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Laser & Optoelectronics Engineering Department
Communication Engineering Lab.

Exp.No.1
Transient Response of R.L. Circuit

OBJECT

TO INVESTIGATE THE RESPONSE BEHAVIOR OF R-L CCT.

APPARATUS

1-signal function generator
2- Oscilloscope
3- Resisters & inductor

THEORY

Before we begin to explore the effects of resistors, inductors, and in the AC circuits, let's briefly review some basic capacitors connected terms and facts:

Resistance is essentially friction against the motion of electrons. It is present in all conductors to some extent (except superconductors!), most notably in resistors. When alternating current goes through a resistance, a voltage drop is produced that is in-phase with the current. Resistance is mathematically symbolized by the letter "R" and is measured in the unit of ohms

Reactance is essentially inertia against the motion of electrons. It is present anywhere electric
or magnetic fields are developed in proportion to applied voltage or current, respectively; but most notably in capacitors and inductors. When alternating current goes through a pure reactance, a voltage drop is produced that is 90^o out of phase with the current. Reactance is mathematically symbolized by the letter "X" and is measured in the unit of ohms.

Impedance is a comprehensive expression of any and all forms of opposition to electron flow
Including both resistance and reactance. It is present in all circuits, and in all components. When alternating current goes through an impedance, a voltage drop is produced that is somewhere between 0^o and 90^o out of phase with the current. Impedance is mathematically symbolized by the letter "Z" and is measured in the unit of ohms. in complex form

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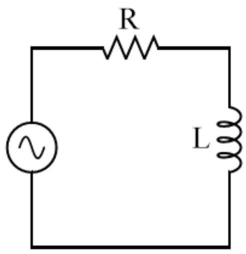
Perfect resistors possess resistance, but not reactance. Perfect inductors and perfect capacitors
Possess reactance but no resistance. All components possess impedance, and because of this universal quality, it makes sense to translate all component values (resistance, inductance, capacitance) into common terms of .impedance as the first step in analyzing an AC circuit.

R-L TRANSIENTS

The changing voltages and current that result during the storing of energy in the form of a magnetic field by an inductor in a ac circuit can be described using the circuit below.



Basic R-L transient network

1- STORAGE CYCLE

The changing voltages& current that result during the storing of energy in the form of magnetic field by an inductor in dc circuit can be described using the network of fig 1.

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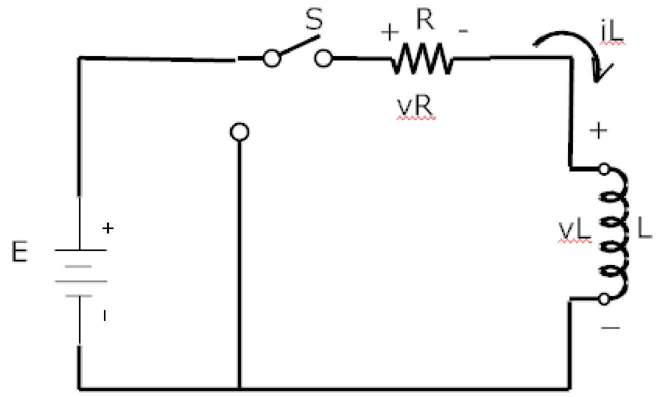

fig(1) D.C. equivalent circuit

At the instant the switch is closed the inductance of the coil will prevent an instantaneous change in current through the coil. The potential drop across the coil v_L ,will equal the impressed voltage .E is determined by kirchhoff's voltage law since $v_R= i.R= 0.R= 0$ volt. The current i_L will then build up from zero, establishing a voltage drop across the resistor & a corresponding drop in v_L. The current will continue to increase until the voltage across the inductor drops to zero volt and the full impressed voltage appears cross the resistor. The current i_L increases quit rapidly, followed by a co the instant the switch of fig.(1) is closed the equivalent network will appear as shown in fig(2):
ntinually decreasing rate until i_L reaches its maximum value of E/R.
the instant the switch of fig.(1) is closed the equivalent network will appear as shown in fig(2):

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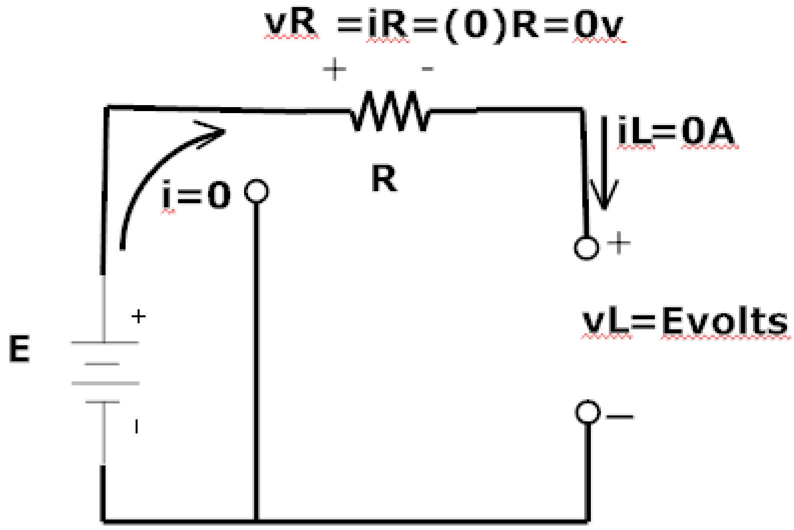

fig. (2)the instant the switch (s)is closed.

The inductor obviously meets all the requirement for an open-circuit equivalent v_L=E volts , i_L = 0A.
When steady –state condition have been established and the storage phase is complete ,the equivalent network will appear as shown in fig.(3):

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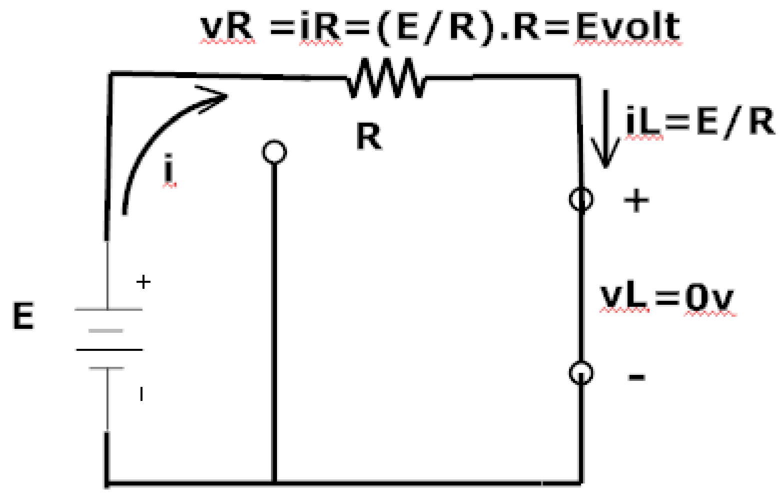

fig.(3)under steady-state condition.

An ideal inductor assumes a-short-circuit equivalent in a d.c. network on steady-state condition have been established.
The equation for the current i_L during the storage phase is the following:

$$i_L = I_m\left(1 - e^{-t/\varepsilon}\right) = \frac{E}{R}\left(1 - e^{-t/(L/R)}\right) \quad \ldots\ldots(1)$$

a plot of the equation in fig.(4) clearly indicate that the maximum steady state value of i_L is E/R ,and that the rate of changing in current decreases as time passes .

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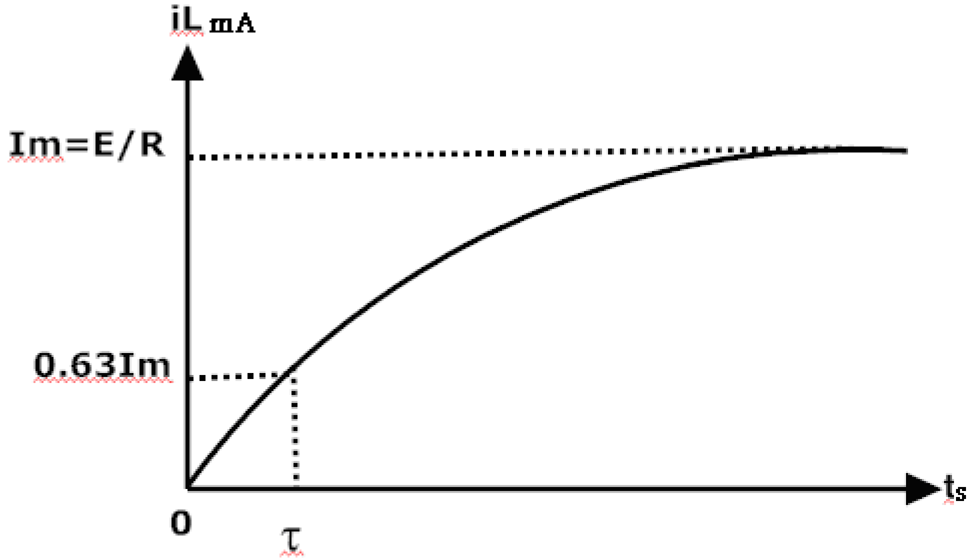

fig (4)a plot of iL during charging phase

the time constant (τ) for inductive cct. Defined by the following:

in second $\tau = \dfrac{L}{R}$ .... **(2)**

Fig.(2&3) clearly reveal that the voltage across the coil jumps to E volt when the switch is closed and decay to 0 volt with time. The decay occurs in an exponential manner and v_L during the storage phase can be described mathematically by the following equation :

$$v_L = Ee^{-t/\tau} \quad \text{...(3)}$$

A plot of v_L is :

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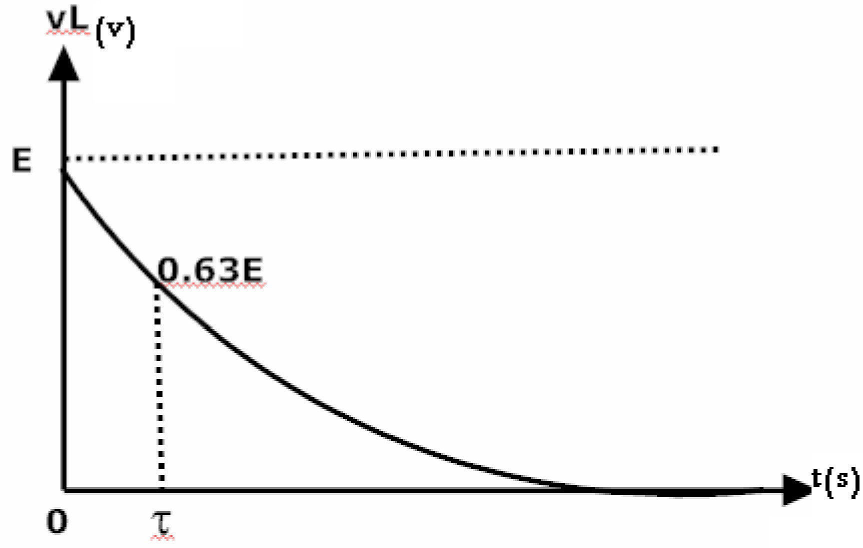

fig(5) a plot of vL during charging phase

Since

$v_R = i_R . R = i_L . R$

$v_R = \frac{E}{R}\left(1 - e^{-t/(L/R)}\right).R$

$v_R = E\left(1 - e^{-t/\tau}\right)$ ....(4)

and the curve for v_R will have the same shape as obtained for i_L

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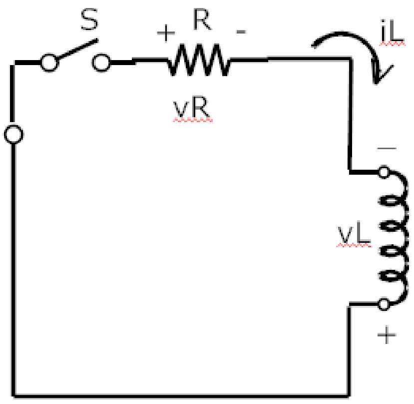
2- DECAY PHASE

After the storage phase has passed and steady –state condition are established the switch can be opened for clarity the discharge path is isolated in fig.(6).



fig(6) discharge phase

The current will decay from maximum of *Im =E/R* To zero in the following manner:

$$i_L = I_m e^{-t/\tau} \qquad (5)$$

The voltage across v_R is expressed as follows:

$$v_R = Ee^{-t/\tau} \qquad (6)$$

PROCEDURE

1-connect the circuit as as shown in fig.(7).
2-adjust the A.C. oscillator to 8 Vp.p & 140Hz ,R1=1K,L=400mH, R2=100 ohm

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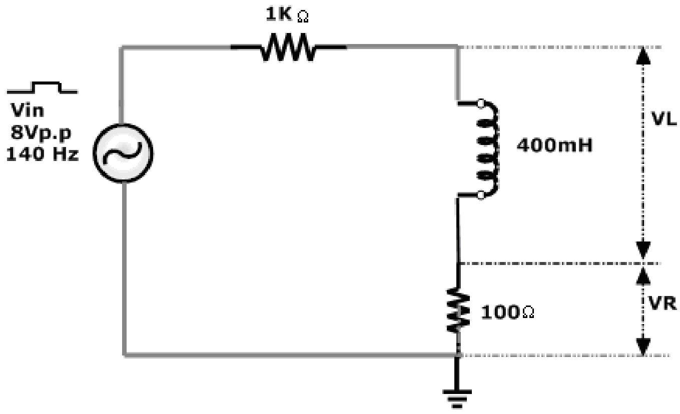
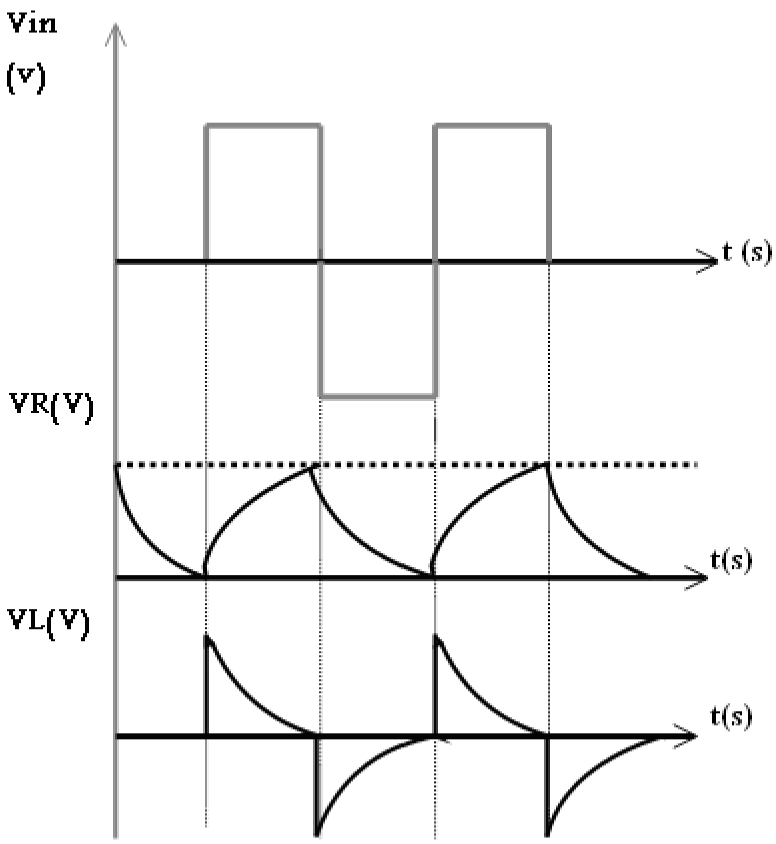


fig(7) practical cct.



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Requirements:

1. Draw on a graph paper:

a. **V_{in} versus time.**
b. V_L versus time.
c. $V_{R=100\Omega}$ versus time.

2. Draw on the same graph paper the function:

1- $f1(t) = e^{-t}$

2- $f2(t) = 1 - e^{-t}$

(for both functions) **t>=0**

DISCUSSION

1. What is the meaning of transient?
2. What is the statement of Lenz law?
3. Define time constant (τ) for (R-L) cct.
4. Comment on your results .

EXP.NO.2

TRANSIENT OF R.C. CIRCUIT

<u>OBJECT:</u>

To investigate the transient response of RC circuit.

