ANNAMALAI UNIVERSITY

WITH COURAGE AND FAITH

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

III SEM B.E. ELECTRICAL & ELECTRONICS

EECP308: CIRCUIT AND DEVICES LAB

Name ....

Reg. No. ....Batch ....

Class ....

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To develop the Department into a "Centre of Excellence" with a perspective to provide quality education and skill-based training with state-of-the-art technologies to the students, thereby enabling them to become achievers and contributors to the industry, society and nation together with a sense of commitment to the profession.

MISSION

M1: To impart quality education in tune with emerging technological developments in the field of Electrical and Electronics Engineering.

M2: To provide practical hands-on-training with a view to understand the theoretical concepts and latest technological developments.

M3: To produce employable and self-employable graduates.

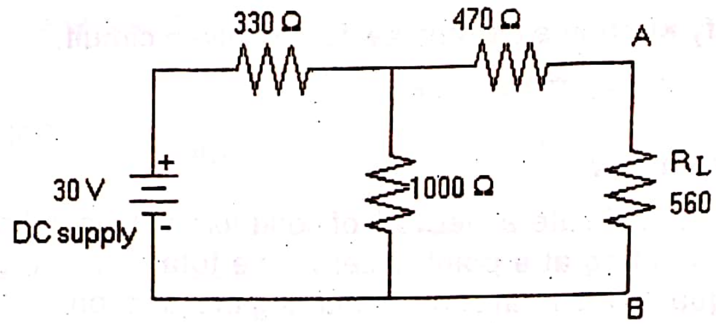
M4: To nurture the personality traits among the students in different dimensions emphasizing the ethical values and to address the diversified societal needs of the Nation

M5: To create futuristic ambience with the state-of-the-art facilities for pursuing research.

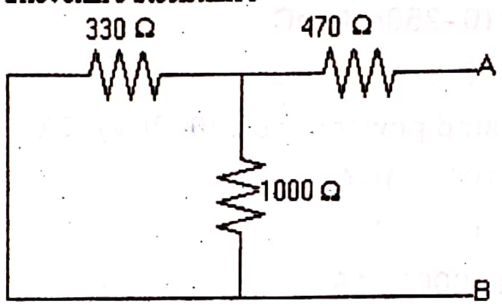
EECP308: CIRCUIT AND DEVICES LAB

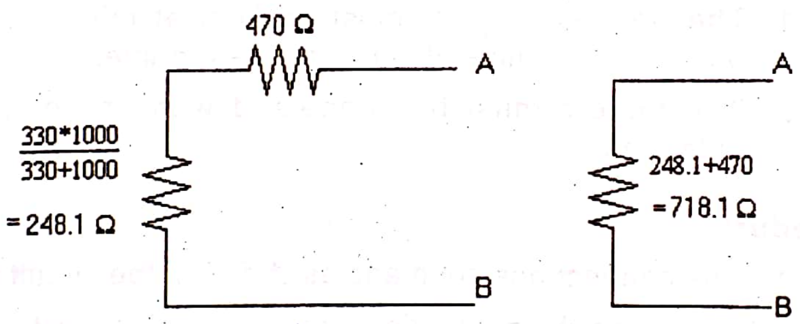
Sl.No.	Date	Name of the Experiments	Page No.	Marks	Signature
1		Verification of Thevenin's theorem			
2		Verification of Norton's theorem.			
3		Verification of Super position theorem			
4		Verification of Maximum power transfer theorem.			
5		Study of Series RL circuits			
6		Study of Series RC circuits			
7		Study of Series RLC circuits			
8		Wave shaping circuits			
9		Series resonance circuits			
10		Parallel resonance circuits			

Circuit for Verification of Thevenin's Theorem

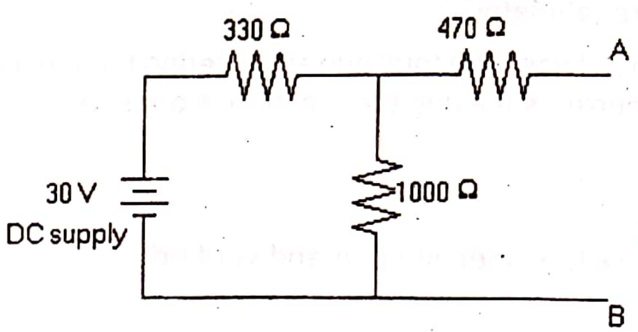


Calculation of Thevenin's Resistance





Calculation of Thevinin's Voltage



$$I = \frac{30}{1000+330} = 0.02256\,A$$

$$V_{th} = 0.02256 \times 1000 = 22.56\ \text{V}$$

Exp. No.: 1 & 2
Date :

VERIFICATION OF THEVENIN'S AND NORTON'S THEOREM

Aim

To verify the thevenin's theorem by comparing the practical value of open circuit voltage across the load points to the theoretical thevinin's voltage and comparing the practical value of equivalent resistance to theoretical value of thevenin's equivalent resistance.

To verify the Norton's theorem by comparing the practical value of short- circuit current across the load points to the theoretical value of Norton's current.

To verify the theoretical values of load current and load voltage (obtained by using thevenin's or Norton's theorem) with the practical values.

Theory

Thevenin's Theorem

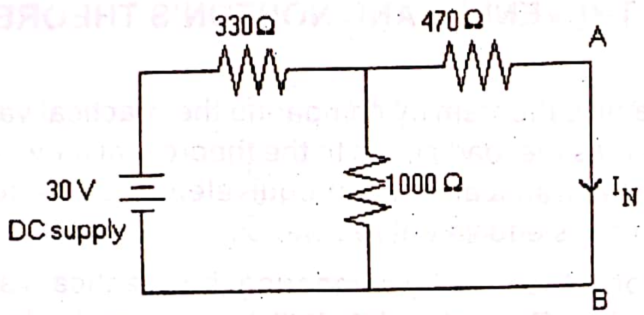
A linear two terminal active network can be replaced at any pair of terminals 'A' & 'B' by a simple equivalent network consisting of a voltage source V_{th} in series with a resistance R_{th}. The source voltage V_{th} is the voltage across the terminals 'A' & 'B' when they are open circuited. The series resistance R_{th} is the resistance looking back in to the network at AB when all the independent sources are set to zero.

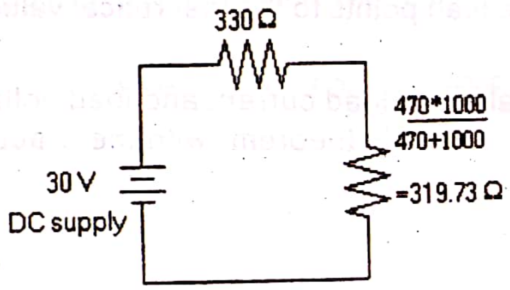
Application of Thevenin's theorem

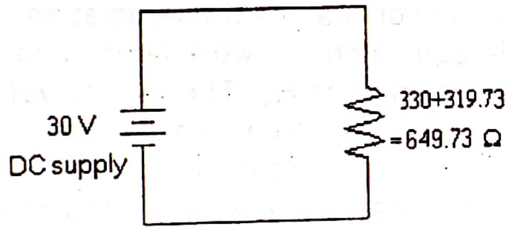
The steps necessary in the application of thevenin's theorem are summarized as follows:

1. Remove the load leaving the circuit with terminals 'A' & 'B'. Thus an open circuit at terminals 'A' & 'B' is created.
2. Find the voltage across the terminal 'A' & 'B' when they are open circuited. This voltage is thevinin's equivalent voltage V_{th}
3. Determine the values of thevinin's equivalent resistance R_{th} with the help of the network reduction methods. For this purpose all independent voltage sources are short-circuited. The equivalent resistance R_{th} is the resistance looking back in to the network at terminals 'A' & 'B'.
4. The thevinin's equivalent circuit is drawn by connecting V_{th} in series with R_{th}.
5. The load under study is reinserted into the series circuit for calculating the voltage across or current through the load.

Calculation of Norton's Current I_N





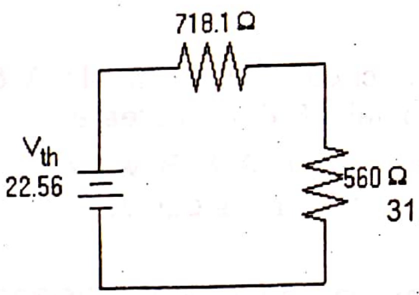


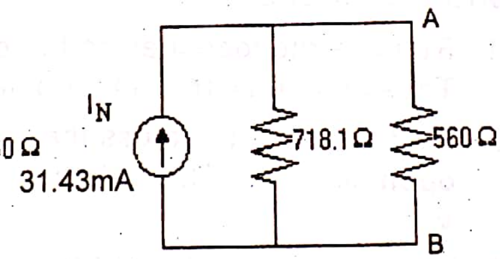
$$I = \frac{30}{649.73} = 0.0462\text{ A}$$

$$I_N = 0.0462 \times \frac{1000}{1000+470}$$

$$= 31.43\text{ mA}$$

Calculation of V_L and I_L





$$I_L = \frac{V_{th}}{R_{th}+R_L} = \frac{22.56}{718.1+560}$$

$$= 17.65\text{ mA}$$

$$V_L = I_L \times R_L = 17.65\times10^{-3}\times560$$

$$= 9.995\text{ V}$$

$$I_L = \frac{R_{th}}{R_{th}+R_L}\times I_N$$

$$= \frac{718.1}{718.1+560}\times31.43\times10^{-3} = 17.65\text{ mA}$$

$$V_L = 17.65\times10^{-3}\times560 = 9.995\text{ V}$$

Norton's Theorem

A linear two terminal active network can be replaced at any pair of terminals 'A' & 'B' by a simple equivalent network consisting of a current source I_N parallel with a resistance R_{eq}. The source voltage across I_N is the current through the terminals AB when they are short-circuited. The series resistance R_{eq} is the resistance looking back in to the network at 'A' & 'B' when all the independent sources are set to zero.

