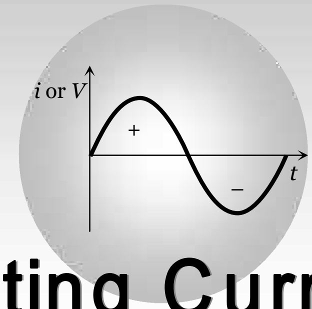
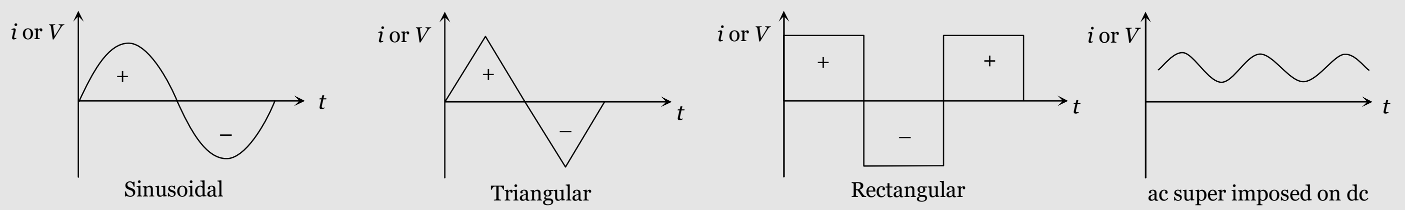


Alternating Current

An alternating quantity (current i or voltage V) is one whose magnitude changes continuously with time between zero and a maximum value and whose direction reverses periodically.

Some graphical representation for alternating quantities



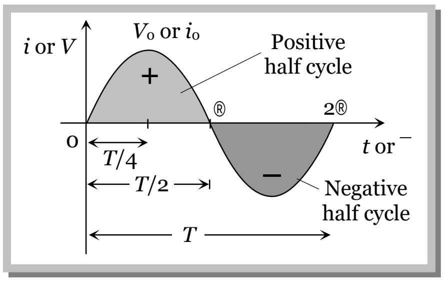
Equation of Alternating Quantities (i or V)

When a coil is rotated rapidly in a strong magnetic field, magnetic flux linked with the coil changes. As a result an emf is induced in the coil and induced current flows through the circuit. These voltage and current are known as alternating voltage and current

(1) **Equation :** Alternating current or voltage varying as sine function can be written as

$i = i_0 \sin µt = i_0 \sin 2®¬\, t = i_0 \sin \dfrac{2®}{T} t$

and $V = V_0 \sin µt = V_0 \sin 2®¬t = V_0 \sin \dfrac{2®}{T} t$



where i and V = Instantaneous values of current and voltage,

i_0 and V_0 = Peak values of current and voltage

µ = Angular frequency in *rad/sec*, ¬ = Frequency in *Hz* and T = time period

(2) **About cycle**

(i) The time taken to complete one cycle of variations is called the periodic time or time period.

(ii) Alternating quantity is positive for half the cycle and negative for the rest half. Hence average value of alternating quantity (i or V) over a complete cycle is zero.

(iii) Area under the positive half cycle is equal to area under negative cycle.

(iv) The value of alternating quantity is zero or maximum 2¬ times every second. The direction also changes 2¬ times every second.

(v) Generally sinusoidal waveform is used as alternating current/voltage.

(vi) At $t = \dfrac{T}{4}$ from the beginning, i or V reaches to their maximum value.

Note : ❑ If instantaneous current i (or voltage V) becomes $1/n$ times of it's peak value in time t then $t = \dfrac{T}{2\pi} \sin^{-1}\left(\dfrac{1}{n}\right)$ second.

Important Values of Alternating Quantities

(1) **Peak value (i_0 or V_0)**

The maximum value of alternating quantity (i or V) is defined as peak value or amplitude.