<u>APPARATUS:</u>

1. Signal function generator
2. Oscilloscope
3. Resistors, capacitor

<u>THEORY:</u>

We will discuss the potential and current developed within the network of fig.(1)

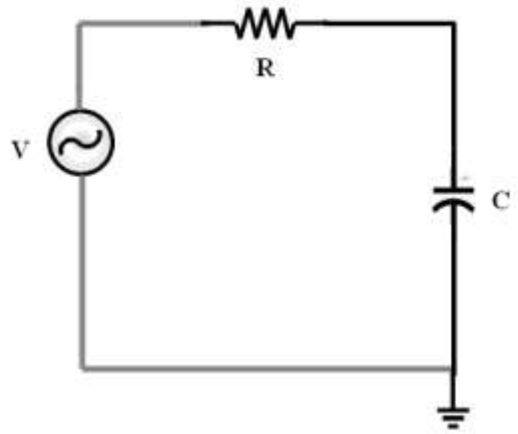

Fig.(1) R.C. circuit

We need an equivalent cct. To explain what will happen in both charge & discharge phases of R.C. circuit. Fig(2).

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EXP.NO.2

TRANSIENT OF R.C. CIRCUIT

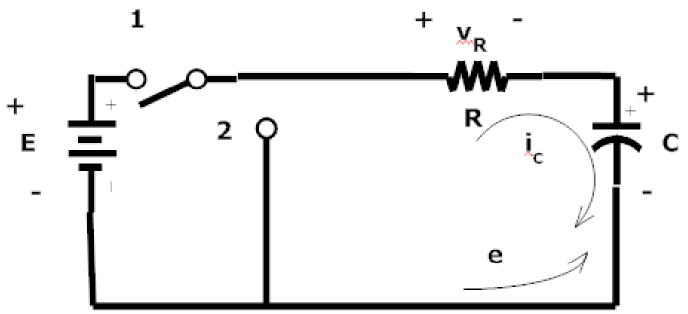

FIG.(2) equivalent cct. of RC cct.

<u>1-CHARGING PHASE</u>:

The instant the switch is closed at t=*0* the electrons are transfer from the top plate and deposited on the bottom plate by the battery, resulting in a net positive charge on the top plate and negative charge on the bottom plate . the transfer of electrons is very rapid at first ,slowing down as the potential across the capacitor approaches the applied voltage of the battery .when the voltage across the capacitor equals to the battery voltage, the transfer of electrons will cease and the plates will have a net charge determined by $Q=CV_C=CE$.

Plots of the changing current and voltage appear in fig (3) &(4) respectively ,

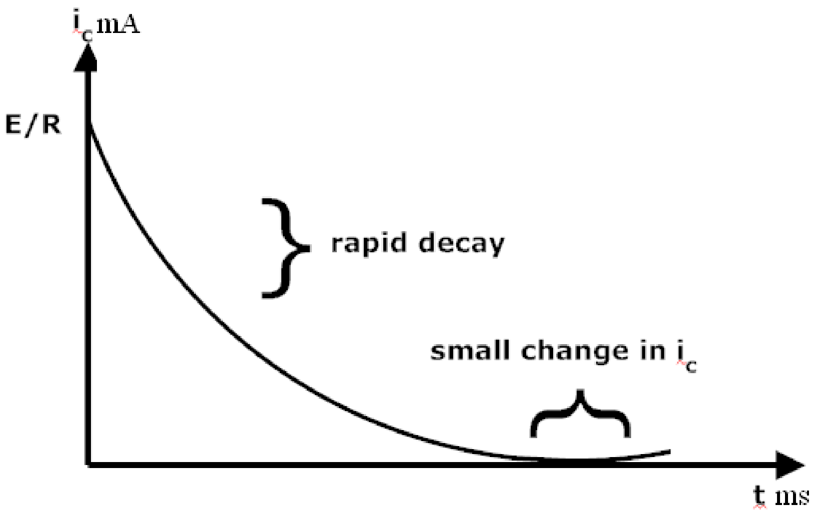

fig.(3) i_c during the charging phase

EXP.NO.2

TRANSIENT OF R.C. CIRCUIT

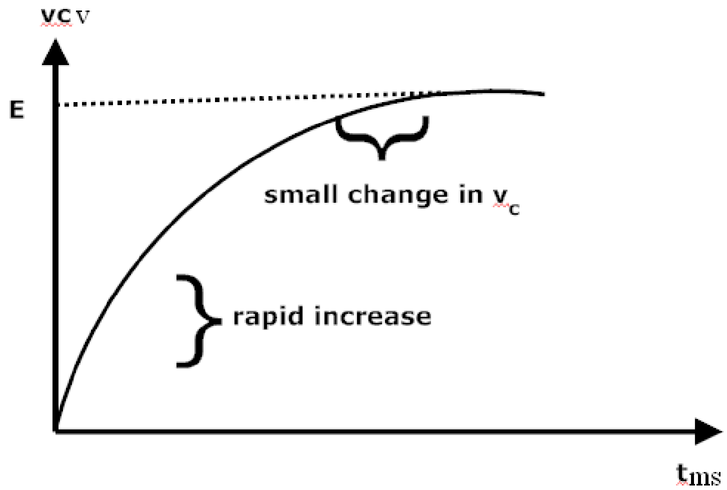

fig.(4) v_c during the charging phase

at *t=0* s ,the current jumps to value limited only by the resistance of the network and then decays to zero as the plates are charged ,since the voltage across the plates is directly related to the charge on the plates by(*vc=q/C)* ,as the rate of flow of (*I)* decreases ,the rate of change in voltage will follow. The flow of charge will stop ,the current I will be zero ,and the voltage Will cease to change in magnitude. at this point the capacitor takes on the characteristics of an open circuit ,and the voltage across the capacitor is the source voltage as shown in fig. (5) .

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TRANSIENT OF R.C. CIRCUIT

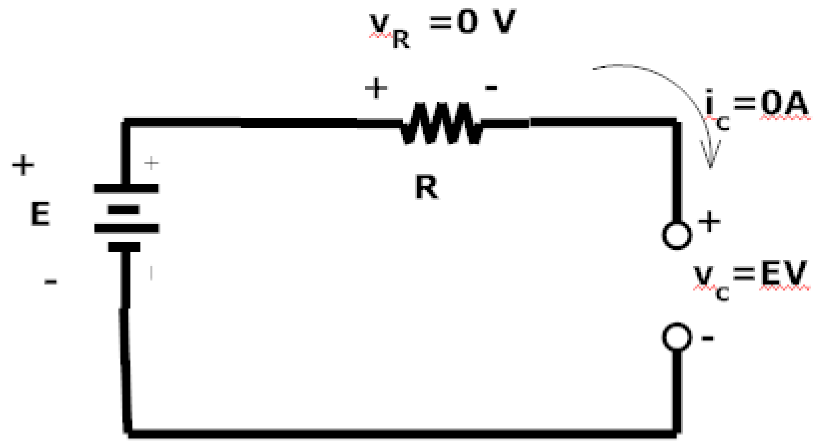

fig.(5) open cct. equivalent for a capacitor

The mathematical equation for the charging current *ic* can be obtained:

$ic = E/R(e^{-t/RC})$

The following equation for the voltage across the capacitor can be determined:

$Vc = E(1 - e^{-t/RC})$

The factor RC in equations above is called the time constant and has the units of time (second) and it called tau (τ)

$\tau = RC$ ***(second)***

The voltage across the resistor is determined by ohm's law:

$V_R(t) = E\, e^{-t/\tau}$

A plot of v_R(t) appears in fig.(7)

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TRANSIENT OF R.C. CIRCUIT

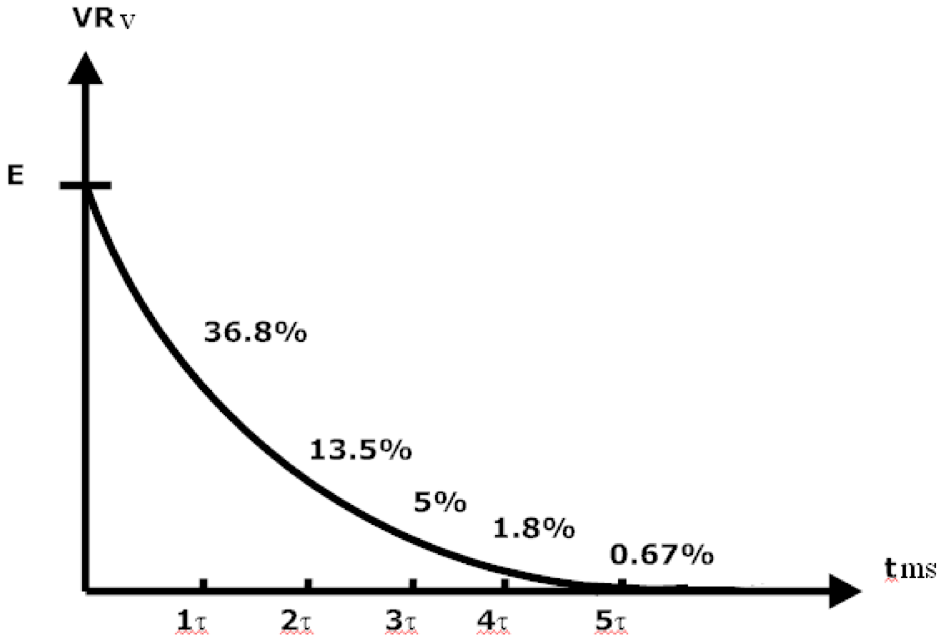

fig.(6) voltage across(R)

2-<u>DISCHARGE PHASE</u> :

The network of fig.(2)is designed to both charge & discharge the capacitor . when the switch is placed in position 1,the capacitor will charge toward the supply voltage as described in the charging phase .at any point in the charging process ,if the switch is moved to position 2,the capacitor will begin to discharge at the same time constant $\tau = RC$ .the established voltage across the capacitor will create a flow of charge in the closed path that will eventually discharge the capacitor completely. The capacitor functions like battery with decreasing terminal voltage .note that the current i_c has reversed direction, changing the polarity of the voltage across R.

If the capacitor had charged to the full battery voltages as indicated in fig(8)

EXP.NO.2

TRANSIENT OF R.C. CIRCUIT

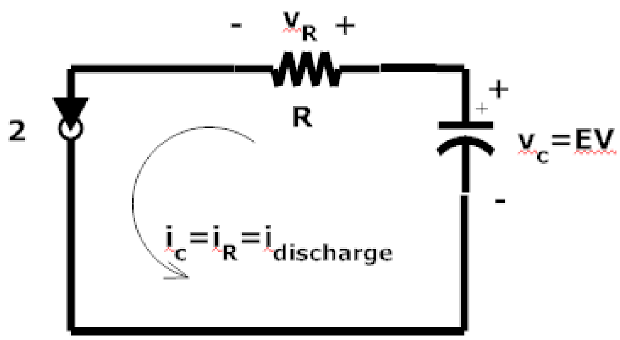

fig.(7) discharge phase

the equation for the decaying voltage across the capacitor would be the following :

$V_C = E\, e^{-t/RC}$ ……..discharging

The resulting curve will have the same shape as the curve for i_C& v_R in the charging phase. During the discharge phase, the current i_c will also decrease with time as defined by the following equation:

$I_C = E/R\, e^{-t/RC}$ ……. Discharging

The voltage $v_R = v_C$

$V_R = E\, e^{-t/RC}$ ……..discharging

The complete discharge will occur for all practical purposes in five time constant if the switch is moved between terminal 1&2 every five time constant the wave shapes of fig.(9)will result for v_C ,i_C, v_R.

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TRANSIENT OF R.C. CIRCUIT

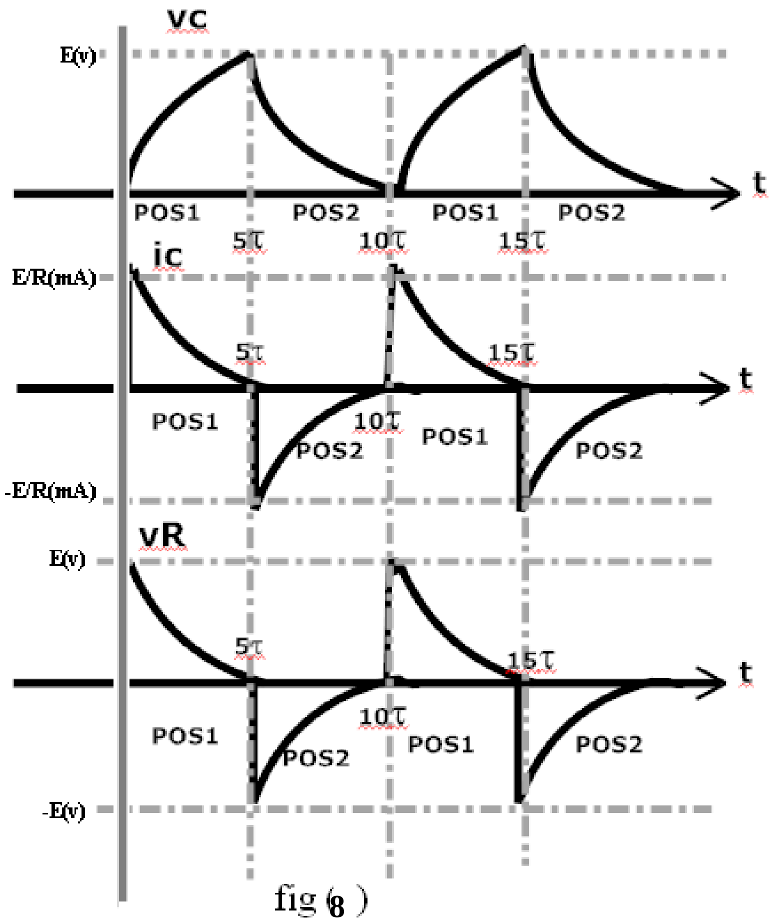

fig (8)

VC ,IC , VR during charging & discharging phases

pos1 (charging phase)

pos2 (discharging phase)

<u>PROCEDURE</u>:

1- **Connect the cct. As shown in fig (10)**
2- **Adjust the function generator to give (8) v p.p (140) Hz and check the signal on oscilloscope channel.**

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TRANSIENT OF R.C. CIRCUIT

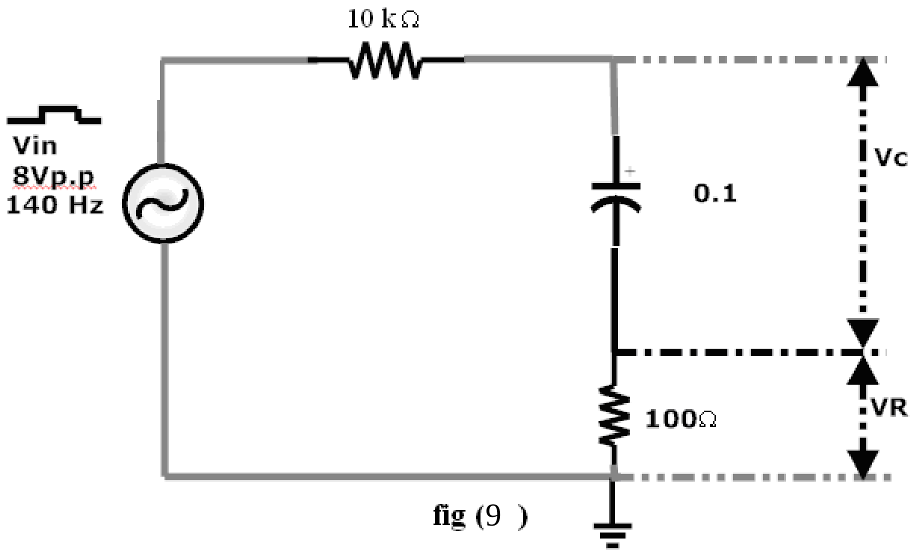

fig (9)

Requirements:

1. plot (v_{in}) versus time {write on the graph paper the voltage &time scales}
2. plot (v_c)versus time.
3. plot(v_{R}) versus time.