Application of Norton's theorem

1. The terminals 'A' & 'B' are short-circuited and the short-circuited current at the terminals is calculated theoretically.
2. The network is redrawn with each ideal voltage source replaced by a short circuit and each ideal current source replaced by an open circuit.
3. The resistance R_{eq} of the redrawn network is calculated using network reduction method as seen back from the terminals 'A' & 'B' is calculated.

Apparatus required

Ammeter (0-50mA) mC	- 1 No.
DC regulated power supply(0-30V)	- 1 No.
Resistors 330Ω, 470Ω, 1000Ω, 560Ω	- 1 No. each
Rheostat 3600Ω, 0.3A	- 1 No.
Voltmeter (0-30V) mC	- 1 No.

Precautions

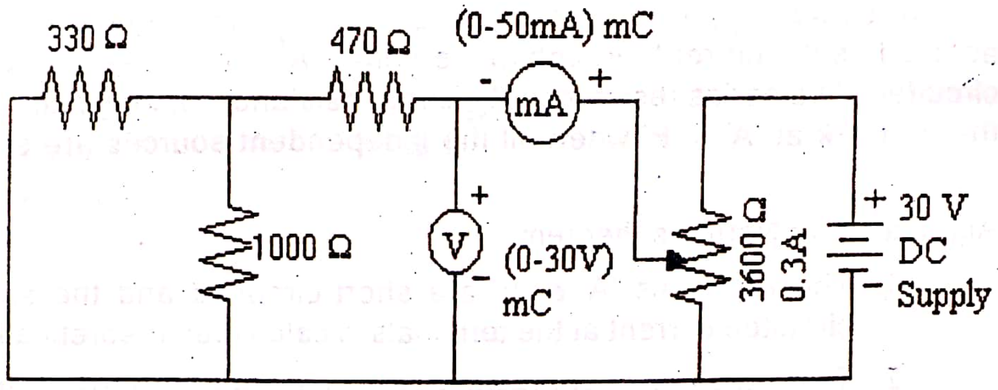
1. The potential divider must be kept at minimum potential position.
2. The meters should be connected with proper range and polarities.

Procedure

1. Connections are made as per circuit diagram.
2. Observing the precautions the power supply is switched on.
3. Thevenin's voltage, Norton's current and actual load current and load voltage are noted.
4. To measure R_{th}, the potential divider is varied and the voltmeter and ammeter readings are noted down and the average thevenin's resistance is calculated.

Circuit diagram

To measure R_{th}



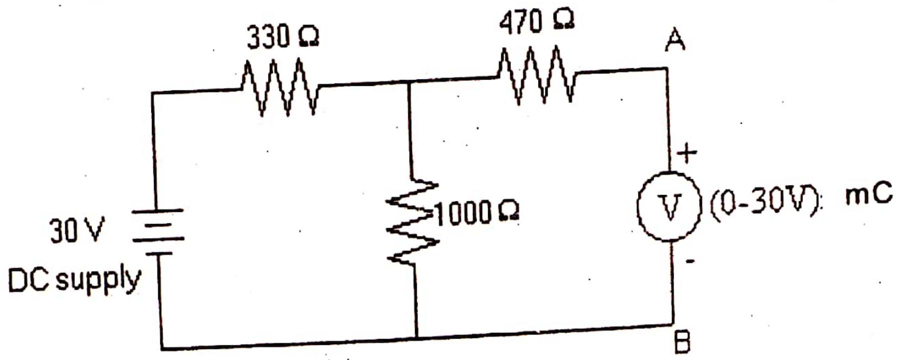
Tabulation

S. No.	Voltage V	Current mA	Resistance $Rth = \frac{V}{I}$ Ω
Average value of R_{th}			Ω

Scanned by CamScanner

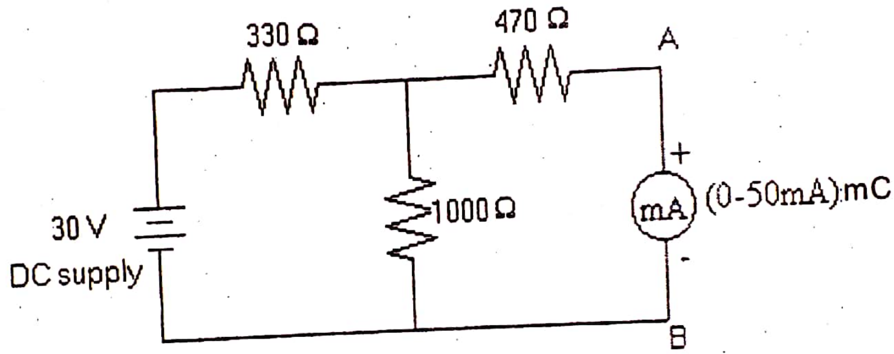
Circuit diagram

To measure V_{th}



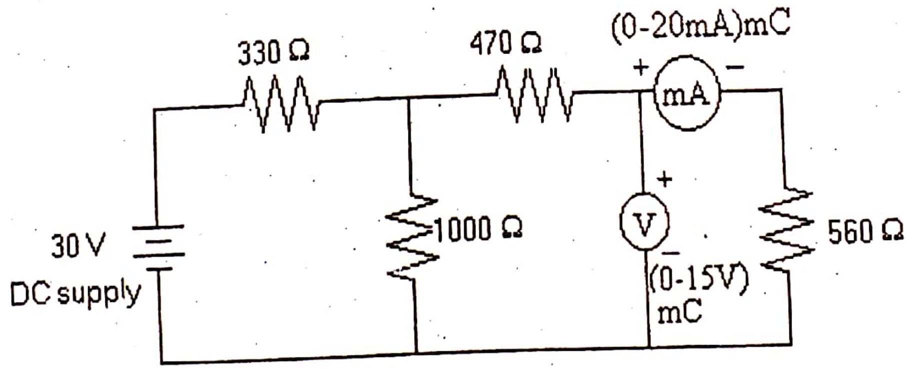
Circuit diagram

To measure I_N



Circuit diagram

To measure V_L and I_L

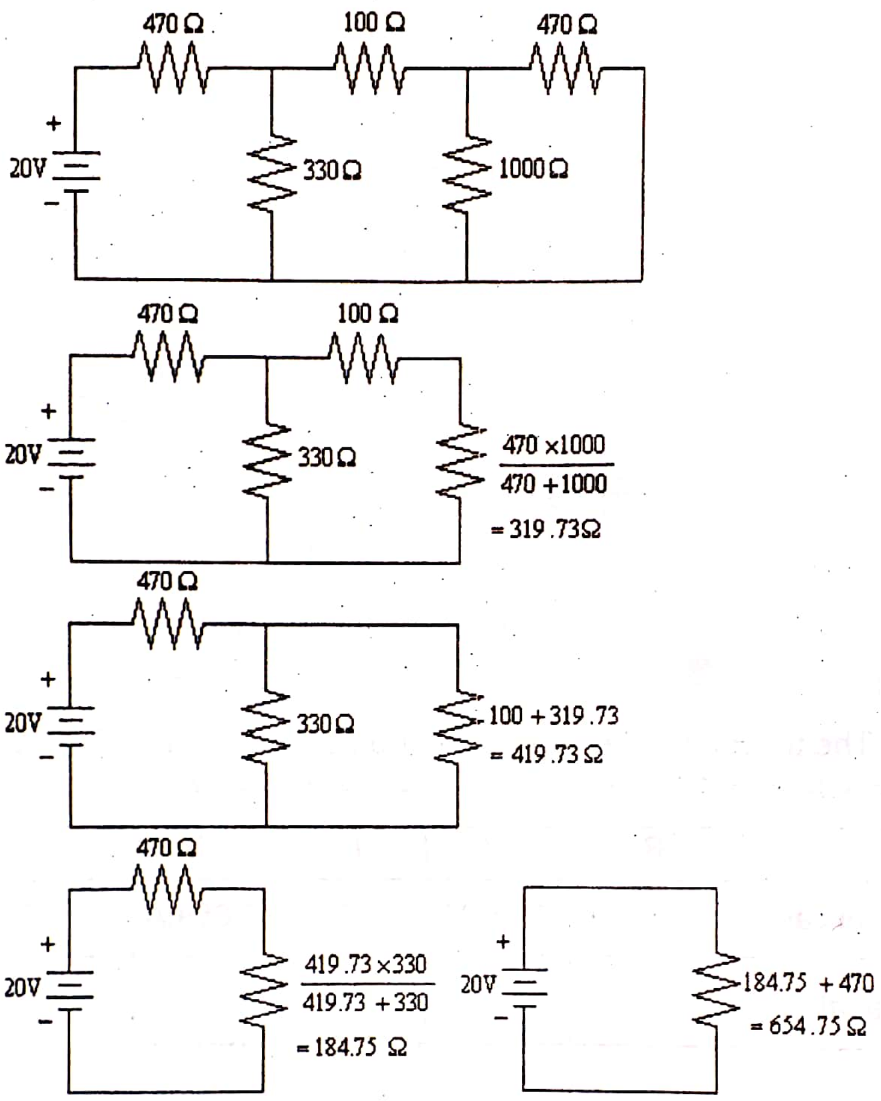


Result

The thevenin's theorem and norton's theorem are verified. The theoretical value and practical values are given below.

