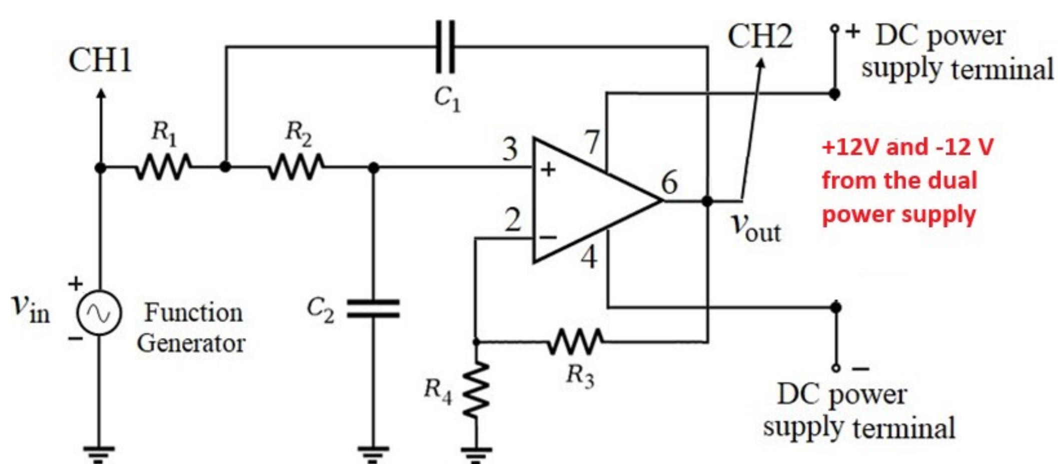


Figure-1: Active Low Pass Filter

2. Set the function generator to the sinusoidal wave with a frequency of 0.1 kHz.

3. Observe the output waveform at pin 6 of the op-amp. Adjust the input peak to peak voltage until the output voltage at pin 6 of the op-amp is approximately 6.0V peak-to-peak.

4. Measure and record the input voltage at pin 2 by CH1 of an oscilloscope and keep it constant during the experiment.

1. Change the frequency of the function generator and measure and record the output voltage from pin 6 of the op-amp. Also measure and record the phase deference between the output and input voltages.

5. Plot the voltage gain and phase data on a separate semi-log paper with frequency on the log scale. This will give response curve of the low pass filter. Take data at sufficient points so that the response curve can be drawn with sufficient accuracy. Try to plot at least 15 different points across the frequency range.

No. Obs.	Frequency (kHz)	Input Voltage (mV)	Output Voltage (V)	Phase (Degree)	Voltage gain (dB)	
					Practical	Theoretical
1	0.1					
2	1.0					
3	2.0					
4	4.0					
5	8.0					
6	10.0					
7	12.0					
8	14.0					
9	16.0					
10	18.0					
11	25.0					
12	30.0					
13	60.0					
14	100.0					
15	500.0					

Report:

1. Plot the magnitude and phase response curves for this filter.
2. Explain the operation of the circuit and determine the cut-off frequency theoretically. Compare this cutoff frequency with that obtained from the response curve.
3. From the response curve find the roll-off in db/decade.

ACTIVE HIGH PASS FILTER:

A simple active high pass filter is shown in Figure-2. C_1, R_1, C_2, R_2 now forms a high pass filter. At low frequencies, the X_C of the capacitor is high. Thus the signal applied at the non-inverting input of the op-amp is very weak. However, at high frequencies, X_C decreases and allows more signal to reach the op-amp.

Theory:

$$|A_v|_{dB} = \frac{1.586}{\sqrt{1 + (f_C/f)^4}}$$

Procedure:

2. Construct the circuit as shown in Figure 1.

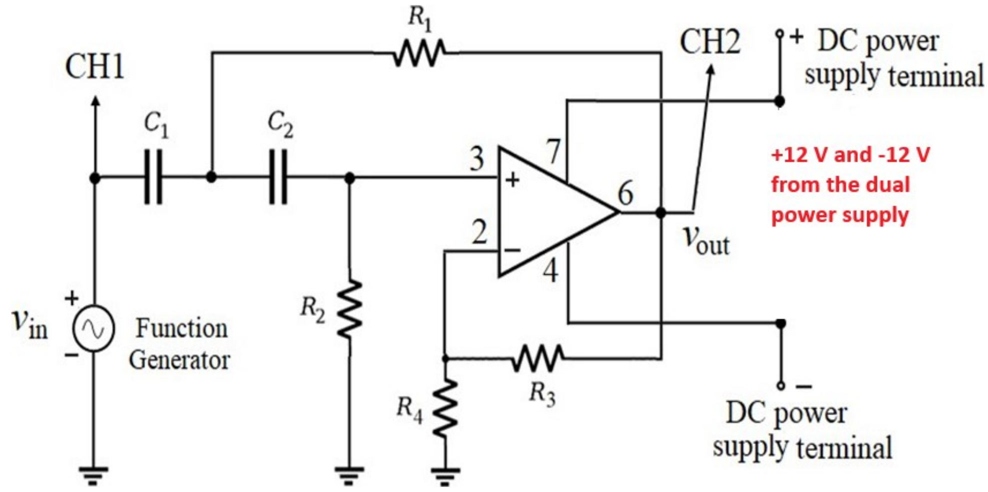


Figure-2: Active High Pass Filter

3. Set the function generator to the sinusoidal wave with a frequency of 1 kHz.

4. Observe the output waveform at pin 6 of the op-amp. Adjust the input peak to peak voltage until the output voltage at pin 6 of the op-amp is approximately 5.0V peak-to-peak.

5. Measure and record the input voltage at pin 2 by CH1 of an oscilloscope and keep it constant during the experiment.

6. Change the frequency of the function generator and measure and record the output voltage from pin 6 of the op-amp. Also measure and record the phase deference between the output and input voltages.

7. Plot the voltage gain and phase data on a separate semi-log paper with frequency on the log scale. This will give response curve of the high pass filter. Take data at sufficient points, so that the response curve can be drawn with sufficient accuracy. Try to plot at least 20 different points across the frequency range.

No. Obs.	Frequency (kHz)	Input Voltage (mV)	Output Voltage (V)	Phase (Degree)	Voltage gain (dB)	
					Practical	Theoretical
1	1.0					
2	2.0					
3	4.0					
4	8.0					
5	10.0					
6	12.0					
7	14.0					
8	16.0					
9	18.0					
10	25.0					
11	30.0					
12	60.0					
13	100.0					
14	500.0					
15	1000.0					

Report:

1. Give a plot of the response curve for this filter.
2. Explain the operation of the circuit and determine the cut-off frequency theoretically. Compare this cutoff frequency with that obtained from the response curve.
3. From the response curve find the roll-off in db/decade.

EXPT. NO.-05

STUDY OF A RC COUPLED TWO STAGES AMPLIFIER

OBJECTIVE

To know the effect of the frequency on the gain of a *RC* coupled amplifier and also to measure the input impedance, output impedance and phase relationships of the amplifier.

MATERIALS REQUIRED

n-p-n transistor C828	two pieces
potentiometer	1kΩ
resistors	100Ω ,470Ω(2), 560Ω(2),33KΩ(2),68KΩ(2)
capacitors	10µF(4)
multimeter	one piece
bread board	one piece
power supply	one piece
signal generator	one piece
oscilloscope	one piece

IRCUIT DIAGRAM

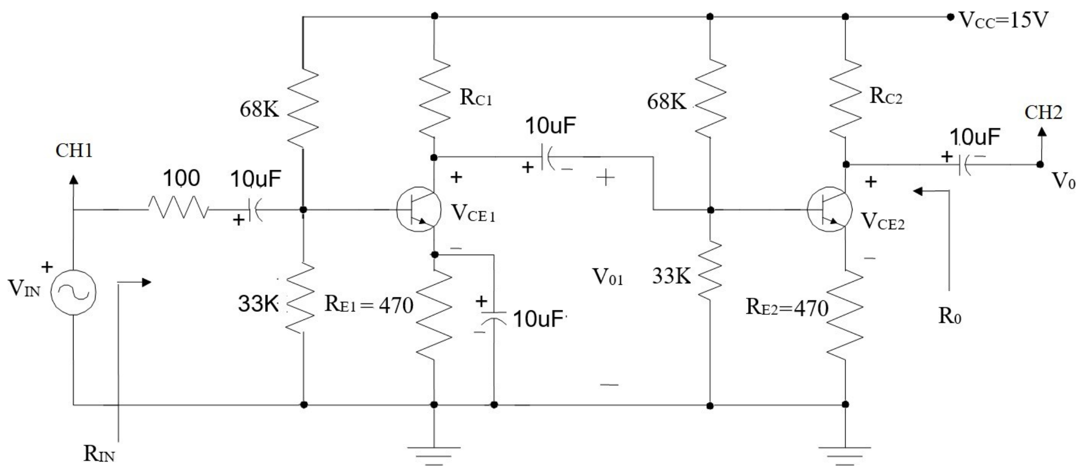


Fig.1 RC Coupled Amplifier

PROCEDURE

1. Construct the circuit as shown in Fig. 1. Verify that both the transistors are properly biased in the active region.

2. Set the function generator frequency at 5 kHz. Increase input signal until the output wave is not distorted.

3. Set the oscilloscope in dual mode. Observe the phase relationships of both input and output. Measure peak value of V_{in}, V_{01} and V_O.