Discussion:

1. **Define a capacitor.**
2. **Define time constant (τ) for charging & discharging phase.**
3. **You have the function :**
   y=f(x) =e $^{-x}$
   Find the value of y when(x) has the following values: 0, 1, 2,5,10,100
   Record your result as shown in the table below:

x	Y(x)
0	
1	
2	
5	
10	
100	

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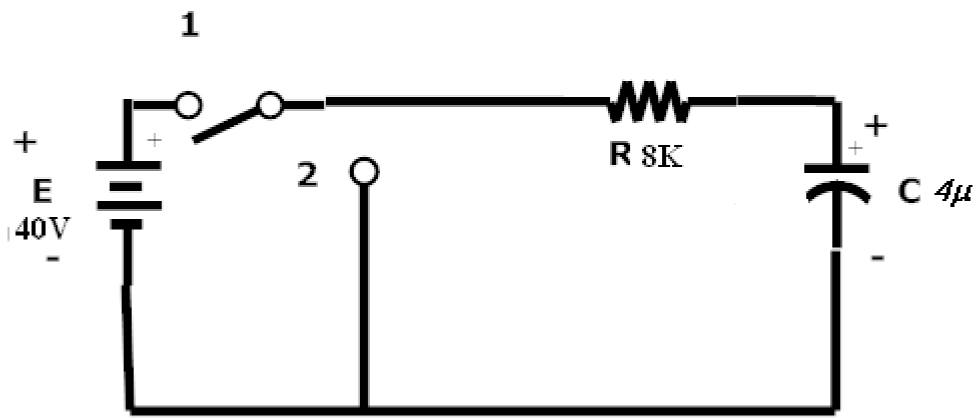
TRANSIENT OF R.C. CIRCUIT

4. **For the cct. Shown below calculate (for charging phase and discharging phase)**

a) **(τ)**
b) **Write the equation of V_c**
c) **Write the equation of i_c**
d) **Write the equation of V_R**
e) **For charging phase plot (on a graph paper)**
   i. V_C
   ii. i_C
   iii. V_R
   iv. E



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EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

OBJECT:

To examine the power distribution on (R, L, C) series circuit.

APPARATUS

1-signal function generator
2- Oscilloscope, A.V.O meter
3- Resisters & inductor &capacitor

THEORY

the following form for the power equation :

$$p = V_m I_m \sin \omega t \sin(\omega t + \theta)$$

If we now apply a number of trigonometric identities, the following form for the power equation will result:

$$\boxed{p = VI \cos \theta(1 - \cos 2\omega t) + VI \sin \theta(\sin 2\omega t)} \qquad (1)$$

where *V* and *I* are the r.m.s values. The conversion from peak values *Vm* and *Im* to r.m.s
values resulted from the operations performed using the trigonometric identities.

For a purely resistive circuit, *v* and *i* are in phase, and **θ** = 0°, as appearing in (Fig. 2**)** **.** Substituting **θ** = 0° into Eq. (1), we obtain

$$p_R = VI \cos(0°)(1 - \cos 2\omega t) + VI \sin(0°) \sin 2\omega t$$
$$= VI(1 - \cos 2\omega t) + 0$$

$$\boxed{p_R = VI - VI \cos 2\omega t}$$

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Power on (resistive –inductive & capacitive) load Series connection

where VI is the average or dc term and $-VI \cos 2\omega\tau$ is a negative cosine wave with twice the frequency of either input quantity (v or i) and a peak value of VI.

Plotting the waveform for ***pR*** (Fig. 1), we see that :

$T1$ _ period of input quantities

$T2$ _ period of power curve ***pR***

Note that in Fig. (1) the power curve passes through two cycles about its average value of VI for each cycle of either v or i ($T_1 = 2T_2$ or $f_2 = 2f_1$). Consider also that since the peak and average values of the power curve are the same, the curve is always above the horizontal axis.

This indicates that**:**

the total power delivered to a resistor will be dissipated in the form of heat.

$$\boxed{P = VI = \frac{V_m I_m}{2} = I^2 R = \frac{V^2}{R}} \qquad \text{(watts, W)}$$

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EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

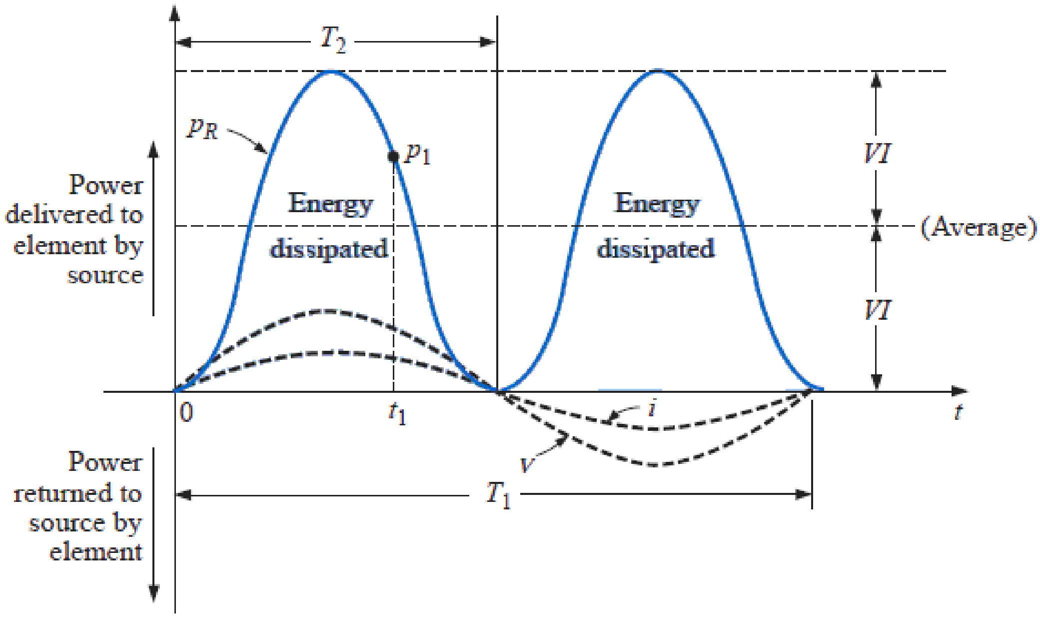

fig. (1)

Power versus time for a purely resistive load.

APPARENT POWER

From our analysis of dc networks (and resistive elements above), it would seem *apparent* that the power delivered to the load of (Fig. 2) is simply determined by the product of the applied voltage and current, with no concern for the components of the load; that is, *P= VI*. However, the power factor (***cos θ)*** of the load will have a pronounced effect on the power dissipated, less pronounced for more reactive loads. Although the product of the voltage and current is not always the power delivered, it is a power rating of significant usefulness in the description and analysis of sinusoidal ac networks and in the maximum rating of a number of electrical components and systems. It is called the **apparent power** and is represented symbolically by ***S.*** Since it is simply the product of voltage and current, its units are *voltamperes*, for which the abbreviation is VA. Its magnitude is determined by:

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Power on (resistive –inductive & capacitive) load
Series connection

$$\boxed{S = VI}$$ (volt-amperes, VA)

Or

$$\boxed{S = I^2Z}$$ (VA)

$$\boxed{S = \frac{V^2}{Z}}$$ (VA)

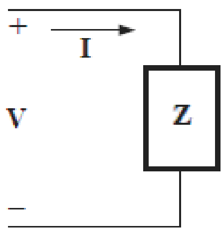

fig. (2)

Defining the apparent power to a load.

The average power to the load of (Fig. 2) is:

P = VI cos θ

However,

S = VI

Therefore,

$$\boxed{P = S\cos\theta}$$ (W)

power factor:

power factor of a system ***Fp*** is:

$$\boxed{F_p = \cos\theta = \frac{P}{S}}$$ (unitless)

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Power on (resistive –inductive & capacitive) load
Series connection

The power factor of a circuit, therefore, is the ratio of the average power to the apparent power. For a purely resistive circuit. Also $\cos\theta = Fp$ is the angle between the input voltage and current.

$$P = VI = S$$

and
$$F_p = \cos\theta = \frac{P}{S} = 1$$

A) INDUCTIVE CIRCUIT AND REACTIVE POWER

For a purely inductive circuit, v leads i by 90°, as shown in Fig. (3) Therefore, in Eq. (1), **θ**= 90°. Substituting **θ** = 90° into Eq. (1) yields:

$$p_L = VI\cos(90°)(1 - \cos 2\omega t) + VI\sin(90°)(\sin 2\omega t)$$
$$= 0 + VI\sin 2\omega t$$

$$\boxed{p_L = VI\sin 2\omega t} \quad \text{———} \quad 2$$

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Series connection

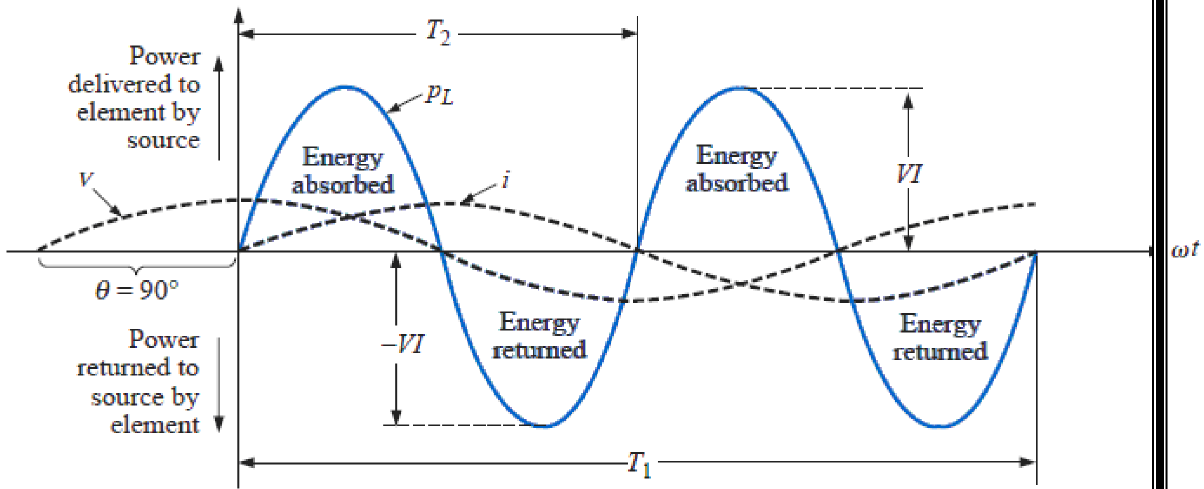

fig. (3)
The power curve for a purely inductive load.

where $VI \sin 2\omega t$ is a sine wave with twice the frequency of either input quantity (v or i) and a peak value of VI. Note the absence of an average or constant term in the equation.
Plotting the waveform for ***pL*** (Fig.3), we obtain:

***T*1 _ period of either input quantity**
***T*2 _ period of *pL* curve**

Note that over one full cycle of pL ($T2$), the area above the horizontal axis in (Fig. 3) is exactly equal to that below the axis. This indicates that over a full cycle of pL, the power delivered by the source to the inductor is exactly equal to that returned to the source by the inductor
The net flow of power to the pure (ideal) inductor is zero over a full cycle, and no energy is lost in the transaction.
The power absorbed or returned by the inductor at any instant of time $t1$ can be found simply by substituting $t1$ into Eq. (2). The peak value of the curve VI is defined as the **reactive power** associated with a pure inductor. In general, the reactive power associated with any circuit is defined to be VI sin v, a factor appearing in the second term of Eq. (1). Note that it is the peak value of that term of the total power equation that produces no

EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

net transfer of energy. The symbol for reactive power is Q, and its unit of measure is the ***volt-ampere reactive*** (VAR).The ***Q*** is derived from the quadrature (90°) relationship between the various powers, to be discussed in detail in a later section. Therefore,

$$\boxed{Q = VI \sin\theta} \qquad \text{(volt-ampere reactive, VAR)}$$

where v is the phase angle between V and I. For the inductor,

$$\boxed{Q_L = VI} \qquad \text{(VAR)}$$

or, since $V = IX_L$ or $I = V/X_L$,

$$\boxed{Q_L = I^2X_L} \qquad \text{(VAR)}$$

or

$$\boxed{Q_L = \frac{V^2}{X_L}} \qquad \text{(VAR)}$$

The apparent power associated with an inductor is $S = VI$, and the average power is $P = 0$, as noted in (Fig. 5). The power factor is therefore

$$F_p = \cos\theta = \frac{P}{S} = \frac{0}{VI} = 0$$

B) CAPACITIVE CIRCUIT

For a purely capacitive circuit, i leads v by 90°, as shown in (Fig. 4). Therefore, in Eq. (1), θ =- 90°. Substituting θ =- 90° into Eq. (1), we obtain

$$p_C = VI\cos(-90°)(1 - \cos 2\omega t) + VI\sin(-90°)(\sin 2\omega t)$$
$$= 0 - VI\sin 2\omega t$$

Or

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Power on (resistive –inductive & capacitive) load
Series connection

$$p_C = -VI \sin 2\omega t \qquad (3$$

Where ($-VI \sin 2\omega t$) is a negative sine wave with twice the frequency of either input (v or i) and a peak value of VI. Again, note the absence of an average or constant term.

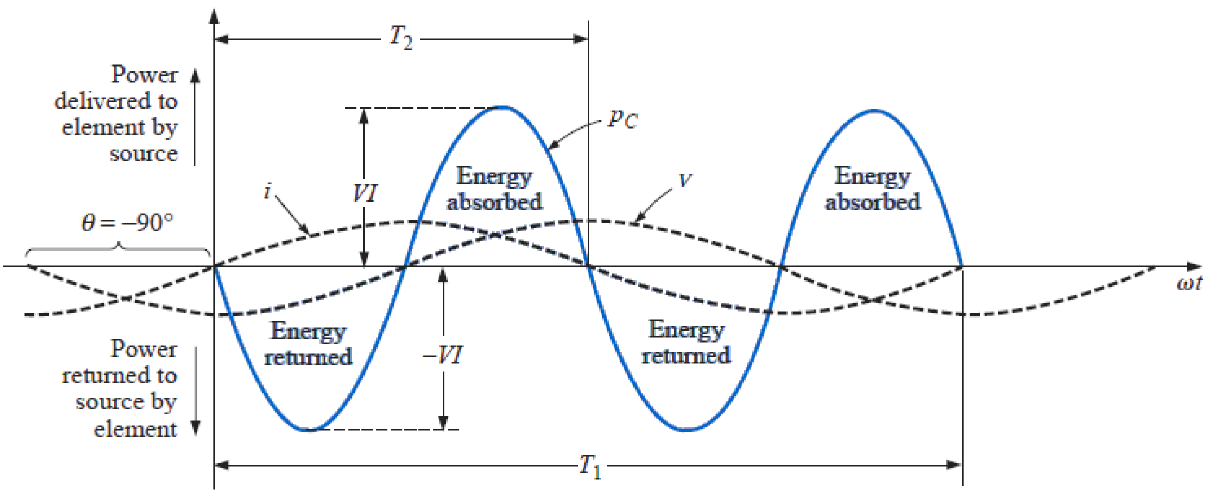

fig (4)

The power curve for a purely capacitive load.

Plotting the waveform for ***PC*** (Fig. 4) gives us

$T1$ _ period of either input quantity

$T2$ _ period of pC curve

Note that the same situation exists here for the pC curve as existed for the pL curve. The power delivered by the source to the capacitor is exactly equal to that returned to the source by the capacitor over one full cycle.