	R_{th}	V_{th}	I_N	I_L	V_L
Theoretical	718.1Ω	22.56V	31.43mA	17.65mA	9.995V
Practical					

To find current through 100 Ω due to 20 V source



$$I_T = \frac{20}{654.75} = 30.55\,\text{mA}$$

$$I_1 = I_T \times \frac{R_1}{R_1 + R_2} = 30.55 \times \frac{330}{419.73+330} = 13.45\,\text{mA}$$

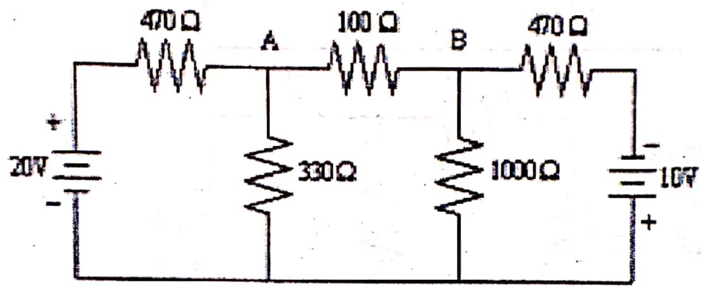
Current through 100 Ω due to 20 V source alone, I_1 = 13.45 mA

Exp. No.:
Date :

4. VERIFICATION OF SUPERPOSITION THEOREM

Aim

To verify the superposition theorem for the circuit shown in the figure.



Theory

Statement

In a linear circuit, the response at any element due to several sources is given by the superposition of the responses due to individual sources acting one at a time, while the rest of the sources reduced to zero.

Apparatus required:

Ammeter (0-50mA) mC	- 1 No
DC regulated power supply (0-30V), 2A	- 2 No.
Resistors 1000Ω, 100Ω, 330Ω	- 1 No. each
Resistors 470Ω	- 2 Nos.

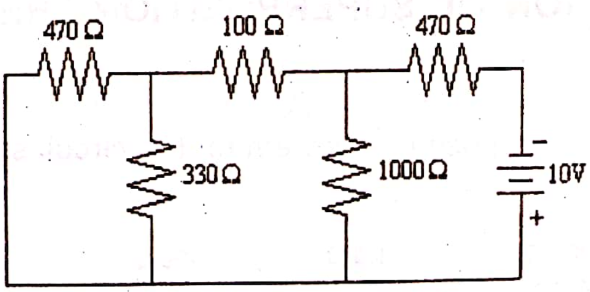
Precautions

Meters should be connected with proper range and polarities.

Procedure

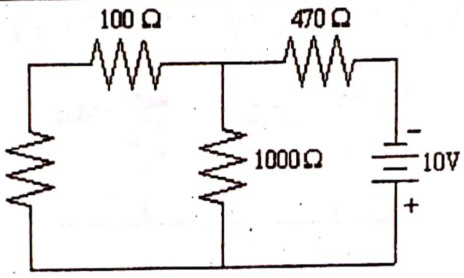
1. The connections are made as per circuit diagram.
2. Observing the precautions, the power supply is switched ON.
3. The ammeter reading I is noted with both voltage sources connected to the circuit.
4. The ammeter reading I_1 is noted with 20V source connected and the other short-circuited.
5. The ammeter reading I_2 is noted with 10V source connected and the other short-circuited.

To find current through 100 Ω due to 10 V source



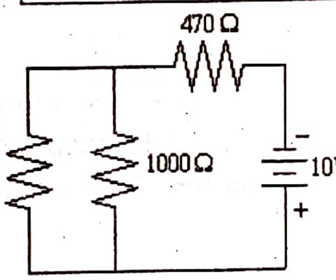
$\frac{470 \times 330}{470 + 330}$

= 193.88 Ω



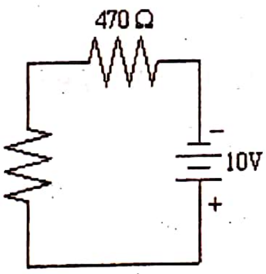
100 + 193.88

= 293.88 Ω



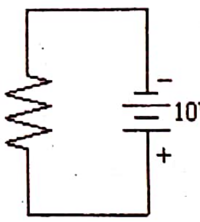
$\frac{293.88 \times 1000}{293.88 + 1000}$

= 227.13 Ω



227.13 + 470

= 697.13 Ω



$$I_T = \frac{10}{697.13} = 14.35\,\text{mA}$$

$$I_2 = I_T \times \frac{R_1}{R_1 + R_2} = 14.35 \times \frac{1000}{1000 + 293.88} = 11.09\,\text{mA}$$

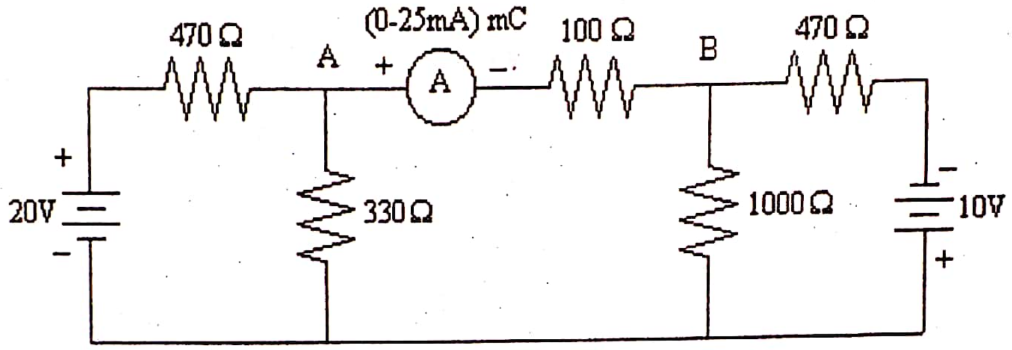
Current through 100 Ω due to 10 V source alone, I_2 = 11.09 mA

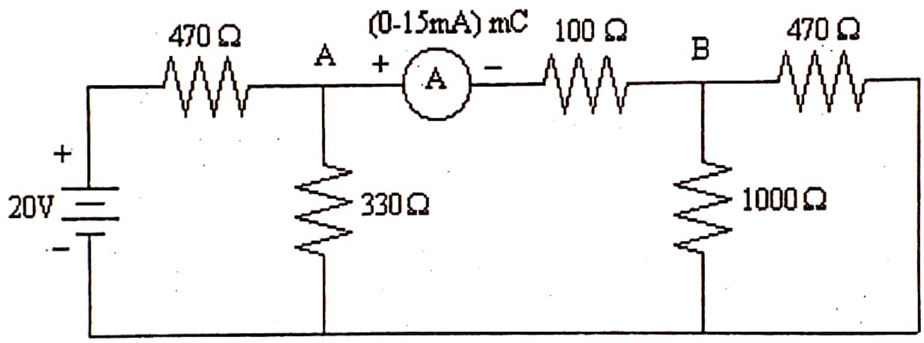
Total current through 100 Ω (due to both the sources), $I = I_1 + I_2$