4. Connect the 1kΩ potentiometer from V_O to ground. Adjust the 1kΩ potentiometer until V_O is half of the open circuit value. Measure the potentiometer resistance.

5. Disconnect CH.2 and connect CH1 across 100Ω and measure peak value.

6. Change the input frequency to 50 Hz. Measure input and output voltages from the oscilloscope to measure the gain. Measure the gain at different frequency. Take sufficient reading in the lower cutoff region, in mid-band and in the upper cutoff region.

No. Obs.	Frequency (kHz)	Input Voltage (mV)	Output Voltage (V)		Phase (Degree)	Voltage gain (dB)	
			V_{01}	V_0		Practical	Theoretical
1	0.05						
2	0.1						
3	0.5						
4	1.0						
5	2.0						
6	4.0						
7	10.0						
8	20.0						
9	50.0						
10	100.0						
11	200.0						
12	300.0						
13	600.0						
14	1000.0						
15	2500.0						

REPORT:

1. Plot the frequency response of the circuit on the semilog graph paper.
2. What is the input impedance, output impedance and mid band gain of amplifier.
3. Calculate the mid band gain of each stage. How are these values compared with the overall gain?
4. Discuss the phase relationships of the two stages.
5. What are the advantage and disadvantage of RC coupled common emitter amplifier?
6. Why does the gain decrease at higher frequency?
7. What is the effect of bypass capacitor on frequency response?
8. Why is bypass capacitor omitted from the second stage?

EXPERIMENT NO. 6

NAMAE OF THE EXPERIMENT: STUDY OF FEEDBACK AMPLIFIER CIRCUIT

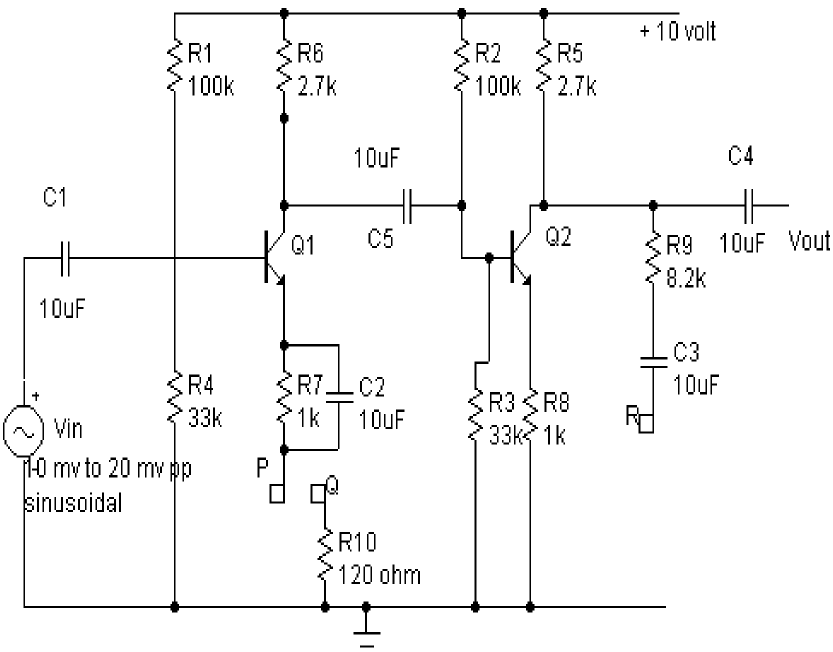
OBJECTIVE

Study of voltage gain, bandwidth, input/ output impedance under current series and voltage series feedback conditions of a two stage CE amplifier configuration.