The net flow of power to the pure (ideal) capacitor is zero over a full cycle,

EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

and no energy is lost in the transaction. The power absorbed or returned by the capacitor at any instant of time $t1$ can be found by substituting $t1$ into Eq. (3).
The reactive power associated with the capacitor is equal to the peak value of the pC curve, as follows:

$$Q_C = VI \quad \text{(VAR)}$$

But, since $V= IX_C$ and $I = V/X_C$, the reactive power to the capacitor can also be written

$$Q_C = I^2 X_C \quad \text{(VAR)}$$

And

$$Q_C = \frac{V^2}{X_C} \quad \text{(VAR)}$$

The apparent power associated with the capacitor is

$$S = VI \quad \text{(VA)}$$

and the average power is $P= 0$, as noted from Eq. (3) or(Fig.4). The power factor is, therefore:

$$F_p = \cos\theta = \frac{P}{S} = \frac{0}{VI} = 0$$

$$\theta = \cos^{-1} F_p$$

THE POWER TRIANGLE

The three quantities **average power, apparent power,** and **reactive power** can be related in the vector domain by

$$\mathbf{S} = \mathbf{P} + \mathbf{Q}$$

With

EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

$\mathbf{P} = P \angle 0^\circ \qquad \mathbf{Q}_L = Q_L \angle 90^\circ \qquad \mathbf{Q}_C = Q_C \angle -90^\circ$

for an inductive load as in fig.(5) :

$\mathbf{S} = P + j\,Q_L$

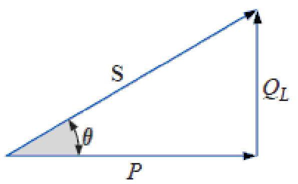

fig. (5)

Power diagram for inductive loads.

for capacitive load as in fig.(6):

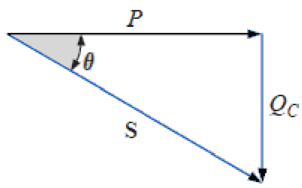

fig. (6)

Power diagram for capacitive loads.

$\mathbf{S} = P - j\,Q_C$

1- Series connection
PROCEDURE:

a-connect the (R.L) circuit as as shown in fig.(7).

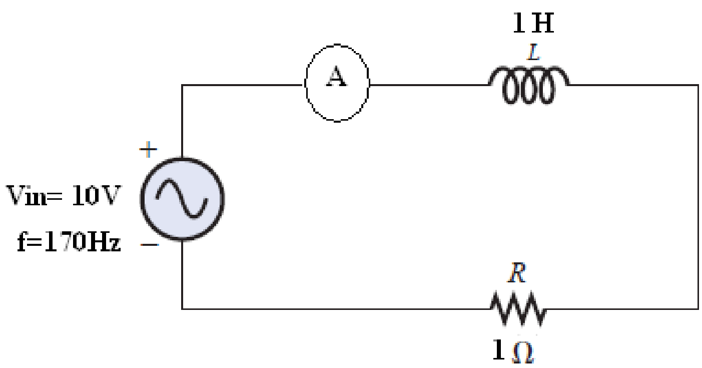

Fig.(7)

EXP. NO. 3

Power on (resistive –inductive & capacitive) load
Series connection

1-Adjust the function generator to give (10 v p.p)(170) Hz .
2-tabulate your results in table as shown in table (1)

(I) TOTAL	V_L	V_R

3- On oscilloscope draw V_L,V_R, F_p
Note: the voltage on the resister (1) ohm has the same shape of the current through the cct.

REQUIREMENTS:

1- Find Z_T theoretically
2- Find I_{TOTAL} theoretically and compare it with practical result.
3- Find V_R, V_L, theoretically and compare it with practical result
4- Find P_T, S_T, Q_T
5- Find power factor F_p theoretically and compare it with practical result.

b- Connect the (R.C) cct. As shown in fig (8)

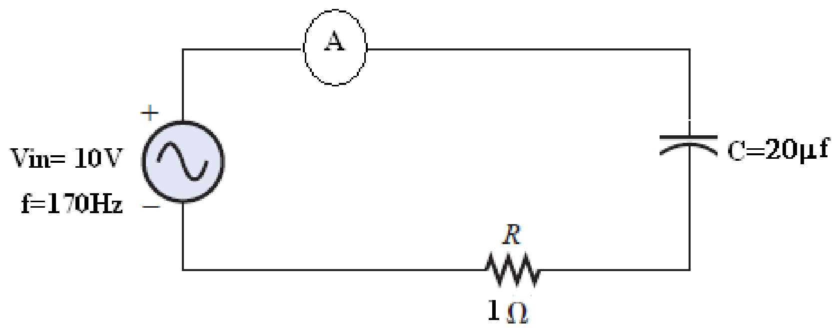

Fig.(8)

1-Adjust the function generator to give (10 v p.p (170) Hz .
2-tabulate your results in table as shown in table (٢)

(I) TOTAL	V_C	V_R

3- On oscilloscope draw V_C,V_R ,F_p

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EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

Note: the voltage on the resister (1) ohm has the same shape of the current through the cct.

REQUIREMENTS:

1- Find Z_T theoretically
2- Find I_{TOTAL} theoretically and compare it with practical result.
3- Find V_R, V_L, theoretically and compare it with practical result
4- Find P_T, S_T, Q_T
5- Find power factor F_p, theoretically and compare it with practical result

C- Connect the (R,L,C) cct. As shown in fig (9)

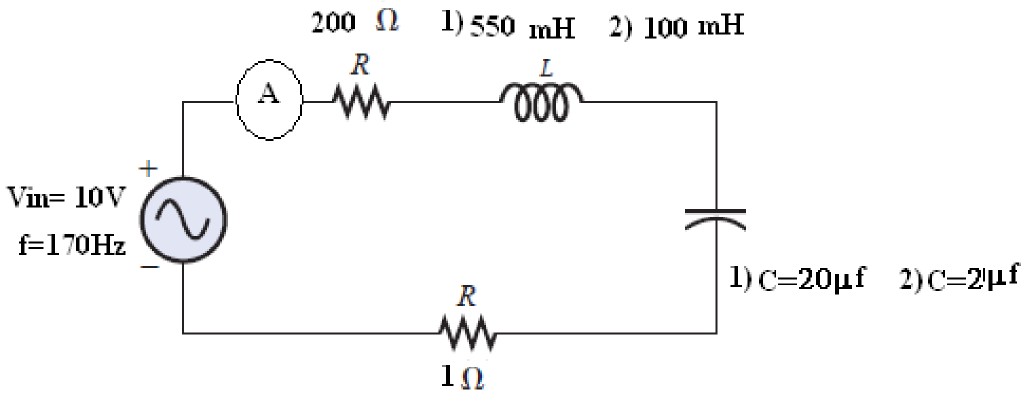

Fig. (9)

1-Adjust the function generator to give (١٠ v p.p) (1٧0) Hz .
2- at first let L=550 mH ,C=20 microfarad ,then let L=100mH,C=2microfarad
3-tabulate your results in table as shown in table (3)

(I) TOTAL	V_L	V_C

4-on oscilloscope draw V_{input}, $V_{R\,(1\,ohm)}$, F_p

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EXP. NO. 3
Power on (resistive –inductive & capacitive) load
Series connection

Note: the voltage on the resister (1) ohm has the same shape of the current through the cct..

REQUIREMENTS:

1- Find Z_T theoretically
2- Find I_{TOTAL} theoretically and compare it with practical result.
3- Find V_R, V_L, theoretically and compare it with practical result
4- Find P_T, S_T, Q_T
5- Find power factor F_p theoretically and compare it with practical result
6 - Draw the power triangle with θ .

DISCUSSION:

1-Comment on your results.
2- An electrical device is rated 5 KVA, 100 V at a 0.6 power-factor lag. What is the Impedance of the device in rectangular coordinates? What is the type of the circuit? Draw it.

EXP. NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

OBJECT :

To investigate the series resonance curve of (R .L. C) circuit.

APPARTUS:

1.signal function generator
2. Voltmeter
3. Ammeter
4. resistor ,inductor, capacitor

THEORY:

Resonant (or tuned)circuit is fundamental to the operation of a wide variety of electrical and electronic systems .the resonant cct. Is a combination of R,L,&C elements having frequency response characteristics as shown in fig1 . note in the figure that the response is a maximum for the frequency f_r, decreasing to the right and left of this frequency. the resonant circuit selects a range of frequencies for which the response will be near or equal to the maximum. the frequencies to the far left or right are for all practical purposes nullified with respect to their effect on the system's response. the radio or TV. receiver has response curve for each broad cast station of the type indicated in fig 1 when the receiver is tuned to a particular station, it is set on or near the frequency fr of fig 1 .stations transmitting at frequencies to the far right or left of this resonant frequency are not carried through with significant power to affect the program of interest. when the response is a maximum, the circuit is said to be in state of resonance, with fr as the resonant frequency

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EXP. NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

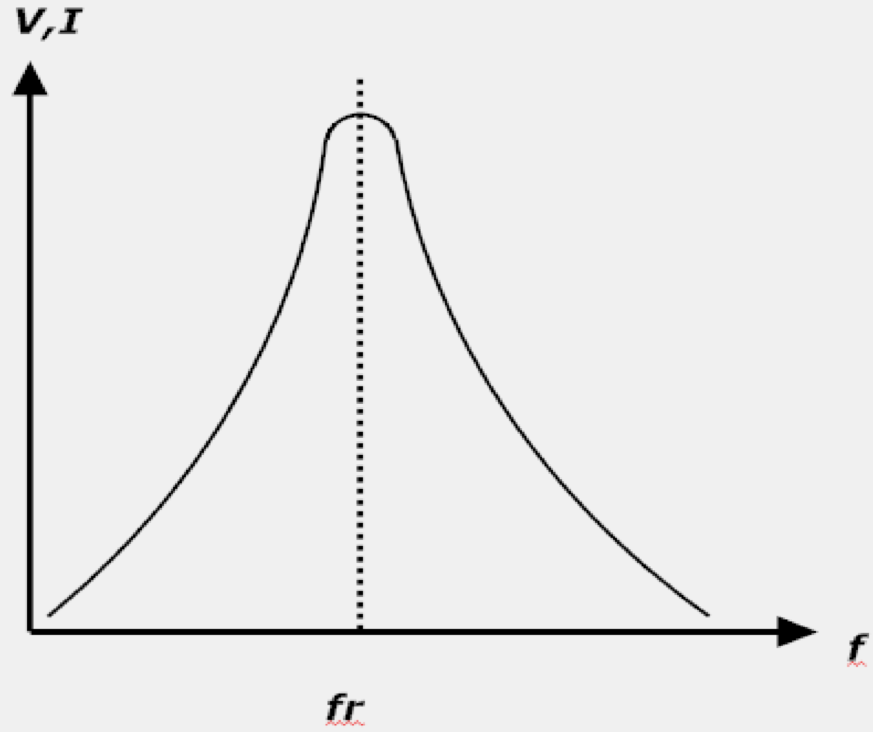

fig. 1 Resonance curve

1- SERIES RESONANCE

The basic circuit configuration for the series resonant circuit appears in fig .(2)

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RESONANT CIRCUIT (SERIES RESONANCE)

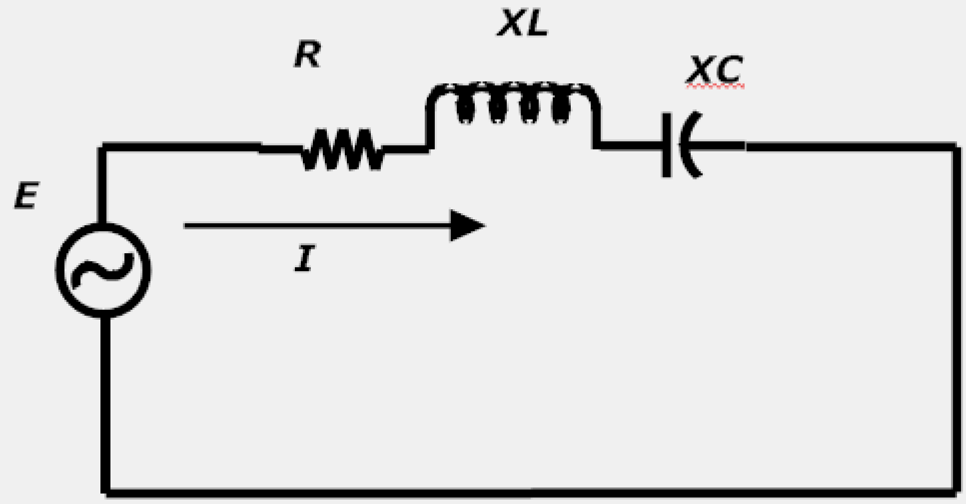

fig.2 series resonant circuit

The total impedance of this network at any frequency is determined by :

$Z_{T}=R+Jx_{L}-jx_{c}=R+j(X_{L}-X_{C})$……….1

Series resonance will occur when

$X_{L}=X_{C}$ 2

Wich remove the reactive component from the total impedance equation .the total impedance at resonanceis then simply

$Z_{T}=R$ ……………3

Representing the minimum value of Z_{T}at any frequency.the subscript $_{S}$will be employed to indicate series resonant conditions .

The resonant frequency can be determined in terms of inductance and capacitance by examining the defining equation for resonance eq. 2

$X_{L}=X_{C}$

Substituting yields

$wL=1/wC$ and ……….4

EXP.NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

$w^2 = 1/LC$

And $w_s = 1/\sqrt{LC}$ 5

$f_s = 1/2\pi\sqrt{LC}$

f= hertz(Hz)
L=henry(H)
C=farad(F)

The current through the circuit at resonance is

I= E/R

We will note the maximum current for the circuit of fig. 2.

For an applied voltage E, since Z_T is a minimum value .consider also that the input voltage and current are in phase at resonance .

Since $X_L = X_C$

So $V_{Ls} = V_{Cs}$

2-THE QUALITY FACTOR (Q)

The quality factor Q of a series resonant circuit is defined as the ratio of the reactive power of either the inductor or the capacitor to the average power of the resistor at resonance :

Q_s= reactive power / average power

$Q_s = I^2 X_L / I^2 R$ for an inductive reactance

$Q_s = X_L/R = w_s L/R$............6

Or for the capacitive reactance

$Q_s = I^2 X_c / I^2 R$

$Q_s = X_c/R = 1/w_s CR$............7

Since :

$f_s = 1/2\pi\sqrt{LC}$

And from 6& 7 yields:

$Q_s = (1/R)(\sqrt{L/C})$ ....8 or

EXP.NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

$$BW = \frac{f_s}{Q_s}$$

3-(R , X_L , X_C & Z) VERSUS FREQUENCY

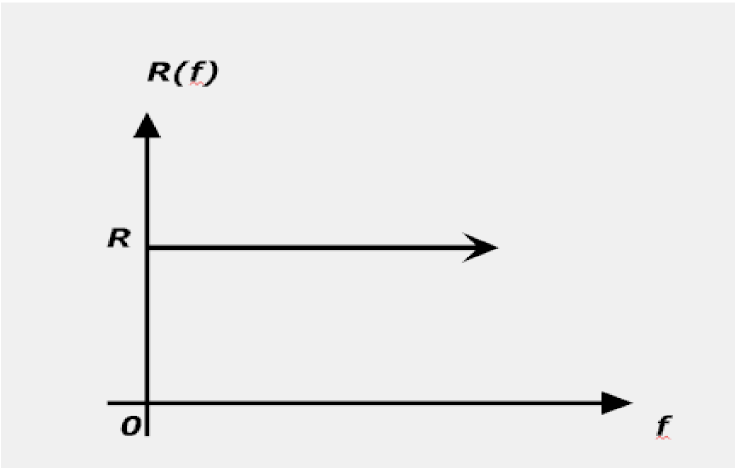

fig.3 resistance vs. frequency

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RESONANT CIRCUIT (SERIES RESONANCE)

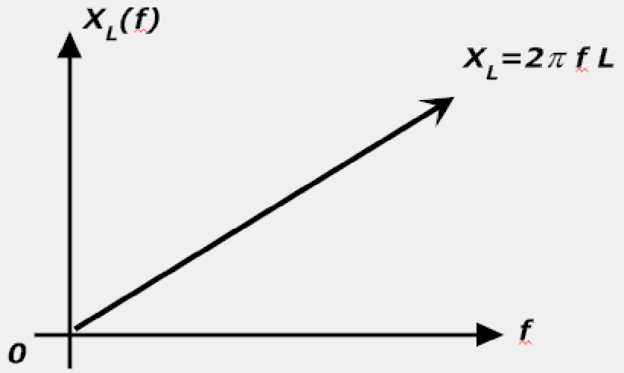

fig.4 inductive reactance vs. frequency

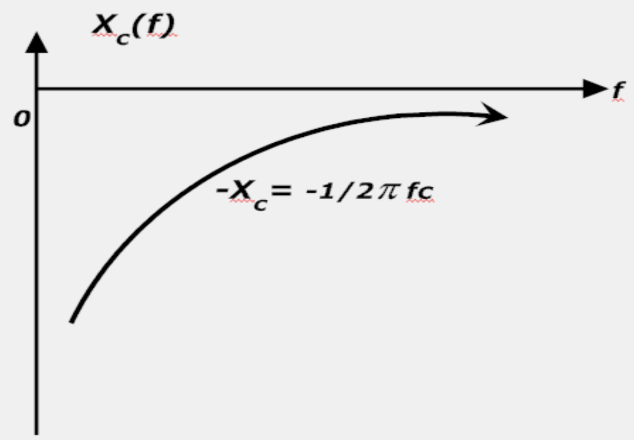

fig.5 capacitive reactance vs. frequency

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RESONANT CIRCUIT (SERIES RESONANCE)