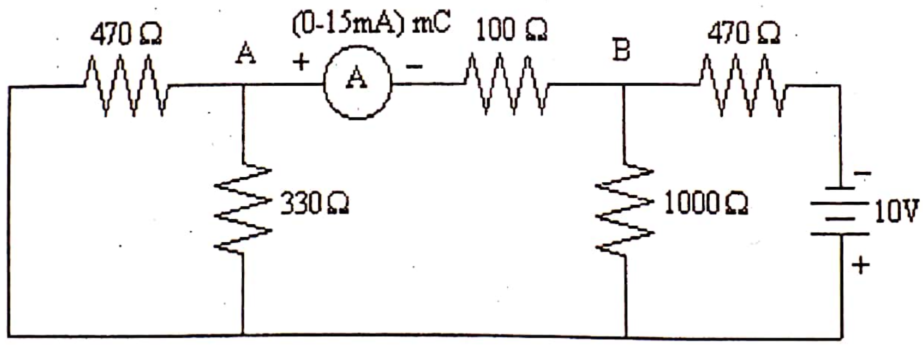
= 24.54 mA

Circuit diagram

To measure I, I_1 and I_2





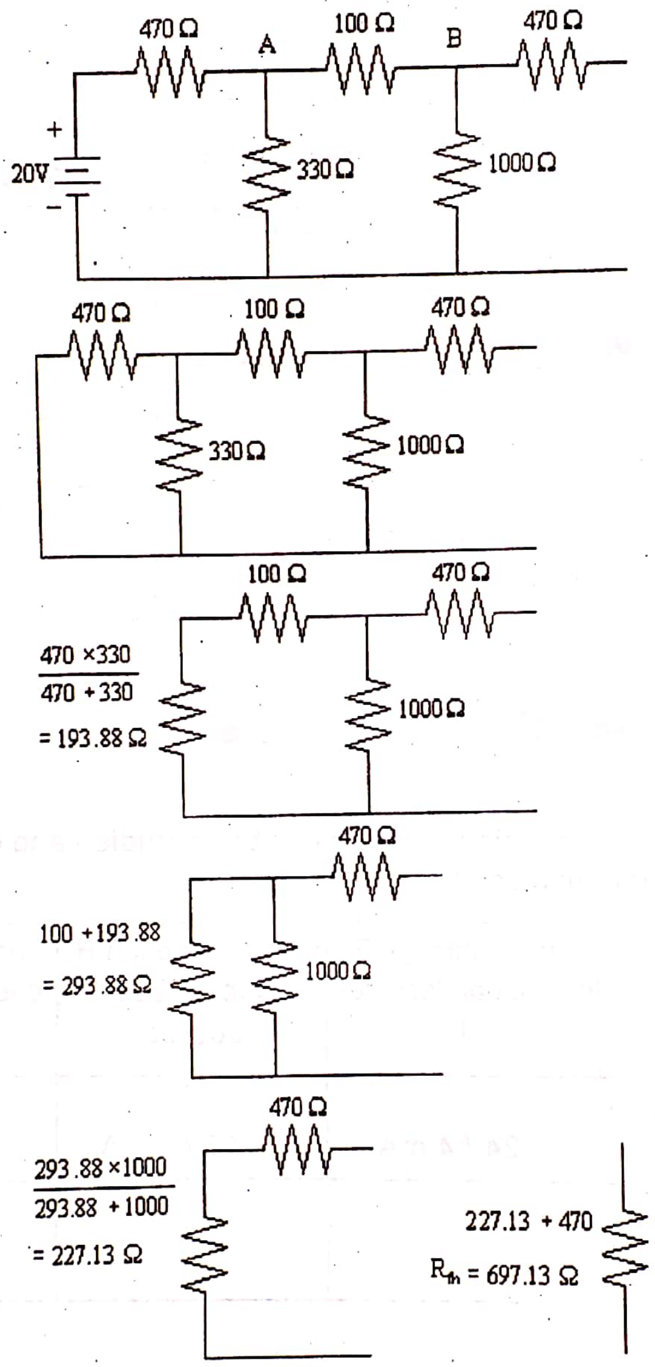


Result

The superposition theorem has been studied and experimentally verified for the given circuit.

	Current through R_L due to both sources I	Current through R_L due to 20V source I_1	Current through R_L due to 10V source I_2
Theoretical Values	24.54 mA	13.45 mA	11.09 mA
Practical Values			

Calculation of equivalent resistance R_{th}

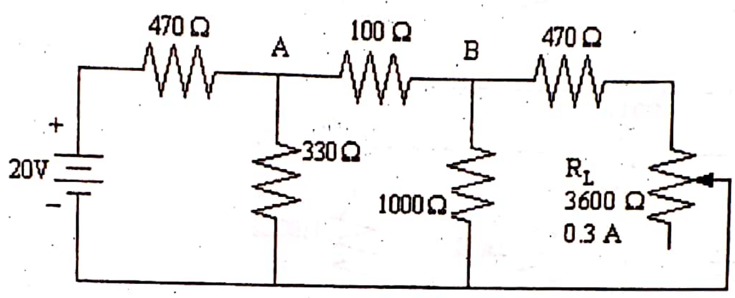


Maximum power will be delivered to the load when $R_L = R_{th} = 697.13\ \Omega$

VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

Aim

To verify the maximum power transfer theorem for the circuit shown in figure.



Theory

Statement

As applied to DC circuit the maximum power transfer theorem states that the maximum possible power that can be delivered to the load when the load resistance is equal to the resistance of the network as viewed from the output terminals, with all sources of emf shorted leaving behind their internal resistance, if any.

Apparatus required

Ammeter (0–10mA) mC	- 1 No.
DC Regulated power supply (0-30V)	- 1 No.
Resistors 1000Ω, 100Ω, 330Ω	- 1 No. each
Resistors 470Ω	- 2 Nos.
Rheostat 3600 Ω, 0.3A	- 1 No.
Voltmeter (0-10V)mC	- 1 No.

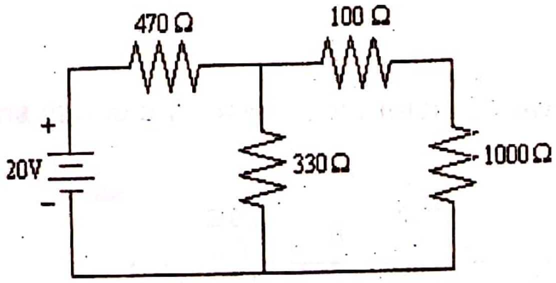
Precautions

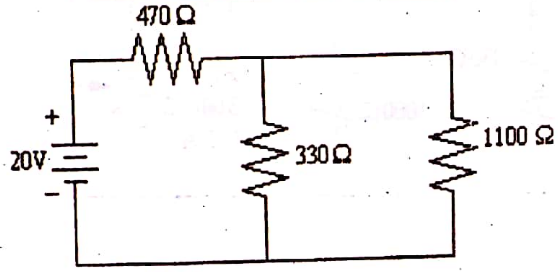
1. Meters should be connected with proper range and polarities.
2. The load rheostat must be kept at maximum resistance position initially.

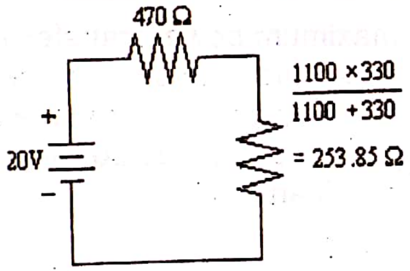
Procedure

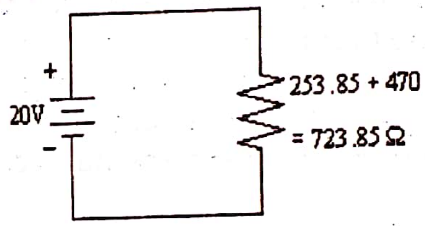
1. The connections are made as per circuit diagram.
2. Observing the precautions, the supply is switched ON.
3. The load rheostat is gradually adjusted in steps at each step the readings of the ammeter and the voltmeter are noted and tabulated.

Calculation of V_{th} and Maximum power P_{max}





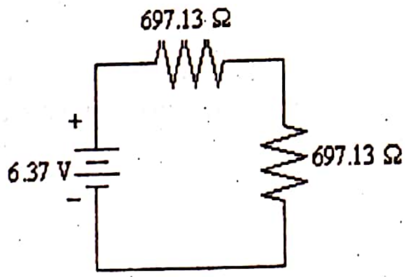




$$I = \frac{20}{723.85} = 27.63\,mA$$

$$I_{1000\,\Omega} = 0.02763 \times \frac{330}{330+1100} = 6.38\,mA$$

$$V_{th} = 0.00638 \times 1000 = 6.38\,V$$

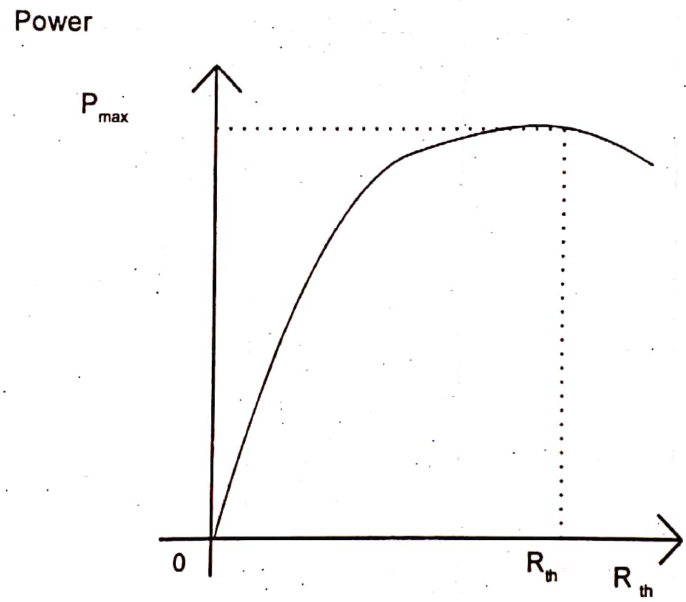


Maximum Current flows in the circuit when $R_L = 0$

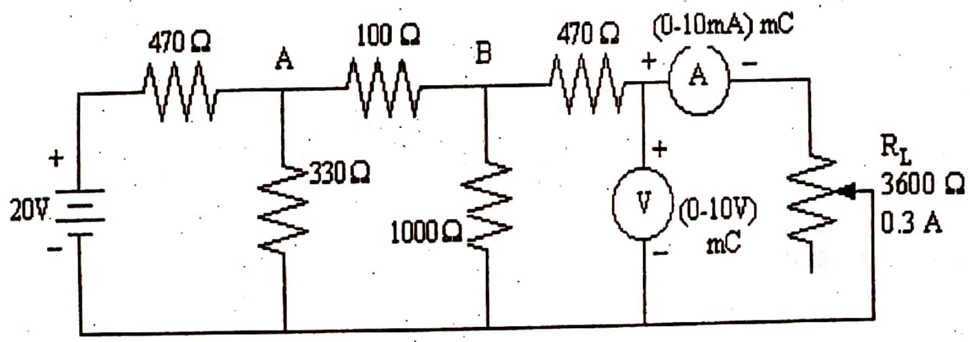
$$I_{max} = \frac{6.38}{0+697.13} = 9.15mA$$

$$P_{max} = \frac{V_{th}^{\,2}}{4\times R_{th}} = \frac{6.37^2}{4\times 697.13} = 14.60mW$$

Model Graph



Circuit diagram



Tabulation

S. No.	Voltmeter Reading V	Ammeter Reading mA	Resistance Ω	Power Dissipation mW

Result

It is observed that the maximum power is transferred at which the load resistance equals the internal resistance of the network as viewed from the output terminal with all the source of emf leaving behind their internal resistance (assumed to be Zero). Hence the maximum power transfer theorem is verified.