EQUIPMENT

Transistor C828 or C829	2 pieces
Resistors	
100k, 33 k, 1k, 2.7k, 8.2k, 120 Ω	2 pieces each
Potentiometer 10 k	1 piece
Capacitors 10 µF	4 pieces
Signal generator	1 unit
Oscilloscope	1 unit
DC power supply	1 unit

CIRCUIT DIAGRAM



PROCEDURE

1. Connect the point P to ground.

2. Apply input signal at 1 kHz, V_{in} should be 10mV to 20 mV (P-P)

3. Keep the input constant during the experiment
4. Keeping the input voltage constant increase the frequency of the input

5. Measure the output voltage V_{out} , find out the 3 db point

6. Connect the 10 k potentiometer to the output terminal. Vary the potentiometer until the voltage is half of the open circuit voltage.

7. Apply **current series feedback** in the first stage of the amplifier. To do this ***connect*** **P and Q**. Repeat step 2,4,5 and 6 respectively.

8. Apply **voltage series feedback**. To do this ***connect*** **P, Q and R**. Repeat step 2,4,5 and 6 respectively.

REPORT

- What is feedback? Why it is used?
- Classify and explain feedback topologies briefly and mention their advantages.
- Calculate gain A and plot frequency response characteristics for the different amplifier configurations
- Find out bandwidth with current series and voltage series feedback
- Relate between output impedances obtained from different amplifier configurations
- Why coupling capacitor is used between the two stages of the amplifier?
- Why emitter bypass capacitor is omitted from the second stage?
- Is it possible that an amplifier without feedback may oscillate at high frequency, if so why?
- Discussion

DATA SHEET:-

Frequency	Without F/B		Current Series F/B		Voltage Series F/B	
Hz	V_{in}	V_{out}	**Vin**	**Vout**	**Vin**	**Vout**
1k to 5 M	mv	mv	mv	mv	mv	mv

Output Resistance, R_o	
Without F/B	
Current Series F/B	
Voltage Series F/B	

EXPERIMENT NO. 7

NAME OF THE EXPERIMENT: STUDY OF A WIEN BRIDGE OSCILLATOR

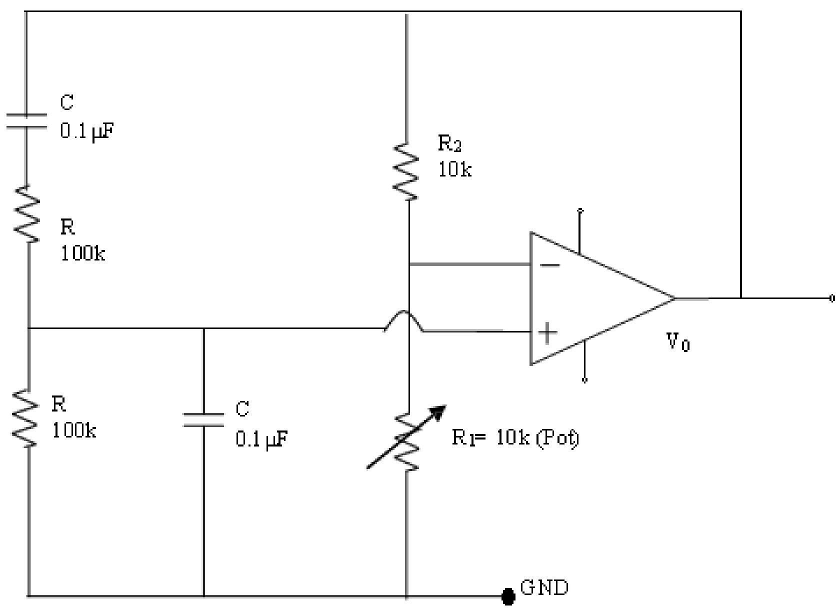
OBJECTIVE

An oscillator circuit in which a balanced bridge is used as the feedback network is the Wien bridge oscillator. The objective of this experiment is to study the operation of the Wien bridge.

EQUIPMENT

1. OPAMP 741 — 1 piece
2. Trainer Board — 1 unit
3. Regulated power supply — 1 unit
4. Oscilloscope — 1 unit
5. Resistor 100k, 10k, 1k — 2 pieces each
   10K, 10K (POT) — 1 piece each
6. Capacitor 0.1µF, 1uF — 2 pieces

CIRCUIT DIAGRAM



PROCEDURE

1) Set up the circuit as shown in the Fig.

2) Connect the oscilloscope lead to the output of the amplifier. Adjust the potentiometer in order to obtain a sinusoidal waveform which is just maintained. Measure the ratio of R_2/R_1 and frequency of oscillation.