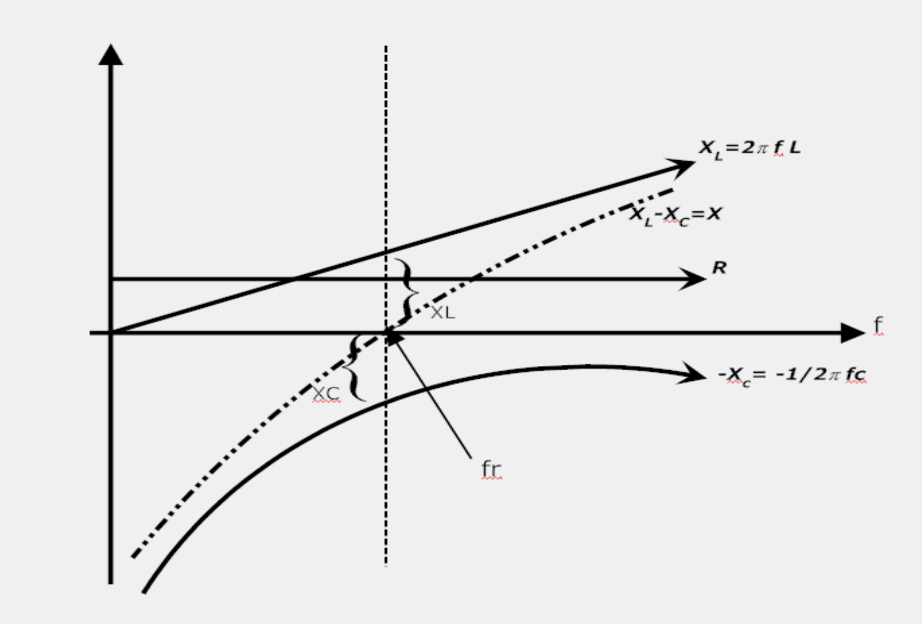

fig. 6 plotting all three quantities on the same axes

EXP.NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

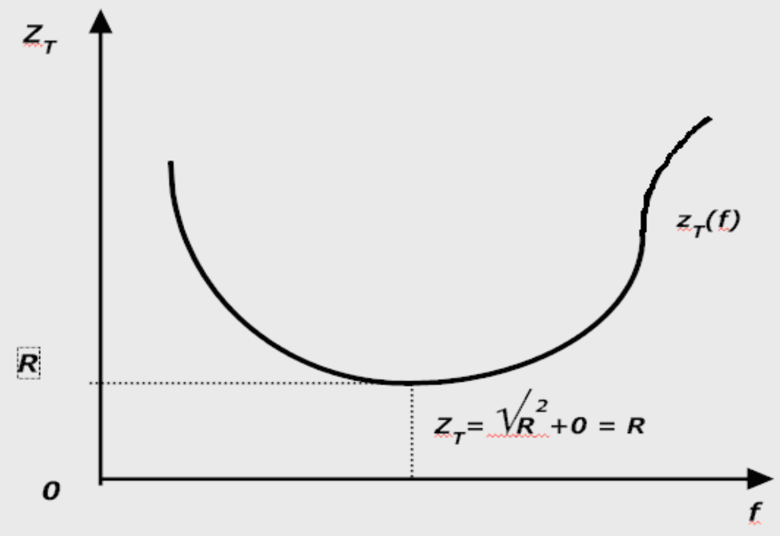

fig.(7) Z_T vs. frequency for the series resonant

4- SELECTIVITY

There is a definite range of frequencies at witch the current is near its maximum value and the impedance is at minimum. Those frequencies corresponding to 0.707 of the maximum current are called the band frequencies cutoff frequencies, or half-power frequencies .they are indicated by f1 and f2 in fig (8) .the range of frequencies between the two is referred to as the bandwidth (BW) of the resonant circuit.

$P_{HPF}=1/2\ P_{MAX}$

$P_{MAX}= I^2_{MAX} . R$

And

$P_{HPF}= I^2 R = (0.707\ I_{MAX})^2 . R= 0.5\ I^2_{MAX} .R= 1/2\ P_{MAX}$

EXP.NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

Since the resonant circuit is adjusted to select a band of frequencies, the curve of fig (8) called the selectivity curve.

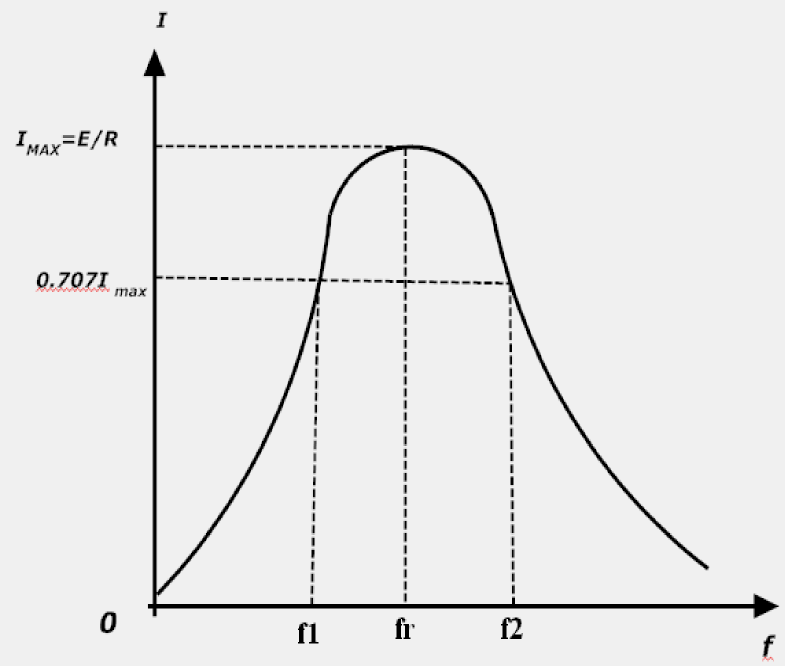

fig.(8) Ivs.frequency for the series resonant circuit

PROCEDURE:

1- connect the circuit as shown in fig.(9)
2- set the function generator freq. to 100 Hz and voltage 10 v(r.m.s)
3- vary the frequency of generator from 100 Hz to 200 Hz in step of 10 Hz take readings of circuit currents(I) , (V_L) ,(V_C)and find the frequency at which the impedance is minimum .(this where the current is maximum) .
4- tabulate your results in table as shown in table (1)

EXP.NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

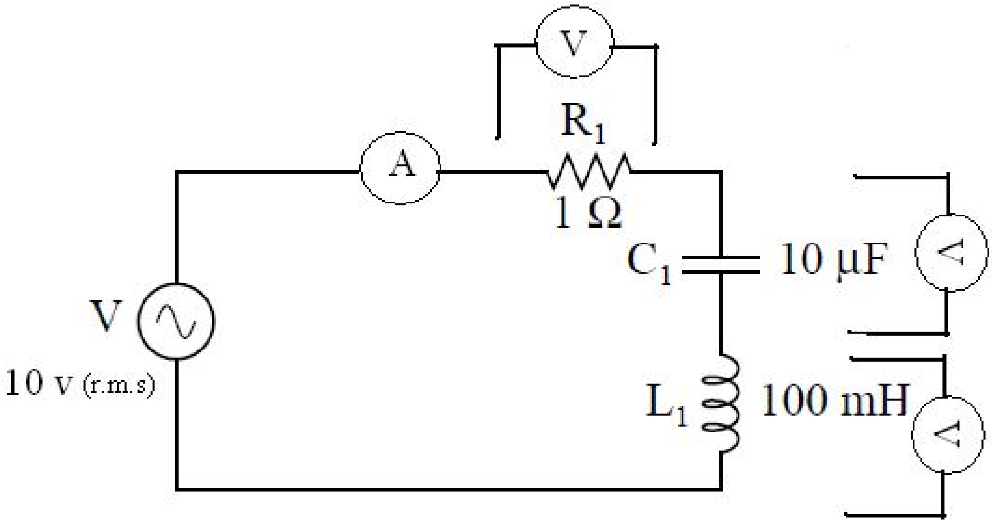

Fig (9)

F(Hz)	V_{in}(r.m.s)	V_c(volt)	V_L(volt)	V_R(volt)	I(mA)
100					
110					
120					
130					
140					
150					
160					
170					
180					
190					
200					

TABLE (1)

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RESONANT CIRCUIT (SERIES RESONANCE)

REQUIREMENTS:

1- Draw the resonant curve (I vs. f)

2-Find the resonant frequency from the resonant curve and compare this value with the theoretical value of the resonant frequency.

3-What is the condition of series resonance?

4-Prove that

$f_{sr}=1/2\pi\sqrt{LC}$ Hz

5-How is the relation between (explain with drawing)

a- R and freq.

b- X_L and freq.

c- X_C and freq.

d- Z_T and freq.

DISCUSSION:

1- Is the concept of resonance limited to electrical or electronic systems.

2- Define selectivity of series resonance circuit.

3- Define cutoff freq., band freq. half-power freq., and prove that the power at these freq. = half the power at resonance.

4- Define quality factor (Qs) and prove that :

$Qs = 1/R\sqrt{L/C}$, what is the quality factor unit.?

5-

a. For the series resonant circuit of Fig. (10), find I, VR,

VL, and VC

at resonance.

b. What is the Qs of the circuit?

EXP.NO.4

RESONANT CIRCUIT (SERIES RESONANCE)

c. If the resonant frequency is 5000 Hz, find the bandwidth.

d. What is the power dissipated in the circuit at the half-power frequencies?

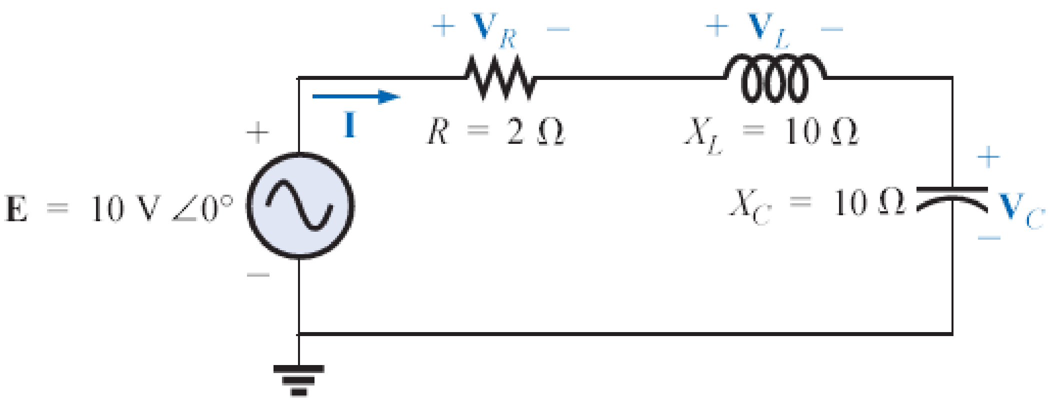

Fig (10)

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EXPERIMENT NO.5
RESONANT CIRCUIT (PARALLEL RESONANCE)

OBJECT:
To investigate the parallel resonance curve of (R, L, C) cct.

APPARTUS:
1. Signal function generator
2. Voltmeter
3. Ammeter
4. Resistors, inductor, capacitor

THEORY:
The parallel resonant circuit has the basic configuration of fig (1) This circuit is often called the tank circuit due to the storage of energy by the inductor and capacitor .a transfer of energy similar to that discussed for the series circuit also occurs in the parallel resonant circuit. In the ideal case (no radiation losses, and so on) ,the capacitor absorbs energy during one half-cycle of the power curves at the same rate at witch it is released by the inductor .during the next half-cycle of the power curves ,the inductor absorbs energy at the same rate at which the capacitor releases it . the total reactive power at resonance is therefore zero. And the total power factor is 1.

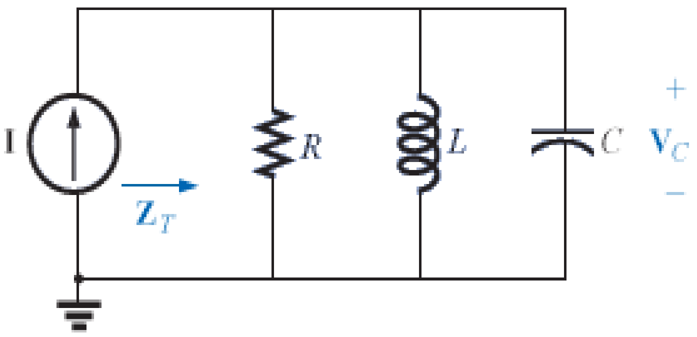

Fig.(1) Ideal parallel resonant network

For the network of fig.(1)

$Y_T=1/Z_T$

$Y_T=1/R+j(1/X_C-1/X_L)$ **or** $Y_T=G+J(W_C-(1/W_L))$ **or** $Y_T=G+J(B_C-B_L)$ **or** $Y_T=G+JB$

At resonance, the reactive component must be zero as defined by:

EXPERIMENT NO.5
RESONANT CIRCUIT (PARALLEL RESONANCE)

$1/X_C - 1/X_L = 0$ or $WC = 1/W_L$
Therefore:
$Y = 1/R$ or $Y = G$
Hence

$$W_O = \frac{1}{\sqrt{LC}} \quad \text{and} \quad f_p = \frac{1}{2\pi\sqrt{LC}}$$

Fig.(2) shows that admittance of the parallel circuit.

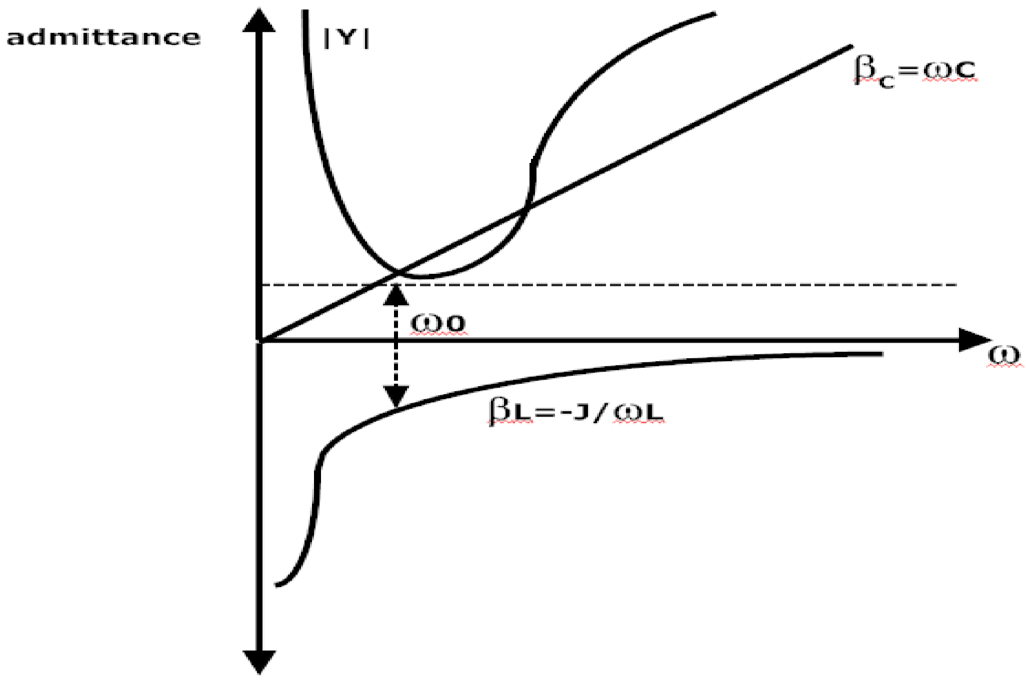

fig.(2) admittance C/CS

The inductive branch is no longer a pure inductive but an inductance and resistance in series fig.(3)

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RESONANT CIRCUIT (PARALLEL RESONANCE)

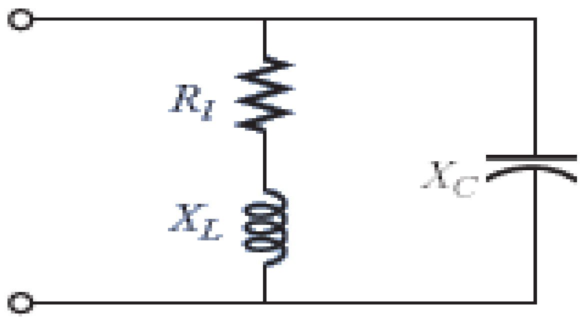


Fig.(3) Practical parallel L-C network.