(2) **Mean square value ($\overline{V^2}$ or $\overline{i^2}$)**

The average of square of instantaneous values in one cycle is called mean square value. It is always positive for one complete cycle. *e.g.* $\overline{V^2} = \frac{1}{T}\int_0^T V^2 dt = \frac{V_0^2}{2}$ or $\overline{i^2} = \frac{i_0^2}{2}$

(3) **Root mean square (r.m.s.) value**

Root of mean of square of voltage or current in an *ac* circuit for one complete cycle is called *r.m.s.* value. It is denoted by V_{rms} or i_{rms}

$$i_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + ...}{n}} = \sqrt{\overline{i^2}} = \sqrt{\frac{\int_0^T i^2 dt}{\int_0^T dt}} = \frac{i_0}{\sqrt{2}} = 0.707\, i_0 = 70.7\% \text{ of } i_0$$

similarly $V_{rms} = \frac{V_0}{\sqrt{2}} = 0.707\, V_0 = 70.7\%$ of V_0

(i) The *r.m.s.* value of alternating current is also called virtual value or effective value.

(ii) In general when values of voltage or current for alternating circuits are given, these are *r.m.s.* value.

(iii) ac ammeter and voltmeter are always measure *r.m.s.* value. Values printed on *ac* circuits are *r.m.s.* values.

(iv) In our houses *ac* is supplied at 220 *V*, which is the *r.m.s.* value of voltage. It's peak value is $\sqrt{2} \times 200 = 311\, V$.

(v) *r.m.s.* value of *ac* is equal to that value of *dc*, which when passed through a resistance for a given time will produce the same amount of heat as produced by the alternating current when passed through the same resistance for same time.

Note : ❑ *r.m.s.* value of a complex current wave (*e.g.* $i = a \sin\mu\, t + b \cos\mu\, t$) is equal to the square root of the sum of the squares of the *r.m.s.* values of it's individual components *i.e.*

$$i_{rms} = \sqrt{\left(\frac{a}{\sqrt{2}}\right)^2 + \left(\frac{b}{\sqrt{2}}\right)^2} = \frac{1}{\sqrt{2}}\left(\sqrt{a^2 + b^2}\right).$$

(4) **Mean or Average value (i_{av} or V_{av})**

The average of instantaneous values of current or voltage in one cycle is called it's mean value. The average value of alternating quantity for one complete cycle is zero.

The average value of *ac* over half cycle (t = 0 to $T/2$)

$$i_{av} = \frac{\int_0^{T/2} i\,dt}{\int_0^{T/2} dt} = \frac{2i_0}{®} = 0.637\, i_0 = 63.7\% \text{ of } i_0, \text{ Similarly } V_{av} = \frac{2V_0}{®} = 0.637\, V_0 = 63.7\% \text{ of } V_0.$$

Specific Examples

Currents	Average value (For complete cycle)	Peak value	*r.m.s.* value	Angular frequency
$i = i_0 \sin\mu\, t$	0	i_0	$\frac{i_0}{\sqrt{2}}$	µ
$i = i_0 \sin\mu\, t \cos \mu\, t$	0	$\frac{i_0}{2}$	$\frac{i_0}{2\sqrt{2}}$	2µ
$i = i_0 \sin\mu\, t + i_0 \cos\mu\, t$	0	$\sqrt{2}\, i_0$	i_0	µ

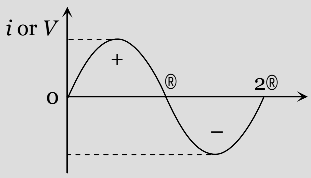
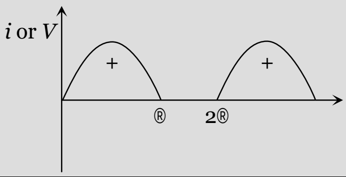
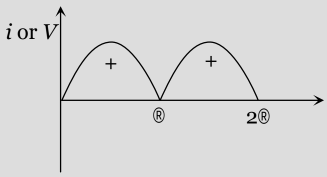
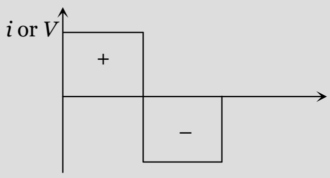
(5) **Peak to peak value**

It is equal to the sum of the magnitudes of positive and negative peak values

$\therefore$ Peak to peak value = $V_0 + V_0 = 2V_0 = 2\sqrt{2}\, V_{rms} = 2.828\ V_{rms}$

(6) **Peak factor and form factor**

The ratio of *r.m.s.* value of *ac* to it's average during half cycle is defined as form factor. The ratio of peak value and *r.m.s.* value is called peak factor