	Equivalent Resistance R_{th}, Ω	Maximum Power Delivered P_{max}, mW
Theoretical Values	697.13	14.60
Practical Values		

Exp. No. :
Date :

Study of Series RL circuits

Aim

To determine and verify the phase angle of the given RL series circuits and to design and verify the differentiator and integrator circuits.

Theory

RL circuit

$$i(t) = I_m \sin \varpi t$$
$$V_R = R \times i(t) = RI_m \sin \varpi t$$
$$V_L = L\frac{di}{dt} = L\frac{d}{dt}(I_m \sin \varpi t)$$
$$= \varpi L \cos \varpi t$$
$$V(t) = V_R + V_L$$
$$= RI_m \sin \varpi t + \varpi L \cos \varpi t$$

Expressing V(t) as a simple sine function with amplitude A and phase angle ϕ

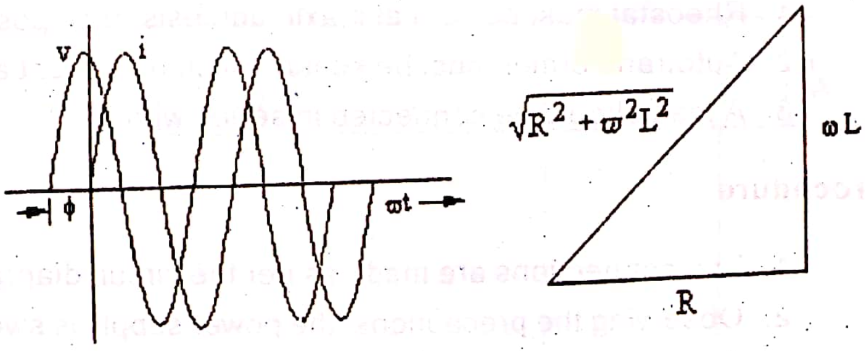
$$V(t) = A\sin(\varpi t + \phi)$$
$$= A\sin \varpi t \cos\phi + A\cos \varpi t \sin\phi$$

Comparing both the equations

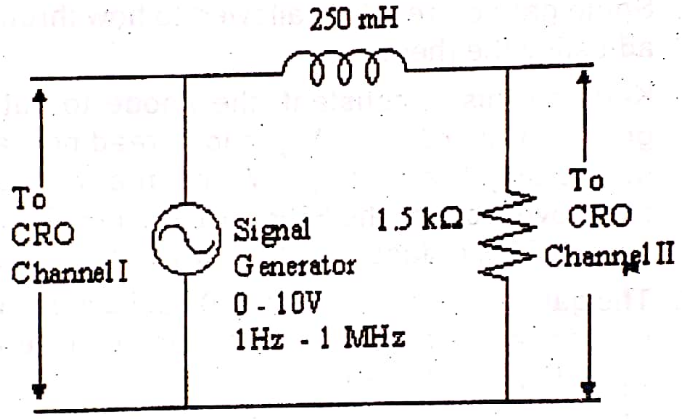
$$A\cos\phi = RI_m, \quad A\sin\phi = \varpi L I_m, \quad \tan\phi = \frac{\varpi L}{R}$$
$$A = I_m\sqrt{(R^2 + \varpi^2 L^2)}$$
$$V(t) = I_m\sqrt{(R^2 + \varpi^2 L^2)}\sin\left(\varpi t + \tan^{-1}\left(\frac{\varpi L}{R}\right)\right)$$

Magnitude of impedance = $\sqrt{(R^2 + \varpi^2 L^2)}$

RL Circuit



Circuit diagram



Design

$$\tan\varphi = \frac{\omega L}{R}$$

$$\tan 45^\circ = \frac{2\pi \times 1000 \times 250 \times 10^{-3}}{R}$$

$$R \approx 1.5k\Omega$$

Scanned by CamScanner

Apparatus required

Inductor 250mH	- 1 No.
Capacitor 0.01μF	- 1 No.
Resistors 1.5 kΩ, 15 kΩ, 8.6 kΩ, 1MΩ, 10KΩ	- 1 No. each
CRO	- 1 No.
Signal generator	- 1 No.

Precautions

The ratings of the devices should not be exceeded.

Procedure

1. The connections are given as per the circuit diagram.
2. After observing the precautions, the power supply is switched ON.
3. The relevant waveforms are traced.
4. From the waveforms, the phase angle between current and applied voltage are calculated.

Result

RC, RL, RLC differentiating and integrating circuits have been studied, verified and corresponding waveforms are traced.

Exp. No. :
Date :

Study of Series RC circuits

Aim

To determine and verify the phase angle of the given RC series circuits and to design and verify the differentiator and integrator circuits.

Theory

RC circuit

$$i(t) = I_m \cos \varpi t$$
$$V_R = R \times i(t) = RI_m \cos \varpi t$$
$$V_C = \frac{1}{C}\int i(t)dt = \frac{1}{\varpi C} I_m \sin \varpi t$$
$$V(t) = V_R + V_C$$
$$= RI_m \cos \varpi t + \frac{1}{\varpi C} I_m \sin \varpi t$$

Expressing V(t) as a simple cosine function with amplitude A and phase angle ϕ

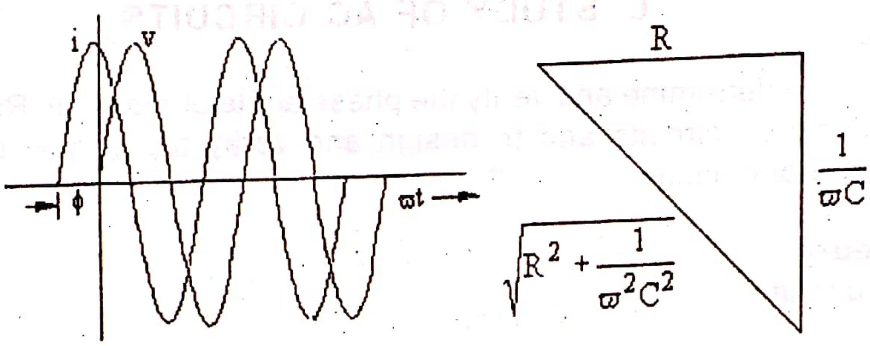
$$V(t) = A\cos(\varpi t + \phi)$$
$$= A\cos \varpi t \cos\phi - A\sin \varpi t \sin\phi$$

Comparing both the equations

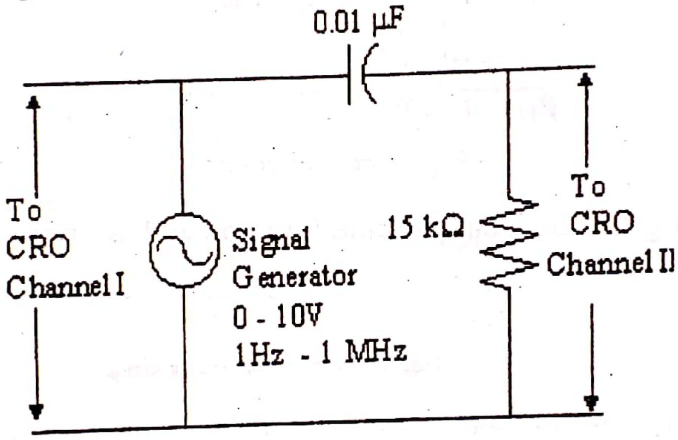
$$A\cos\phi = RI_m, \quad A\sin\phi = \frac{I_m}{\varpi C}, \quad \tan\phi = \frac{1}{\varpi CR}$$
$$A = I_m\sqrt{\left(R^2 + \frac{1}{\varpi^2 C^2}\right)}$$
$$V(t) = I_m\sqrt{\left(R^2 + \frac{1}{\varpi^2 C^2}\right)}\cos\left(\varpi t + \tan^{-1}\left(\frac{1}{\varpi CR}\right)\right)$$

Magnitude of impedance = $\sqrt{\left(R^2 + \frac{1}{\varpi^2 C^2}\right)}$

RC circuit



Circuit diagram



Design

$$\tan\phi = \frac{1}{\varpi CR}$$

$$\tan 45^\circ = \frac{1}{2\pi \times 1000 \times 0.01 \times 10^{-6} \times R}$$

$$R \approx 15k\Omega$$

Apparatus required

Inductor 250mH	- 1 No.
Capacitor 0.01μF	- 1 No.
Resistors 1.5 kΩ, 15 kΩ, 8.6 kΩ, 1MΩ, 10KΩ	- 1 No. each
CRO	- 1 No.
Signal generator	- 1 No.