Hence the resonant frequency is equal to:

$$f_P = \frac{1}{2\pi\sqrt{LC}} \times \sqrt{1 - \frac{Rl^2 C}{L}}$$

$$f_p = f_s\sqrt{1 - \frac{Rl^2 C}{L}}$$

THE QUALITY FACTOR Q_P:

The quality factor of the parallel resonant circuit continues to be determined by the ratio of the reactive power to the real power. That is,

$$Q_P = \frac{V^2 / X_L}{V^2 / R}$$

$$Q_P = \frac{R}{XL}$$

SINCE $X_L = X_C$

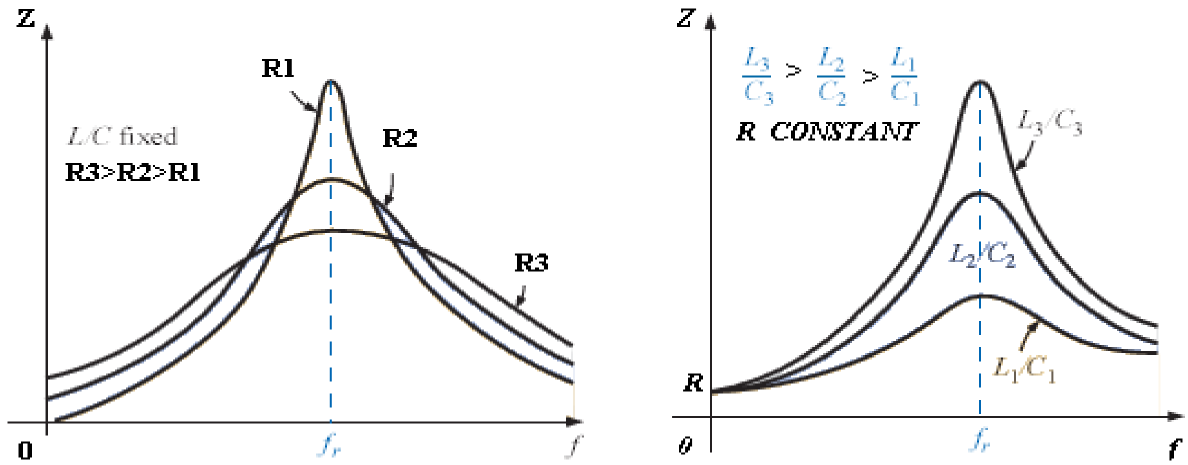
$$Q_P = \frac{R}{XC}$$

B.W. $= f_2 - f_1 = \frac{f_O}{Q_O}$

The effect of R, L, and C on the shape of the parallel resonance curve, as shown in Fig. (4) for the input impedance, is quite similar to their effect on the series resonance curve.
to their effect on the series resonance curve.

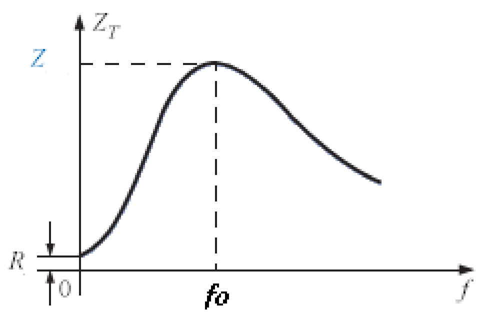
EXPERIMENT NO.5

RESONANT CIRCUIT (PARALLEL RESONANCE)



Fig(4) effect of R , L& C on the parallel resonance curve

The Z_T versus-frequency curve of fig. (5)clearly reveals that a parallel resonant circuit exhibits maximum impedance at resonance, unlike the series resonant circuit which experiences minimum resistance levels at resonance.



Fig(5) Z_T versus frequency for the parallel resonant circuit

PROCEDUER

1-connect the circuit as shown in fig.(6)

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EXPERIMENT NO.5

RESONANT CIRCUIT (PARALLEL RESONANCE)

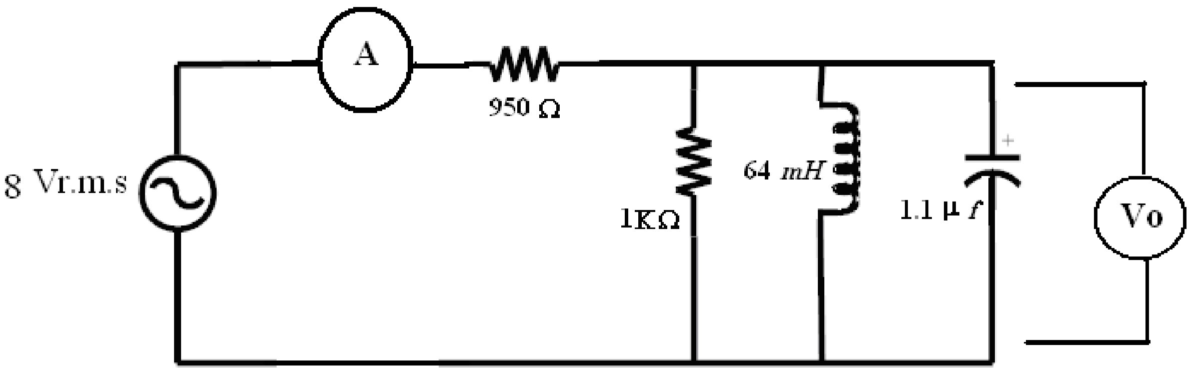

Fig.(6) the practical cct.

2-set the function generator freq. to 200 Hz and voltage 5 v(r.m.s)

3- vary the frequency of generator from 200 Hz to 1 KHz in step of 50 Hz take readings of circuit currents(I) ,(V_R), (V_L) ,(V_C)and find the frequency at which the impedance is maximum (at resonance).

4-Tabulate your results in table as shown in table (1)

F(Hz)	I(mA)	V_O(volt)	$Z_{in} = V_{in} / I$
200			
250			
300			
350			
400			
.			
.			
.			
.			
1000			

TABLE(1)

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EXPERIMENT NO.5

RESONANT CIRCUIT (PARALLEL RESONANCE)

REQUIREMENTS:

1- draw(Z_{in}) versus frequency (f_p)
2- discuss the plot you obtained in(1)
3- what is the value of (f_p) which obtained experimentally ,calculate the theoretical of(f_p) and find the error between the two values.
4- You have the following equation

$$f^2 - \frac{f}{2\pi RC} - \frac{1}{4\pi^2 LC} = 0$$

Prove that:

$$f_1 = \frac{1}{4\pi C}\left[\frac{1}{R} - \sqrt{\frac{1}{R^2} + \frac{4C}{L}}\right]$$

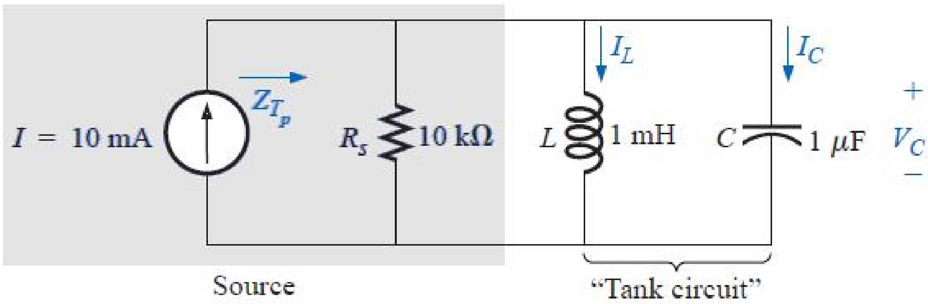
$$f_2 = \frac{1}{4\pi C}\left[\frac{1}{R} + \sqrt{\frac{1}{R^2} + \frac{4C}{L}}\right]$$

where(f1&f2) the cut off frequency

DISCUSSION:

1- Comment on your result.
2- Given the parallel network of Fig. (7)composed of "ideal" elements:
a. Determine the resonant frequency *fp*.
b. Find the total impedance at resonance.
c. Calculate the quality factor, bandwidth, and cutoff frequencies *f*1 and *f*2 of the system.

EXPERIMENT NO.5
RESONANT CIRCUIT (PARALLEL RESONANCE)



Fig(7)

3-find the parallel equivalent network of a series R.L. combination in fig (8).

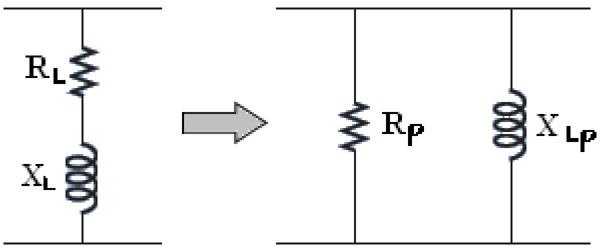


Fig.(8) series combination

REVIEW:

1- $f_r = f_0 = f_p$ = resonance frequency in parallel cct.

2- Band (cutoff, half-power, corner) frequencies that define the points on the resonance curve that are 0.707 of the peak current or voltage value. In addition, they define the frequencies at which the power transfer to the resonant circuit will be half the maximum power level.

3-**Bandwidth (BW)** The range of frequencies between the band, cutoff, or half-power frequencies.

4- **Quality factor (Q**) A ratio that provides an immediate indication of the sharpness of the peak of a resonance curve. The higher the Q, the sharper the peak and the more quickly it drops off to the right and left of the resonant frequency.

5- **Resonance** A condition established by the application of a particular frequency (the resonant frequency) to a series or parallel R-L-C network. The transfer of power to the system is a maximum, and, for frequencies above and below, the power transfer drops off to significantly lower levels.

6- **Selectivity** A characteristic of resonant networks directly related to the bandwidth of the resonant system. High selectivity is associated with small bandwidth (high Q's), and low selectivity with larger bandwidths (low Q's).

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EXP. NO.6
FILTERS
Low –pass filter (integrator R.C. circuit)

OBJECT:

To steady the behavior and response of R.C. Circuit.

APPARTUS:

1- Signal function generator
2- Oscilloscope
3- Resisters, capacitors)
4- A.V.O. meter.

THEORY:

Consider the circuit shown in fig. (1)

If the output is taken off the capacitor, as shown in Fig. (1) , it will respond as a low-pass filter.

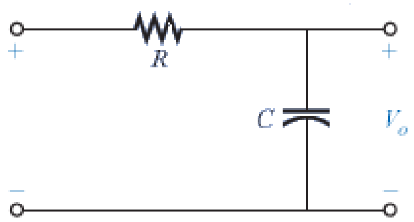
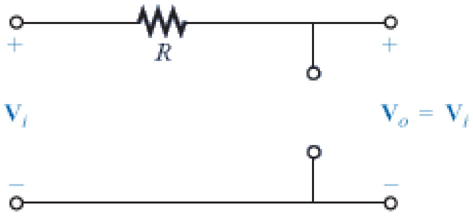


Fig.(1) integrator R.C. circuit (low-pass filter)

At $f = 0$ Hz,

$$X_C = \frac{1}{2\pi f C} = \infty\ \Omega$$

and the open-circuit equivalent can be substituted for the capacitor, as shown in Fig. (2), resulting in Vo = Vi.



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FILTERS

Low –pass filter (integrator R.C. circuit)

fig.(2) R-C low-pass filter at low frequencies.

At very high frequencies, the reactance is:

$$X_C = \frac{1}{2\pi f C} \cong 0\ \Omega$$

and the short-circuit equivalent can be substituted for the capacitor, as shown in Fig. (3), resulting in Vo = zero V.

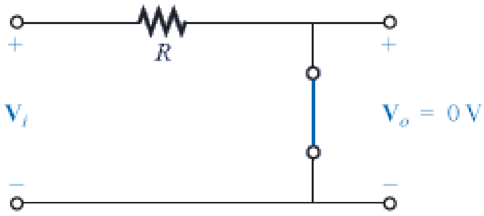

fig.(3) R-C low-pass filter at high frequencies.

A plot of the magnitude of Vo versus frequency will result in the curve of Fig. (4).

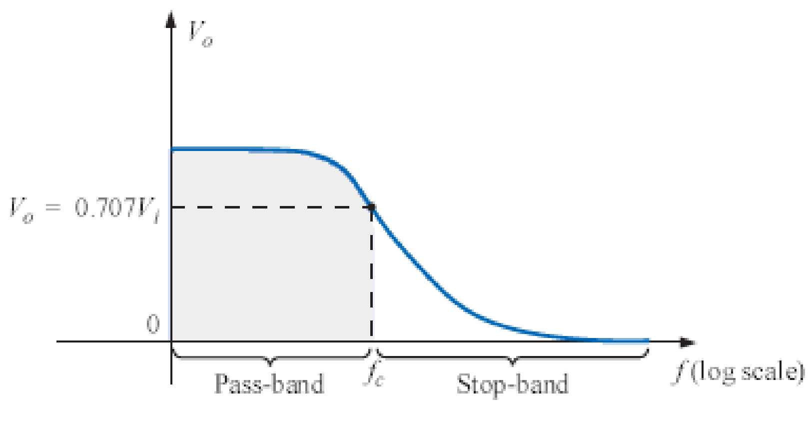

fig.(4) Vo versus frequency for a low-pass R-C filter.

For filters, a normalized plot is employed more often than the plot of Vo versus frequency of Fig. (4).

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FILTERS

Low –pass filter (integrator R.C. circuit)

Normalization *is a process whereby a quantity such as voltage, current, or impedance is divided by a quantity of the same unit of measure to establish a dimensionless level of a specific value or range.*

A normalized plot in the filter domain can be obtained by dividing the plotted quantity such as Vo of Fig. (4) with the applied voltage Vi for the frequency range of interest. Since the maximum value of Vo for the low-pass filter of Fig. (1) is Vi, each level of Vo in Fig. (4) is divided by the level of Vi. The result is the plot of Av = Vo/Vi of Fig. (5). Note that the maximum value is 1 and the cutoff frequency is defined at the 0.707 level.

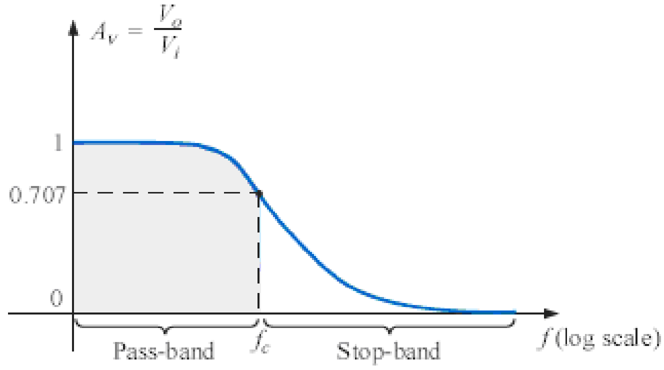

fig.(5) Normalized plot of Fig. (4).