Nature of wave form	Wave form	*r.m.s* . value	averag e value	Form factor $R_f = \frac{\text{r.m.s. value}}{\text{Average value}}$	Peak factor $R_p = \frac{\text{Peak value}}{\text{r.m.s. value}}$
Sinusoidal		$\frac{i_0}{\sqrt{2}}$	$\frac{2}{\text{®}} i_0$	$\frac{\text{®}}{2\sqrt{2}} = 1.11$	$\sqrt{2} = 1.41$
Half wave rectified		$\frac{i_0}{2}$	$\frac{i_0}{\text{®}}$	$\frac{\text{®}}{2} = 1.57$	2
Full wave rectified		$\frac{i_0}{\sqrt{2}}$	$\frac{2i_0}{\text{®}}$	$\frac{\text{®}}{2\sqrt{2}}$	$\sqrt{2}$
Square or Rectangula r		i_0	i_0	1	1

Phase

Physical quantity which represents both the instantaneous value and direction of alternating quantity at any instant is called it's phase. It's a dimensionless quantity and it's unit is radian.

If an alternating quantity is expressed as $X = X_0 \sin(\mu\, t \pm ¤_0)$ then the argument of $\sin(\mu\, t + ¤)$ is called it's phase. Where μ *t* = instantaneous phase (changes with time) and $¤_0$ = initial phase (constant *w.r.t.* time)

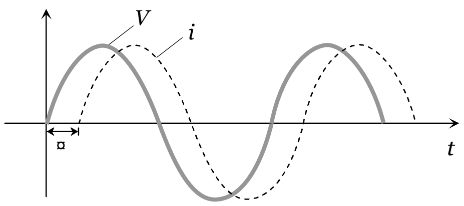
(1) **Phase difference** (Phase constant)

The difference between the phases of currents and voltage is called phase difference. If alternating voltage and current are given by $V = V_0 \sin(\mu\, t + ¤_1)$ and $i = i_0 \sin(\mu\, t + ¤_2)$ then phase difference $¤ = ¤_1 - ¤_2$ (relative to current) or $¤ = ¤_2 - ¤_1$ (relative to voltage)

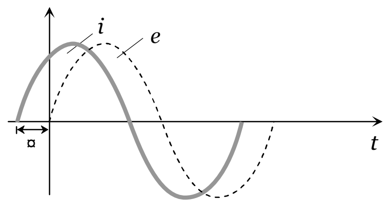
Note : ❑ Phase difference, generally is given relative to current.

❑ The quantity with higher phase is supposed to be leading and the other quantity is taken to be lagging.

(2) **Graphical representation**



Voltage (V) = $V_0 \sin \mu\, t$
Current (i) = $i_0 \sin (\mu\, t - ¤)$
Phase difference = 0 – (– ¤) = + ¤
i.e. voltage is leading by an angle (+ ¤) *w.r.t.* current



Voltage (V) = $V_0 \sin \mu\, t$
Current (i) = $i_0 \sin (\mu\, t + ¤)$
Phase difference = 0 – (+ ¤) = – ¤
i.e. voltage is leading by an angle (– ¤) *w.r.t.* current

(3) **Time difference**

If phase difference between alternating current and voltage is ¤ then time difference between them is given as

$$\text{T.D.} = \frac{T}{2®} \times ¤$$

(4) **Phasor and phasor diagram**

The study of *ac* circuits is much simplified if we treat alternating current and alternating voltage as vectors with the angle between the vectors equals to the phase difference between the current and voltage. The current and voltage are more appropriately called phasors. A diagram representing alternating current and alternating voltage (of same frequency) as vectors (phasors) with the phase angle between them is called a phasor diagram.

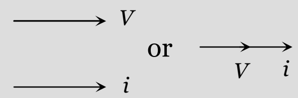
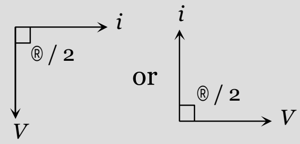
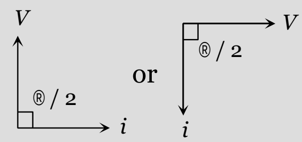
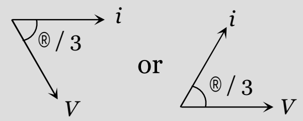
While drawing phasor diagram for a pure element (*e.g.* *R*, *L* or *C*) either of the current or voltage can be plotted along *X*-axis.