Precautions

The ratings of the devices should not be exceeded.

Procedure

1. The connections are given as per the circuit diagram.
2. After observing the precautions, the power supply is switched ON.
3. The relevant waveforms are traced.
4. From the waveforms, the phase angle between current and applied voltage are calculated.

Result

RC, RL, RLC differentiating and integrating circuits have been studied, verified and corresponding waveforms are traced.

Exp. No. :
Date :

Study of Series RLC circuits

Aim

To determine and verify the phase angle of the given RLC series circuits and to design and verify the differentiator and integrator circuits.

Theory

RLC Circuit

$$i(t) = I_m \sin \varpi t$$

$$V_R = R \times i(t) = RI_m \sin \varpi t$$

$$V_L = L\frac{di}{dt} = \varpi L I_m \cos \varpi t$$

$$V_C = \frac{1}{C}\int i(t)dt = -\frac{I_m}{\varpi C}\cos \varpi t$$

$$V(t) = V_R + V_L + V_C$$

$$= RI_m \sin \varpi t + \varpi L I_m \cos \varpi t - \frac{I_m}{\varpi C}\cos \varpi t$$

$$= RI_m \sin \varpi t + \left(\varpi L - \frac{1}{\varpi C}\right) I_m \cos \varpi t$$

Expressing V(t) as a simple sine function with amplitude A and phase angle ϕ

$$V(t) = A\sin(\varpi t + \phi) = A\sin \varpi t \cos\phi + A\cos \varpi t \sin\phi$$

Comparing both the equations

$$A\cos\phi = RI_m, \quad A\sin\phi = \left(\varpi L - \frac{1}{\varpi C}\right) I_m \quad \tan\phi = \frac{\left(\varpi L - \frac{1}{\varpi C}\right)}{R}$$

$$A = I_m\sqrt{\left(R^2 + \left(\varpi^2 L^2 - \frac{1}{\varpi^2 C^2}\right)\right)}$$

$$V(t) = I_m\sqrt{\left(R^2 + \left(\varpi^2 L^2 - \frac{1}{\varpi^2 C^2}\right)\right)} \sin\left(\varpi t + \tan^{-1}\left(\frac{\varpi L}{R}\right)\right)$$

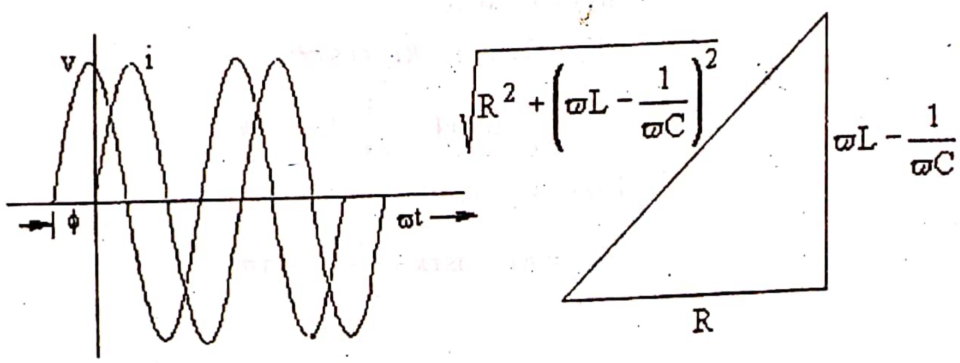
Magnitude of impedance = $\sqrt{\left(R^2 + \left(\varpi^2 L^2 - \frac{1}{\varpi^2 C^2}\right)\right)}$

$\varpi L > \frac{1}{\varpi C}$ then ϕ is positive and the circuit is inductive

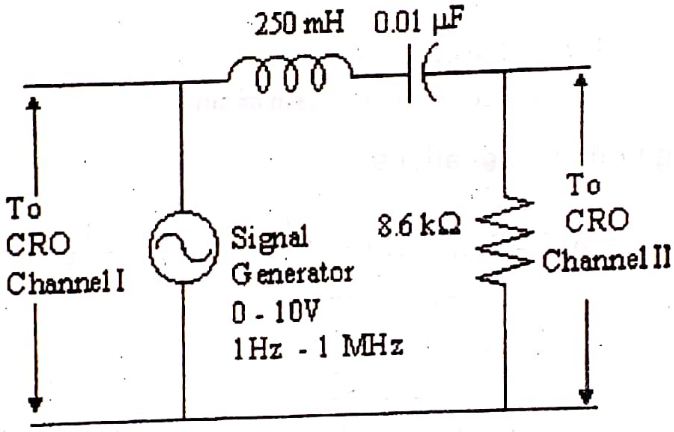
$\varpi L < \frac{1}{\varpi C}$ then ϕ is negative and the circuit is capacitive

$\varpi L = \frac{1}{\varpi C}$ then the circuit is resistive

RLC circuit



Circuit diagram



Design

$$\tan\phi = \left[\frac{\left(\varpi L - \frac{1}{\varpi C}\right)}{R}\right]$$

$$\tan 60^{o} = \left[\frac{\left(2\pi\times 1000\times 250\times 10^{-3} - \frac{1}{2\pi\times 1000\times 0.01\times 10^{-6}}\right)}{R}\right]$$

$R \approx 8.6k\Omega$

Apparatus required

Inductor 250mH	- 1 No.
Capacitor 0.01μF	- 1 No.
Resistors 1.5 kΩ, 15 kΩ, 8.6 kΩ, 1MΩ, 10KΩ	- 1 No. each
CRO	- 1 No.
Signal generator	- 1 No.

Precautions

The ratings of the devices should not be exceeded.

Procedure

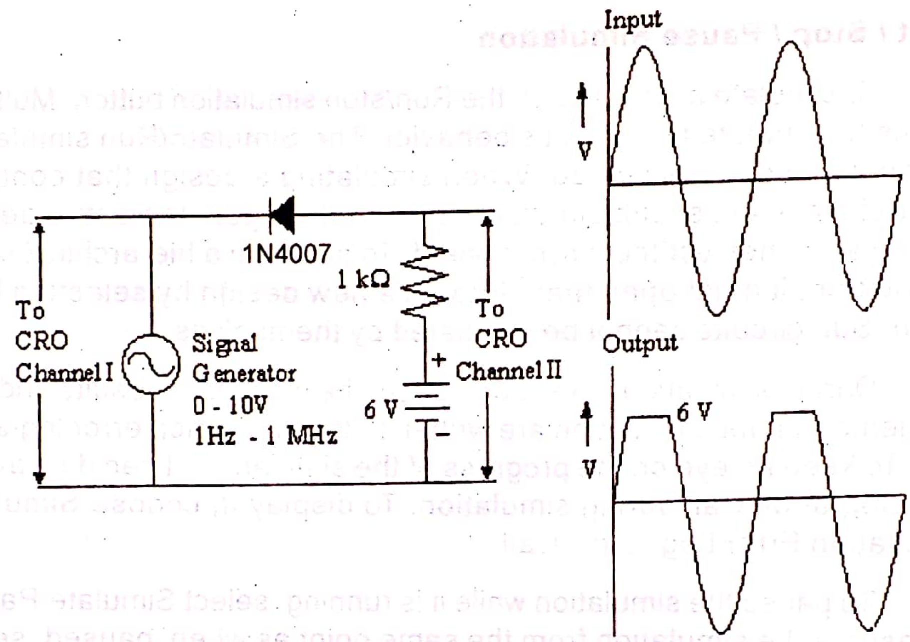
1. The connections are given as per the circuit diagram.
2. After observing the precautions, the power supply is switched ON.
3. The relevant waveforms are traced.
4. From the waveforms, the phase angle between current and applied voltage are calculated.