At any intermediate frequency, the output voltage Vo of Fig. (1) can be determined using the voltage divider rule:

$$\mathbf{V}_o = \frac{X_C \angle -90° \mathbf{V}_i}{R - jX_C} \qquad \text{----------------------1}$$

or

$$\mathbf{A}_v = \frac{\mathbf{V}_o}{\mathbf{V}_i} = \frac{X_C \angle -90°}{R - jX_C} = \frac{X_C \angle -90°}{\sqrt{R^2 + X_C^2} \angle -\tan^{-1}(X_C/R)} \qquad \text{\}----------------------2\&3}$$

and

$$\mathbf{A}_v = \frac{\mathbf{V}_o}{\mathbf{V}_i} = \frac{X_C}{\sqrt{R^2 + X_C^2}} \angle -90° + \tan^{-1}\left(\frac{X_C}{R}\right)$$

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FILTERS

Low –pass filter (integrator R.C. circuit)

The magnitude of the ratio Vo/Vi is therefore determined by

$$A_V = \frac{V_o}{V_i} = \frac{X_C}{\sqrt{R^2 + X_C^2}} = \frac{1}{\sqrt{\left(\frac{R}{X_C}\right)^2 + 1}}$$ --------------------------------4

and the phase angle is determined by

$$\theta = -90° + \tan^{-1}\frac{X_C}{R} = -\tan^{-1}\frac{R}{X_C}$$ -----------------------------5

For the special frequency at which XC = R, the magnitude becomes

$$A_V = \frac{V_o}{V_i} = \frac{1}{\sqrt{\left(\frac{R}{X_C}\right)^2 + 1}} = \frac{1}{\sqrt{1+1}} = \frac{1}{\sqrt{2}} = 0.707$$ ----------------------- 6

which defines the critical or cutoff frequency of Fig. (5). The frequency at which XC = R is determined by

$$\frac{1}{2\pi f_c C} = R$$ ---------------------7

and

$$f_c = \frac{1}{2\pi RC}$$ ----------------------------8

The impact of Eq. (8) extends beyond its relative simplicity. For any low-pass filter, the application of any frequency less than fc will result in an output voltage Vo that is at least 70.7% of the maximum. For any frequency above fc, the output is less than 70.7% of the applied signal.

Solving for Vo and substituting Vi = Vi < 0° gives

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FILTERS

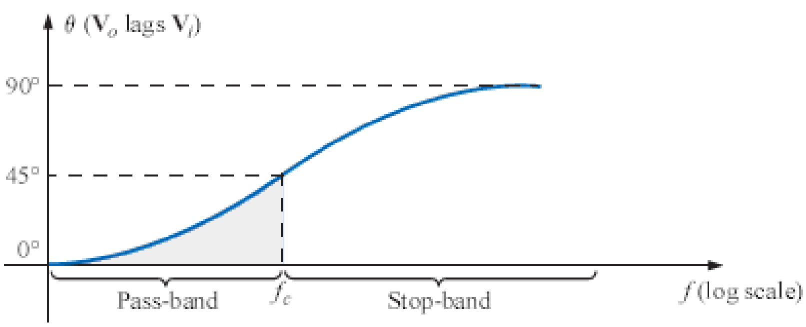
Low –pass filter (integrator R.C. circuit)

$$\mathbf{V}_o = \left[\frac{X_C}{\sqrt{R^2 + X_C^2}} \angle\theta\right]\mathbf{V}_i = \left[\frac{X_C}{\sqrt{R^2 + X_C^2}} \angle\theta\right] V_i \angle 0° \qquad \text{---------------------9}$$

and

$$\mathbf{V}_o = \frac{X_C V_i}{\sqrt{R^2 + X_C^2}} \angle\theta$$

The angle ϴ is, therefore, the angle by which Vo lag Vi. this angle change from 0 to 90° ,if the input voltage is sine wave with angle =0 then the out put voltage become sine wave with angle =90° (i.e. cosine wave) Vin = Asin(ωt)
Vo= B sine(ωt-90°)= - B cos (ωt) for this reason ,this circuit called integrator .
Since ϴ = $-\tan^{-1}$(R/XC) is always negative (except at f = 0 Hz), it is clear that Vo will always lag Vi, leading to the label lagging network for the network of Fig. (1).
At high frequencies, XC is very small and R/XC is quite large, resulting in ϴ=$-\tan^{-1}$(R/XC) approaching -90°. At low frequencies, XC is quite large and R/XC is very small, resulting in v approaching 0°. At low frequencies, XC is quite large and R/XC is very small, resulting in ϴ approaching 0°.
At (XC = R) , or (f = fc) , $-\tan^{-1}$(R/XC) = $-\tan^{-1}$ 1 = - 45°.
A plot of v versus frequency results in the phase plot of Fig. (6).



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FILTERS

Low –pass filter (integrator R.C. circuit)

fig.(6) Angle by which Vo lags Vi.

PROCEDURE

1-Connect the cct. Shown in fig .(7):

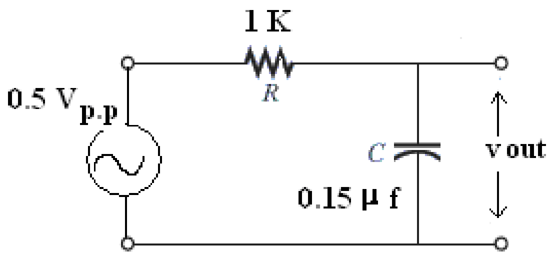

Fig. (7)

very the frequency and measure V_o for every setting of (f). Tabulate your result as in table (1)

F(Hz)	50	100	200	400	600	800	1K	1.5K	5K	10K
$\mathbf{V_o}$										
$\mathbf{V_o/V_{in}}$										

Table (1)

2- using the oscilloscope to measure the phase shift θ for each frequency setting

3- apply a sine-wave voltage at the input terminals of the cct. of fig. (7).with $\mathbf{V_{in}=10V_{p.p}}$.
For the values of (f , R, C) as in the table (2). **Draw V_o & V_{in}**

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Low –pass filter (integrator R.C. circuit)

f	R	C
1KHz	1KΩ	0.15µf
500Hz	10KΩ	0.1 µf
50 Hz	1KΩ	0.001 µf

Table (2)

REQUERMENTS:

1- draw a graph between the gain ($A=V_o/V_{in}$) versus frequency, find (fc) and Compare it with that obtained from equation (8).

2- draw a graph between(θ) and (f), from the graph find fc at θ=45 and compare it with that obtained from equation (8).

DISCUSSION:

a. Sketch the output voltage Vo versus frequency for the low-pass R-C filter of Fig. (8).

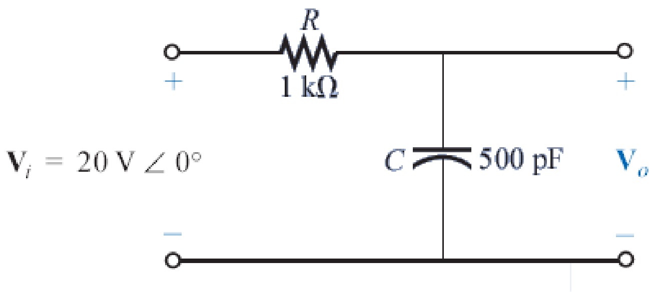

Fig.(8)

b. Determine the voltage Vo at f = 100 kHz and 1 MHz, and compare

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FILTERS
Low –pass filter (integrator R.C. circuit)

the results to the results obtained from the curve of part (a).
c. Sketch the normalized gain Av = Vo/Vi.

EXP. NO.8

(PASS-BAND FILTER)

OBJECT:

To establish the pass-band characteristic.

APPARTUS:

1- Signal function generator
2- Oscilloscope
3- Resisters ,capacitors
4- A.V.O. meter.

THEORY:

Any combination of passive (R, L, and C) and/or active (transistors or operational amplifiers) elements designed to select or reject a band of frequencies is called a filter. In communication systems, filters are employed to pass those frequencies containing the desired information and to reject the remaining frequencies. In stereo systems, filters can be used to isolate particular bands of frequencies for increased or decreased emphasis by the output acoustical system (amplifier, speaker, etc.). Filters are employed to filter out any unwanted frequencies, commonly called noise, due to the nonlinear characteristics of some electronic Devices or signals picked up from the surrounding medium. In general, there are two classifications of filters:

1. Passive filters are those filters composed of series or parallel combinations of R, L, and C elements
2. Active filters are filters that employ active devices such as transistors and Operational amplifiers in combination with R, L, and C elements.

The analysis of this experiment will be limited to passive filters. All filters belong to the four broad categories of (low-pass, high-pass, pass-band, and stop-band), as depicted in fig. (1) For each form there are critical frequencies that define the regions of pass-bands and stop-bands (often called reject bands). Any frequency in the pass-band will pass through to the next stage with at least 70.7% of the maximum output voltage. Recall the use of the 0.707 level to define the bandwidth of a series or parallel resonant circuit (both with the general shape of the pass-band filter).

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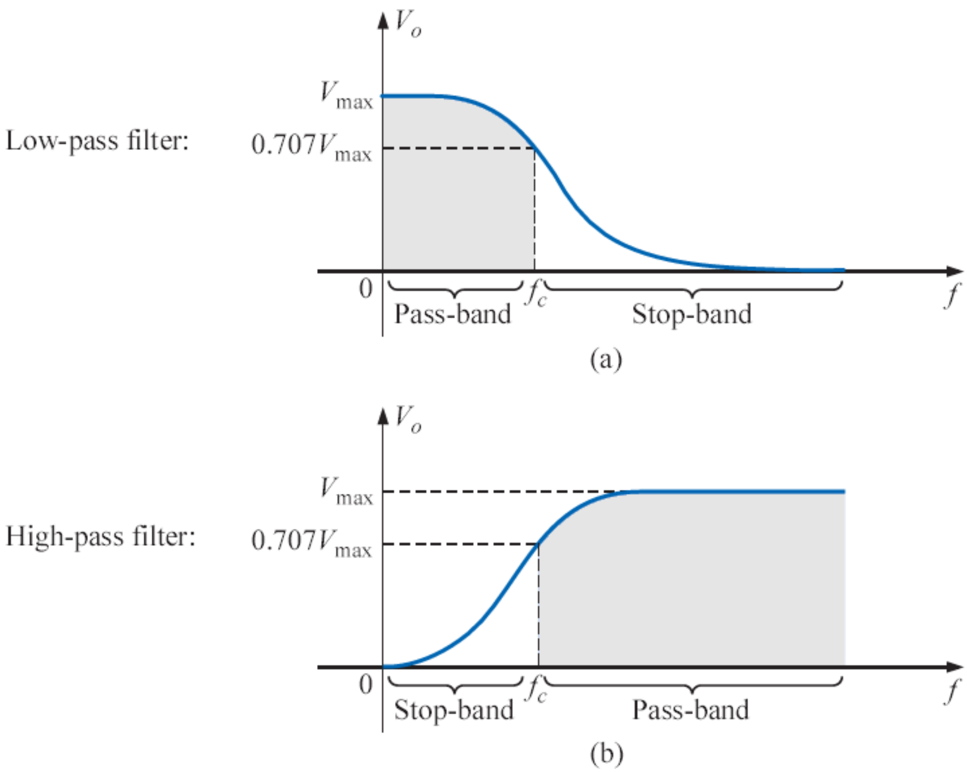

EXP. NO.8
(PASS-BAND FILTER)

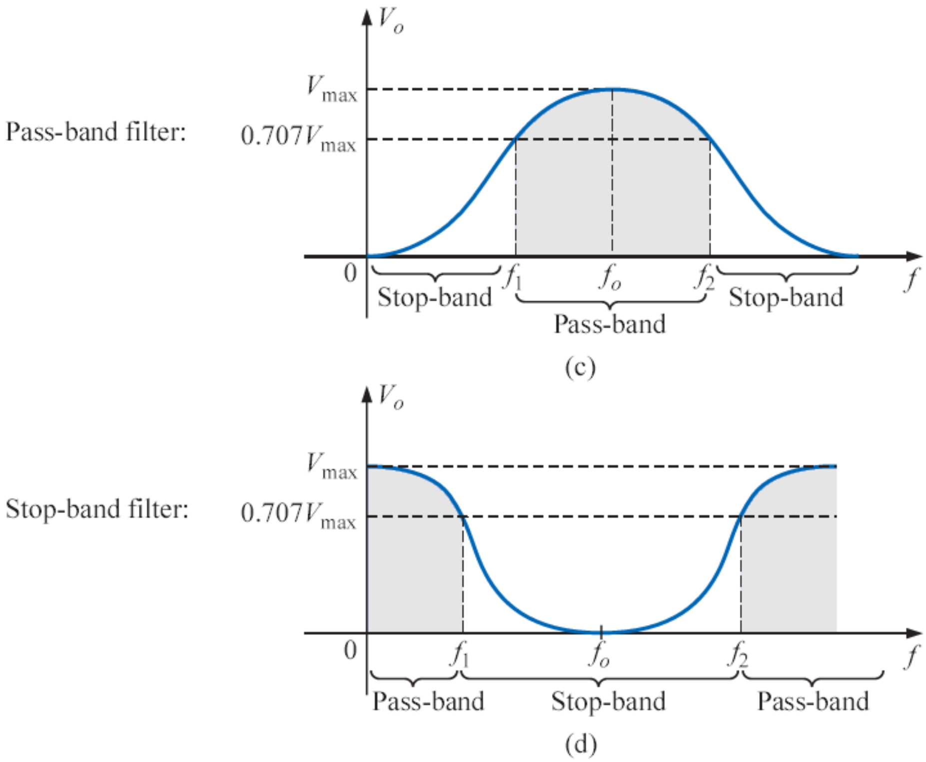

Fig.1 (Defining the four broad categories of filters.)

A number of methods are used to establish the pass-band characteristic of Fig. 1(c). One method employs both a low-pass and a high-pass filter in cascade, as shown in Fig.(2) .

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(PASS-BAND FILTER)

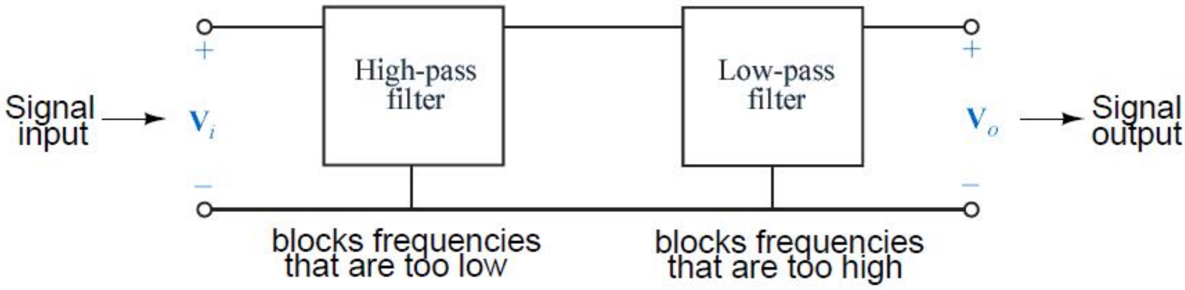

Fig.(2) Pass-band filter.

The components are chosen to establish a cutoff frequency for the high-pass filter that is lower than the critical frequency of the low-pass filter, as shown in Fig(3). A frequency f_1 may pass through the low-pass filter but have little effect on V_o due to the reject characteristics of the high-pass filter. A frequency f_2 may pass through the high-pass filter unmolested but be prohibited from reaching the high-pass filter by the low-pass characteristics. A frequency f_o near the center of the pass band will pass through both filters with very little degeneration.

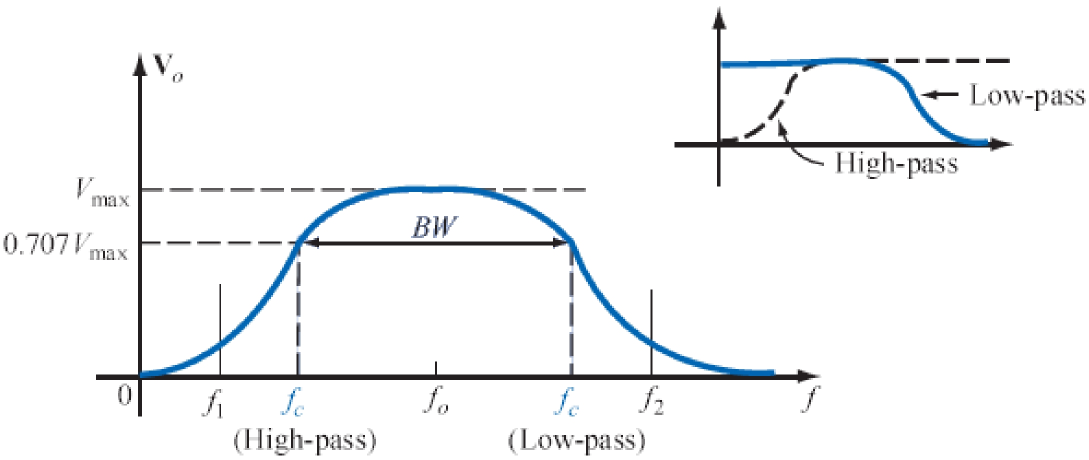

Fig.(3) Pass-band characteristics.