3) Theoretically the frequency of oscillation is given by $f = 1/2\pi RC$ (here R=100K) . The oscillation is maintained when R_2/R_1 ratio is approximately 2. Notice that if R_2 is made appreciably greater than $2R_1$ a square wave oscillation is produced and if R2 is made less than $2R_1$ oscillation decays and ceases.

4) Replace the resistor R with 10k. Repeat step 2.

REPORT

1) Compare the observed frequency with the theoretical one.
2) Draw the output wave shape.
3) Describe the significance of R_2/R_1 ratio.
4) What are the methods of changing frequency of Wien bridge oscillator?

EXPERIMENT NO. 8

NAME OF THE EXPERIMENT: STUDY OF A R-C OSCILLATOR

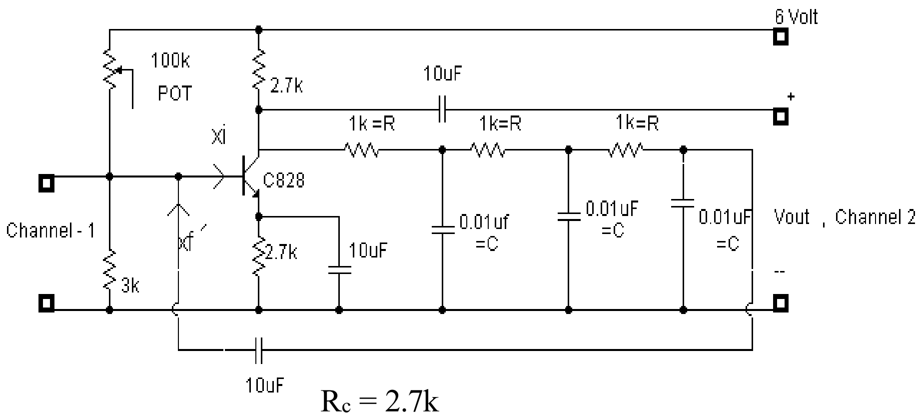
OBJECTIVE

A typical R-C phase shift oscillator will be constructed and studied in this experiment. The theoretical frequencies of oscillation are:

$$\frac{\sqrt{6}}{2\pi RC} \quad \text{for R - C Oscillator}$$

$$\frac{1}{2\pi RC}\frac{1}{\sqrt{6+4(R_c/R)}} \quad \text{for C - R Oscillator}$$

CIRCUIT DIAGRAM



$R_c = 2.7k$

PROCEDURE

1. Connect the circuit as shown in the figure for R-C phase shift oscillator.
2. Vary the 100k pot to have the undistorted sine wave at the output terminal
3. Determine the frequency of output and verify it with the theoretical frequency
4. Determine the phase shift of the input and output signal. To do this, connect both the channels and operate the oscilloscope in XY mode.
5. Reconnect the circuit for C-R oscillator by interchanging the R and C elements
6. Repeat steps 2,3 and 4.

REPORT

1. Why R-C oscillator is called phase shift oscillator?
2. Why there is discrepancy between the observed and theoretical frequency?
3. How the amplitude and the frequency of the oscillator can be changed?

4. What type of feedback is used in the oscillator circuit?
5. What is the frequency range of R-C oscillator?
6. What is the criterion to be followed in obtaining oscillator output?
7. Derive the above two equations
8. Make comparison between RC phase shift oscillator and Wien bridge oscillator using Opamp as active element.

Exp. No. 9
Study of Mutual Inductance

Introduction

When the magnetic flux produced in one circuit links a second circuit, the two circuits are magnetically coupled. Mutual inductance between the two circuits determines the coupling between the circuits and the energy that can be transferred from one circuit to another. In this experiment, we will determine the mutual inductance *M* and coefficient of coupling *K*. *K* is defined by

$$K = \frac{M}{\sqrt{L_1 L_2}}$$

Where L_1 and L_2 are the self inductances of the first and second coil, respectively.

Circuit Diagram

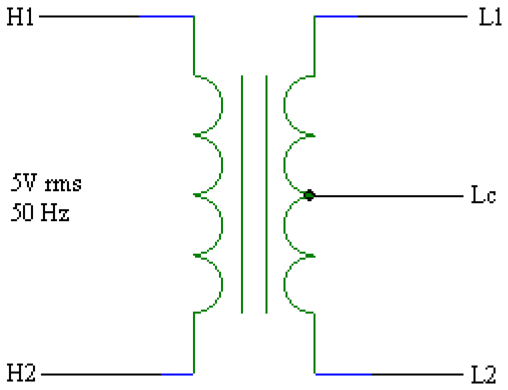


Figure 1:

Equipment

1. 220v/9v transformer
2. Voltmeter
3. Ammeter
4. Multimeter
5. SPST switch
6. Signal Generator

Procedure

1. Connect the circuit as shown in the diagram. Energize the HV side of the transformer with 5v rms, 50 Hz supply from the signal generator. Measure the current flowing in the primary and the voltage induced in the open circuited LV side. The LV side voltage is to be measured between the end terminals not with respect to the center-tap.
2. Disconnect the circuit and set the signal generator to give 1V rms, 50 Hz supply and connect across the two end terminals of the LV side. Measure the current flowing in the circuit and the voltage induced in open circuited HV side.
3. Disconnect the circuit and measure the dc resistance of the HV and LV winding with multimeter. Though the effective ac resistance of the transformer winding is higher than the dc resistance, for simplicity we sill take them equal.
4. Connect the two coils of the transformer is in series. Apply 5V, 50 Hz supply across the series connected coils and measure the current.

5. Reverse the connection of any one of the two coils and measure the applied voltage and line current.

Table

For HV side Energized

V_1	I_1	I_2

For LV side Energized

V_1	V_2	I_2

For dc resistance measurement and polarity of the coil

R_1	R_2	I_{1S}	I_{2S}

Report

1. From the readings taken in steps 1, 2 and 3 calculate L_1, L_2 and M_{12} and M_{21}. Compare M_{12} and M_{21}. If the two values are not equal an effective M can be obtained by taking the geometric mean of the two. Calculate the coefficient of coupling.
2. From the readings of step 4 & 5, label the appropriate terminals on the HV and LV side with dot marks. Also calculate M form these readings. Compare the value of M with the one determined in the previous step.

Exp No. 10
Study of Power factor correction

Introduction

In all manufacturing plant (large or small) power factor is usually low and lagging (due to usage of induction motors). This low power factor causes extra line loss which is not registered at consumers meter. For this reason power system authority penalizes the consumer if power is consumed below a certain power factor (normally if less than 0.85). So it is the consumer's duty to improve the power factor. Lagging power factor (usually industrial loads are lagging) is improved by adding capacitors parallel to the load. In this experiment we shall study how power factor can be corrected by varying the parallel capacitance.

Equipment

1. One rheostat (120Ω)
2. Decade capacitor box
3. Decade inductance box
4. Oscilloscope
5. Ammeter
6. Signal generator

Circuit Diagram

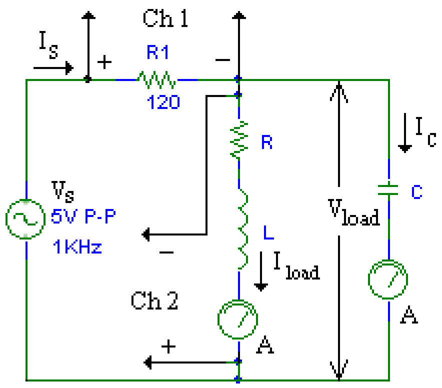


Figure 1:

Procedure

1. Complete the RL circuit by setting 500Ω resistance and 100mH inductance. Keep capacitance at zero.
2. Connect the probe across RL load as input to the channel 2 of the oscilloscope, and the voltage across the 120 Ω resistance as input to the channel 1, accordingly as shown in the diagram. Remember to connect the grounds of both oscilloscope probes to the same point and to pull the inverter knob of channel 2.
3. With capacitance zero, observe the wave shapes in both channels separately and in dual mode. Measure the value of current I_s (by dividing the voltage of channel 1 by the value of 120 Ω resistor) and voltage V_{load}, and phase difference between V_{load} and I_s. *To measure the phase difference, observe the two wave forms in dual mode. Determine the time delay Δt between the*

waves. The phase difference is then calculated from $\theta = \frac{\Delta t}{T} 360$ *degrees. Also* note which wave leads.

4. Set the capacitor to 10nf. Then repeat measurements of step 3. Also measure currents I_{load} and I_c from the ammeter.
5. Increase the capacitance gradually until unity pf between V_{load} and I_s is obtained.
6. Continue to increase the capacitance gradually until a leading pf of about 45 degree is obtained. Repeat all measurements in each step.

Report

1. Plot the pf vs. C curve and show the capacitance for which the f is unity.
2. Draw the vector diagram for 45° lag, unity and 45° lead pf.
3. Sketch the wave shapes of V_{load} and I_s for the three cases mentioned above.
4. Discuss the overall system performance, power absorbed without and with pf correction.