Result

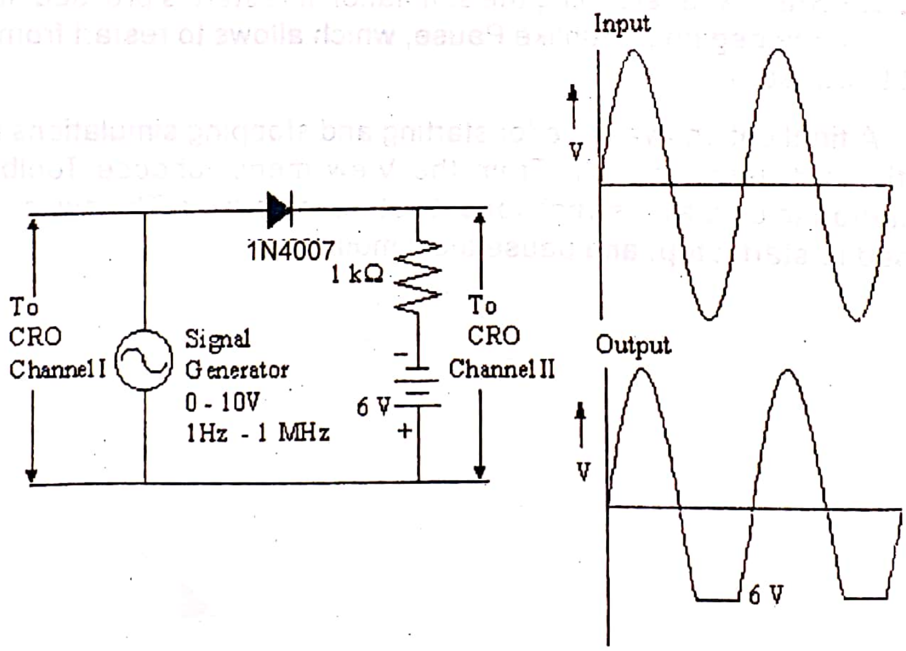
RC, RL, RLC differentiating and integrating circuits have been studied, verified and corresponding waveforms are traced.

Circuit diagram

Series Top Clipper



Series Bottom Clipper



Exp. No. :
Date :

WAVE SHAPING CIRCUITS

Aim

To construct and study various clipping circuits and the clamping circuit.

Theory

Clipping circuit

The circuit with which the waveform is shaped by removing or clipping a portion of the input waveform is known as clipping circuit.

Biased clipper

Sometimes it is desired to remove a small portion of the positive and negative half cycles of the signal voltage. For this purpose biased clippers are used.

Shunt top clipper

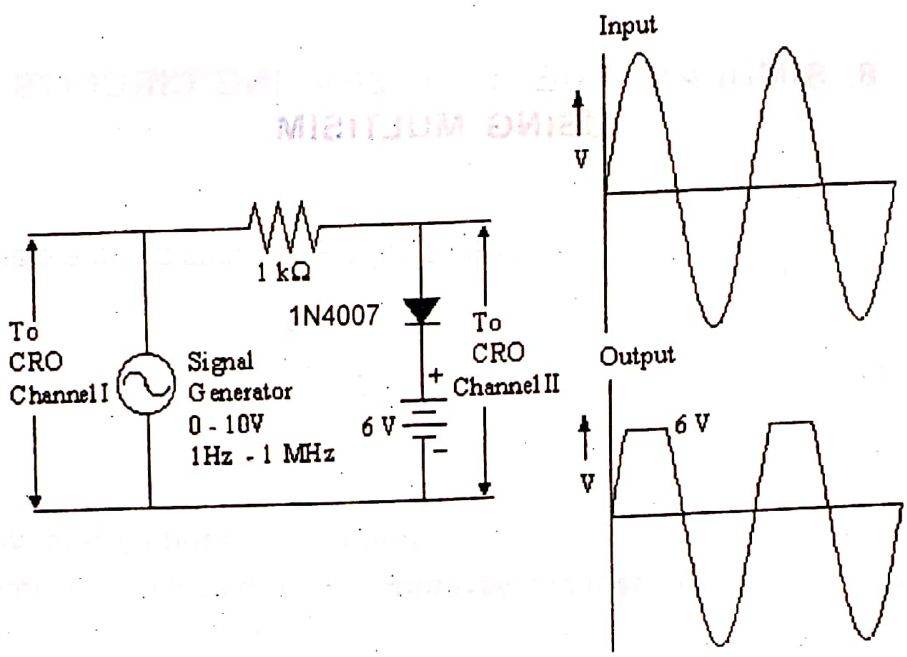
During the positive half cycle of the input, when the instantaneous value of the voltage is less than the biasing voltage (battery voltage) the diode is reverse biased and the output voltage will be same as input. When the instantaneous value exceeds the biasing voltage the diode will be forward biased and the output will be same as biasing voltage.

During negative half cycle, the diode is reverse biased the input signal appears at the output.

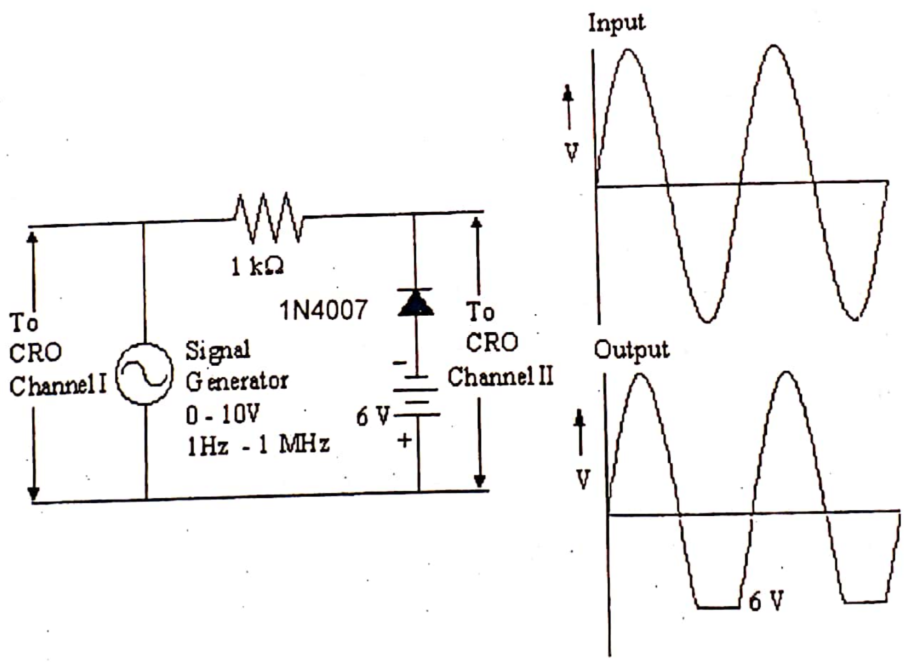
Shunt bottom clipper

The output is similar to that of shunt top clipper but clipping takes place in the negative half cycle of the input. This is because battery terminal and the diode terminal are reversed.

Shunt Top Clipper



Shunt Bottom Clipper



Series top clipper

During the positive half cycle of the input, when the instantaneous voltage is less than the biasing voltage the diode conducts and acts as short circuit and the output voltage will be same as input. When the instantaneous voltage exceeds the biasing voltage, the diode is reverse biased and output will be same as biasing voltage.

During the negative half cycle, the diode is forward biased and the input signal appears at the output.

Series bottom clipper

The operation is similar to that of series top clipper but clipping takes place in the negative half cycle of input. Here the battery and diode terminals are reversed.

Combinational circuit

It is a combinational of both shunt top and bottom clipper. So the clipping takes place during both positive and negative half cycles.

Clampers

Initially the capacitor is charged through diode D, to a maximum of V_m with polarities as shown in the figure. The input signal is superimposed with the capacitor voltage (dc voltage equal to V_m) and is available at the output. The output will be the input voltage whose reference is shifted by V_m.

Apparatus required

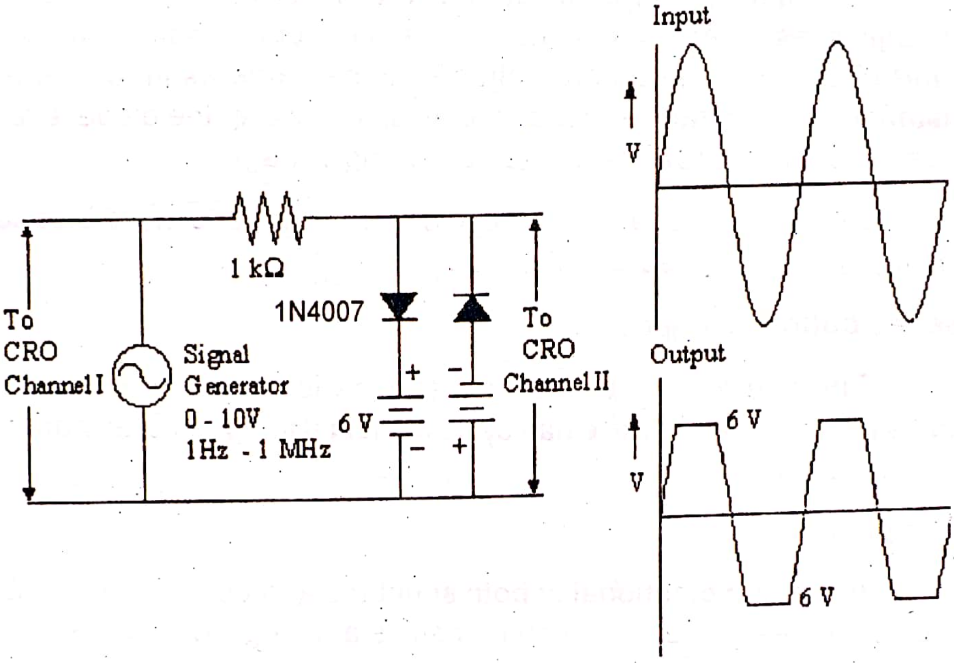
Capacitor 100μF, 25V	- 1 No.
CRO	- 1 No.
DC power supply (0-10V)	- 2 Nos.
Diode 1N4007	- 2 Nos.
Resistor 1 kΩ, 1 MΩ	- 1 No.
Signal generator (0-10V)(0-1 MHz)	- 1 No.