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(PASS-BAND FILTER)

The network of fig (4) will generate the characteristics of Fig. (3). However, for a circuit such as the one shown in Fig.(4), there is a loading between stages at each frequency that will affect the level of Vo. Through proper design, the level of V_o may be very near the level of Vi in the pass-band, but it will never equal it exactly. In addition, as the critical frequencies (f_C) of each filter get closer and closer Together to increase the quality factor of the response curve, the peak values within the pass-band will continue to drop. For cases where V_o max ≠ V_i max the bandwidth is defined at 0.707 of the resulting V_o max.

Definitions

Filter Networks designed to either pass or reject the transfer of signals at certain frequencies to a load.

Active filter a filter that employs active devices such as transistors or operational amplifiers in combination with R, L, and C elements.

High-pass filter a filter designed to pass high frequencies and reject low frequencies.

Low-pass filter a filter designed to pass low frequencies and reject high frequencies.

Pass-band (band-pass) filter a network designed to pass signals within a particular frequency range.

Band-pass filters can also be constructed using inductors, but as mentioned before, the reactive "purity" of capacitors gives them a design advantage. If we were to design a band -pass filter using inductors, it might look something like this fig(4):

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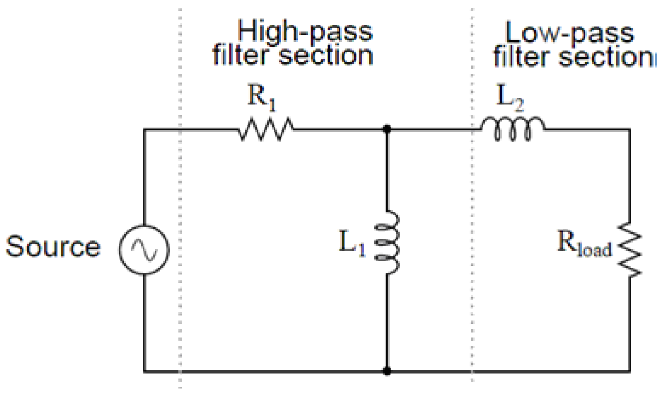
(PASS-BAND FILTER)



Inductive band-pass filter

fig (4)

Stop-band filter a network designed to reject (block) signals within a particular frequency range.

PROCEDURE

1-Connect the cct. Shown in fig. (5):

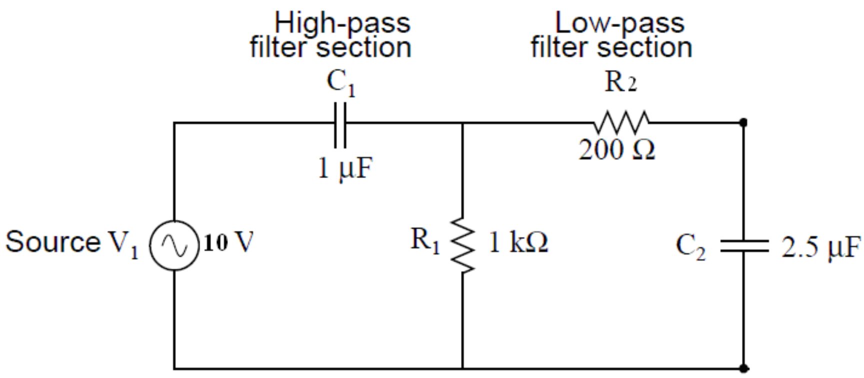


Fig.(5) Capacitive band-pass filter

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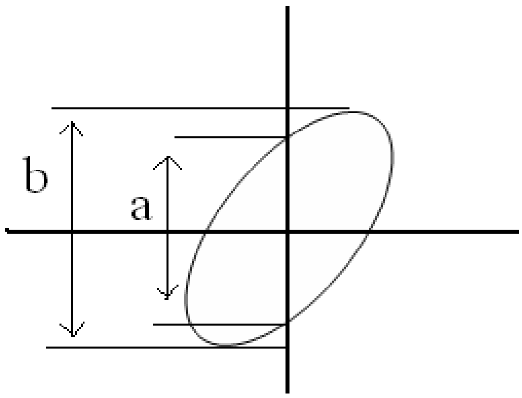
(PASS-BAND FILTER)

1- Change the frequency and measure V_o for every setting of (f). Tabulate your result as in table (1)

$F(H_z)$	20	30	40	60	100	200	400	600	700	800	900	1000	1100	1200	1300	1400
V_o																
θ																

Table (1)

2- Measure the phase shift θ for each frequency setting using the oscilloscope Where $\theta = \sin^{-1}(a/b)$ as in figure below:



REQUERMENTS:

1- Draw a graph between the gain (V_o) versus frequency, find (f_c) and Compare it with theoretical value. from the graph find f_1 & f_2 & B.W.

2- Draw a graph between (θ) and (f).

DISCUSSION:

1- compare between the theoretical &experimental results
2- write some of application of band pass filter
3- For the pass-band filter of Fig. (6)

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(PASS-BAND FILTER)

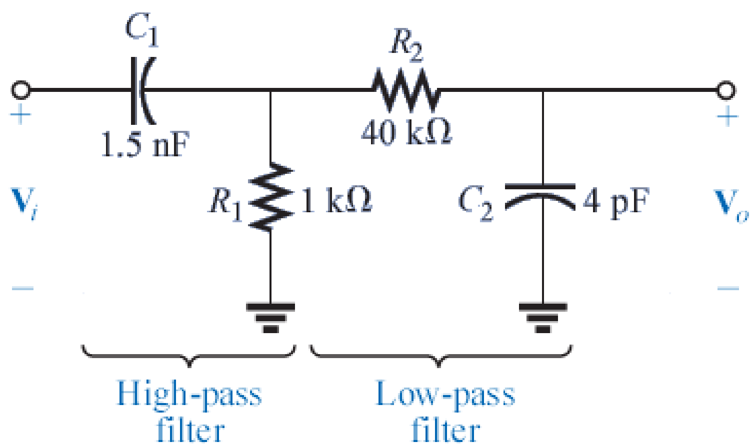

Fig (6)

a. Determine the critical frequencies for the low- and high-pass filters
b. Using only the critical frequencies, sketch the response characteristics
c. Determine the actual value of Vo at the high-pass critical frequency calculated in part (a), and compare it to the level that will define the upper frequency for the Pass-band.

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EXP. NO.9

(STOP-BAND FILTER)

OBJECT:

To establish the stop-band filter characteristic.

APPARTUS:

1- Signal function generator
2- Oscilloscope
3- Resisters ,capacitors
4- A.V.O. meter.

THEORY:

Also called band-elimination, band-reject, or notch filters, this kind of filter passes all frequencies **above and below a particular range set by the component values**. Stop-band filters can be constructed using a low-pass and a high pass filter. However, rather than the cascaded configuration used for the pass-band filter, a parallel arrangement is required, as shown in Fig. (1). A low-frequency f_1 can pass through the low-pass filter, and a higher-frequency f_2 can use the parallel path, as shown in Fig. (2). However, a frequency such as f_o in the reject-band is higher than the low-pass critical frequency and lower than the high-pass critical frequency, and is therefore prevented from contributing to the levels of V_o above $0.707V$max.

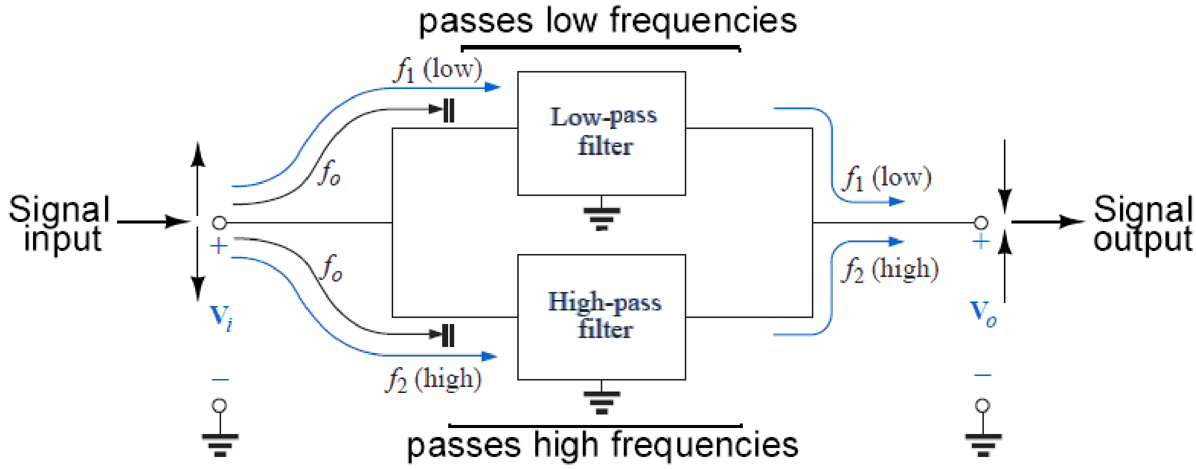

Fig.(1) stop-band filter

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(STOP-BAND FILTER)

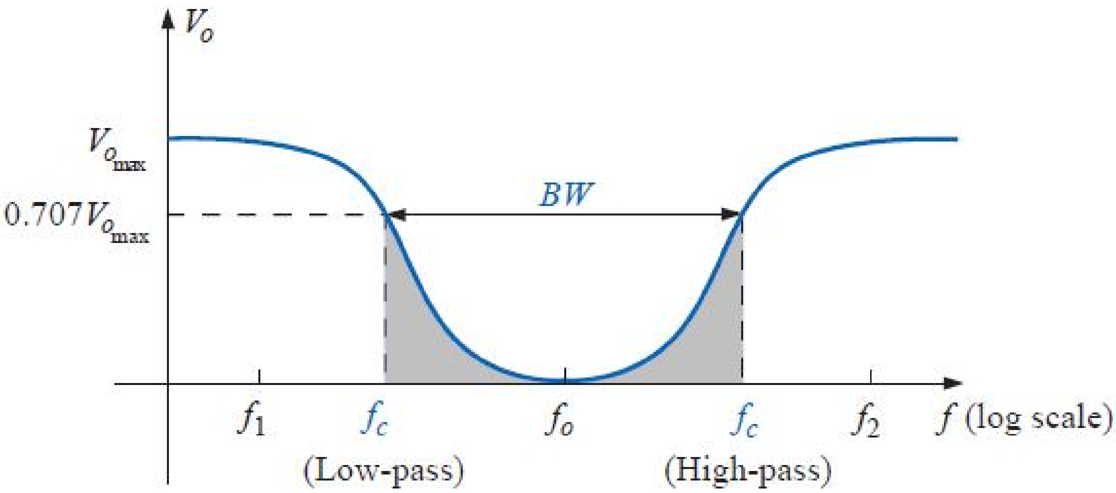
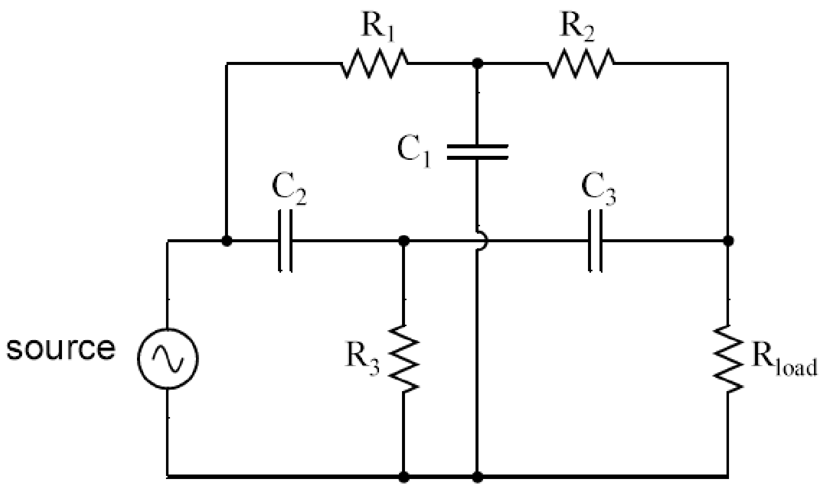


Fig.(2) Stop-band characteristics.

The characteristics of a stop-band filter are the inverse of the pattern obtained for the pass-band filters.

Fig.(3) shows the band stop filter, it was Constructed using two capacitive filter sections, it looks something like this:



Fig(3) "Twin-T" band-stop filter

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(STOP-BAND FILTER)

The low-pass filter section is comprised of R1, R2, and C1 in a "T" configuration. The high pass filter section is comprised of C2, C3, and R3 in a "T' configuration as well. Together, this arrangement is commonly known as a "Twin-T" filter, giving sharp response when the component values are chosen in the following ratios:

$\mathbf{R_1 = R_2 = 2(R_3)}$

$\mathbf{C_2 = C_3 = (0.5)\ C1}$

Given these component ratios, the frequency of maximum rejection can be calculated as follows:

$f = 1/\ (4\pi R_3 C_3)$

PROCEDURE

1-Connect the cct. Shown in fig. (4):

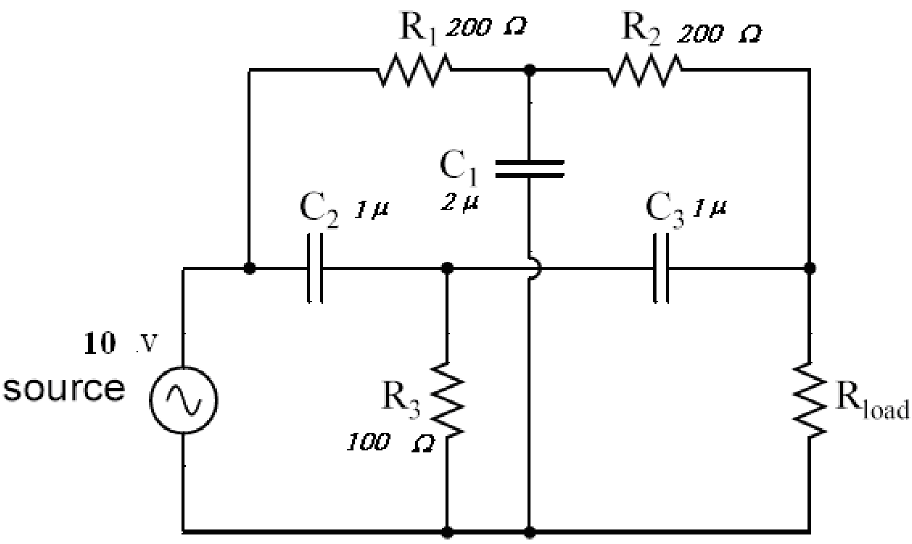


Fig (4)

2-change the frequency and measure V_o). Tabulate your result as in table (1)

F(Hz)	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
V_o														
θ														

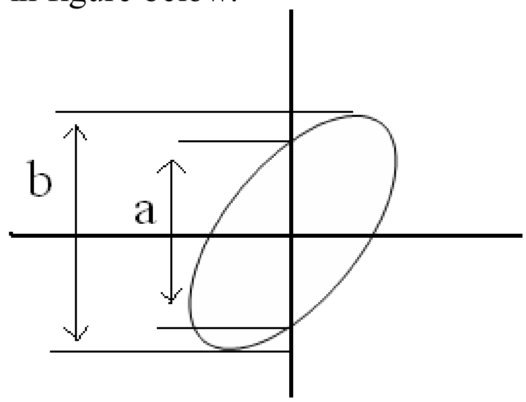
Table (1)

EXP. NO.9

(STOP-BAND FILTER)

3- Measure the phase shift θ for each frequency setting by using the oscilloscope

Where $\theta = \sin^{-1}(a/b)$ as in figure below:



REQUERMENTS:

1- Draw a graph between the (V_o) versus frequency, from the graph find f_1& f2 & B.W.

2-draw a graph between (θ) and (f),.

DISCUSSION:

1- Compare between band pas filter & stop band filter

2- Mentioning some application of band stop filter