Specifications:

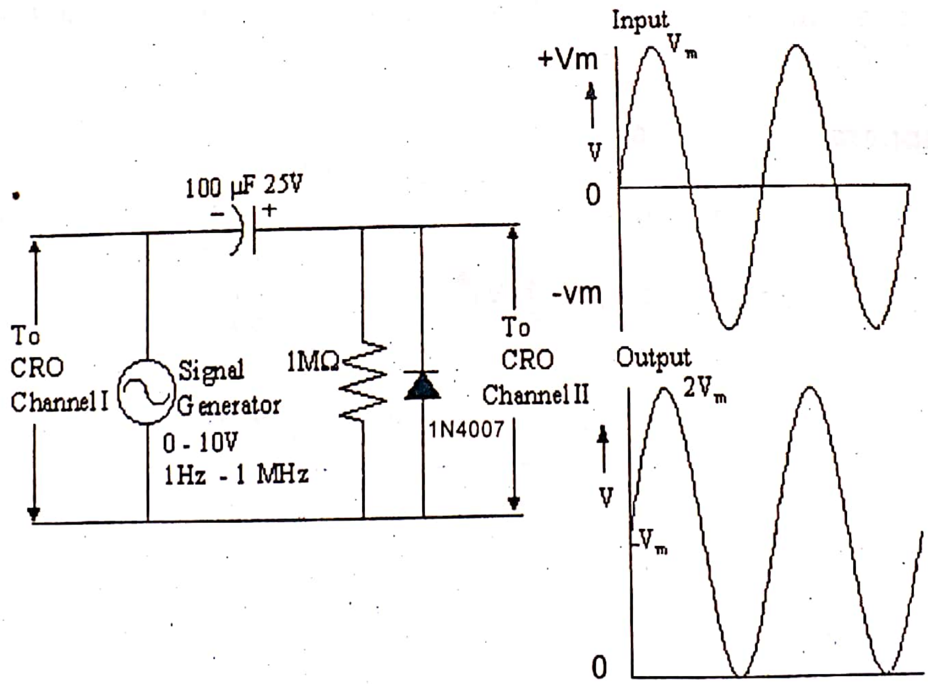
1N 4007

PIV	1250 V
$I_{F(av)}$	1 A

Clipping at both levels



Clamping Circuit



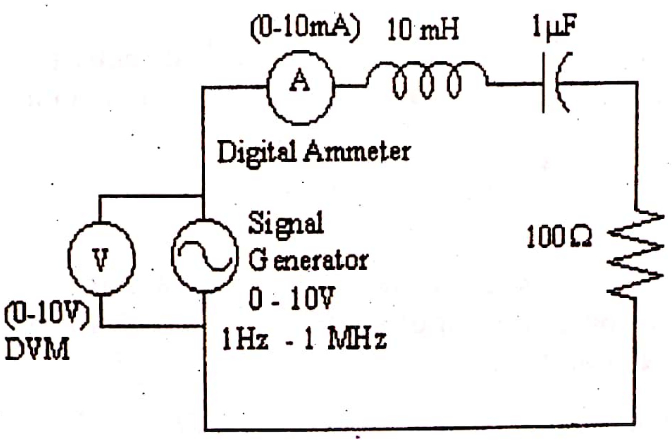
Precautions

1. Fabricate the circuit using multi sim as per the circuit diagram.
2. The input and the ouput gave form are treated.

Result

Different types of wave shaping circuits have been studied and input and output waveforms are traced.

Circuit diagram



Design

$$F_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{10\times10^{-3}\times1\times10^{-6}}} = 1.591\,kHz$$

$$Q\ factor = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{100}\sqrt{\frac{10\times10^{-3}}{1\times10^{-6}}} = 1$$

$$Bandwidth = \frac{F_r}{Q} = 1.591\,kHz$$

$$I_r = \frac{V}{R} = \frac{2}{100} = 20mA$$

Tabulation

S. No.	Voltage = 1 V	
	Frequency, Hz	Current, A

Exp. No.: 9 & 10
Date :

SERIES AND PARALLEL RESONANCE CIRCUITS

Aim

To plot the current vs. frequency graph of series and parallel resonance circuit and to measure bandwidth, resonant frequency and Q-factor.

Theory

Series resonance in RLC circuit

A circuit is said to be in resonance when the applied voltage V and current I are in phase with each other. Thus, at resonance condition, the equivalent complex impedance of the circuit consists of only resistance (R) (which is small) and the current is maximum. Since V and I are in phase, the power factor is unity.

At resonance

$$X_L = X_C$$

where

$$X_L = \varpi L$$

$$X_C = \frac{1}{\varpi C}$$

$$\varpi = 2\pi f$$

Resonant frequency

$$\varpi L = \frac{1}{\varpi C}$$

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

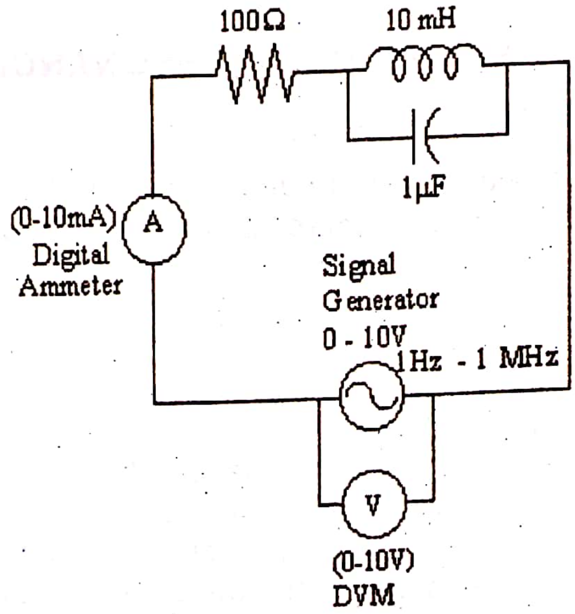
The circuit behaves like a pure resistive circuit. So, $I_r = \frac{V}{R}$

Resonance curve

The curve between current and frequency is known as resonance curve.

9.4.16

Circuit diagram



Tabulation

S. No.	Voltage = V	
	Frequency Hz	Current A

Bandwidth of a resonance circuit

Bandwidth of a circuit is given by the band of frequencies, which lies between two points on either side of resonance frequency where current falls through $\frac{1}{\sqrt{2}}$ of the maximum value at resonance.

The bandwidth AB is given by

$$Band\ \text{width} = f_2 - f_1$$

where

f_1 is the lower cut-off frequency
f_2 is the upper cut-off frequency

Q -Factor

It is defined as the voltage magnification in RLC series circuit at resonance. At resonance, the current $I_r = V / R$ is maximum in RLC series circuit, the voltage across either the inductor or capacitor is equal to $I_r X_c$.

$$V = I_r R$$

$$Q\ \text{factor} = \frac{V_L}{V} = \frac{I_r X_L}{I_r R}$$

$$= \frac{\varpi L}{R} = \frac{2\pi F_r L}{R}$$

$$= \frac{1}{R}\sqrt{\frac{L}{C}}$$

Parallel resonance in RLC circuit

Let us consider the practical curve of the circuit in parallel with the capacitor as shown in figure. Such a circuit is said to be in electrical resonance when the reactive component of leakage current becomes zero. The frequency at which this happens is known as resonance frequency.

$$Fr = \frac{1}{2\pi}\sqrt{\left[\frac{1}{R^2} - \left(\frac{R}{L}\right)^2\right]}$$

If R is small then

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

In parallel resonance, the line current at resonance is minimum, and is in phase with the applied voltage. Hence, power factor is unity.

Comparison of series and parallel resonance

S. No.	Item	Series	Parallel
1	Impedance of circuit	Minimum	Maximum
2	Current at resonance	Maximum	Minimum
3	Effective impedance	R	$\frac{L}{CR}$
4	Power factor at resonance	Unity	Unity
5	Resonance frequency	$\frac{1}{2\pi\sqrt{LC}}$	$\frac{1}{2\pi}\sqrt{\left[\frac{1}{R^2}-\left(\frac{R}{L}\right)^2\right]}$
6	Magnifies	Voltage	Current
7	Quality factor	$\frac{\omega L}{R}$	$\frac{\omega L}{R}$

Apparatus required

Capacitor 1μF	- 1 No
Digital multimeter	- 2 Nos.
Inductor 10mH	- 1 No.
Resistor 100Ω	- 1 No
Signal generator	- 1 No.

Precautions

1. The ratings of the devices used should not be exceeded.
2. Meters should be connected with proper ranges for measurement.

Procedure

1. The connections are made as shown in the circuit diagram.
2. Keeping the input voltage constant, the frequency is varied and the corresponding meter readings are noted down.
3. Current vs. frequency graph is drawn. The bandwidth, resonance frequency and Q-factor are calculated.

Result

Current vs. frequency graph was drawn and the bandwidth, resonance and Q factor were calculated for both series and parallel resonance circuit.