But when phasor diagram for a combination of elements is drawn then quantity which remains constant for the combination must be plotted along *X*-axis so we observe that

(a) In series circuits current has to be plotted along *X*-axis.

(b) In parallel circuits voltage has to be plotted along X-axis.

Specific Examples

Equation of V and i	Phase difference ¤	Time difference T.D.	Phasor diagram
$V = V_0 \sin \mu\, t$ $i = i_0 \sin \mu\, t$	0	0	
$V = V_0 \sin \mu\, t$ $i = i_0\ \sin(\mu t + \frac{\text{®}}{2})$	$-\frac{\text{®}}{2}$	$\frac{T}{4}$	
$V = V_0 \sin \mu\, t$ $i = i_0\ \sin(\mu t - \frac{\text{®}}{2})$	$+\frac{\text{®}}{2}$	$\frac{T}{4}$	
$V = V_0 \sin \mu\, t$ $i = i_0\ \sin(\mu t + \frac{\text{®}}{3})$	$-\frac{\text{®}}{3}$	$\frac{T}{6}$	

Measurement of Alternating Quantities

Alternating current shows heating effect only, hence meters used for measuring *ac* are based on heating effect and are called hot wire meters (Hot wire ammeter and hot wire voltmeter)

ac measurement	*dc* measurement
(1) All ac meters read *r.m.s.* value.	(1) All dc meters read average value
(2) All ac meters are based on heating effect of current.	(2) All dc meters are based on magnetic effect of current
(3) Deflection in hot wire meters : ¯ $\propto i_{rms}^2$  (non-linear scale)	(3) Deflection in *dc* meters : ¯ $\propto i$  (Linear scale)

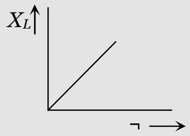
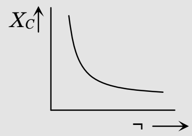
Note : ❑ *ac* meters can be used in measuring *ac* and *dc* both while *dc* meters cannot be used in measuring *ac* because the average value of alternating current and voltage over a full cycle is zero.

Terms Related to ac Circuits

(1) **Resistance (*R*) :** The opposition offered by a conductor to the flow of current through it is defined as the resistance of that conductor. Reciprocal of resistance is known as conductance (G) *i.e.* $G = \frac{1}{R}$

(2) **Impedance (*Z*) :** The opposition offered by the capacitor, inductor and conductor to the flow of ac through it is defined as impedance. It's unit is *ohm*(Ω). $Z = \frac{V_0}{i_0} = \frac{V_{rms}}{i_{rms}}$

(3) **Reactance (*X*) :** The opposition offered by inductor or capacitor or both to the flow of ac through it is defined as reactance. It is of following two type –

Inductive reactance (X_L)	**Capacitive reactance (X_C)**
(i) Offered by inductive circuit	(i) Offered by capacitive circuit
(ii) $X_L = \text{µ}L = 2\text{®¬}L$	(ii) $X_C = \frac{1}{\text{µ}C} = \frac{1}{2\text{®¬}C}$
(iii) $\text{¬}_{dc} = 0$ so for dc, $X_L = 0$	(iii) For dc $X_C = \infty$
(iv) X_L-¬ Graph 	(iv) X_C - ¬ Graph 

Note : ❑ Resultant reactance of *LC* circuit is defined as $X = X_L \sim X_C$.

(4) **Admittance (*Y*) :** Reciprocal of impedance is known as admittance $\left(Y = \frac{1}{Z}\right)$. It's unit is *mho*.

(5) **Susceptance (*S*) :** the reciprocal of reactance is defined as susceptance $\left(S = \frac{1}{X}\right)$. It is of two type

(i) inductive susceptance $S_L = \frac{1}{X_L} = \frac{1}{2\text{®¬} L}$ and (ii) Capacitive susceptance, $S_C = \frac{1}{X_C} = \text{µ} C = 2\text{®¬} C$.

Power and Power Factor

The power is defined as the rate at which work is being done in the circuit.

In dc circuits power is given by *P* = *Vi*. But in ac circuits, since there is some phase angle between voltage and current, therefore power is defined as the product of voltage and that component of the current which is in phase with the voltage.

Thus $\boldsymbol{P = V i \cos \text{¤}}$; where *V* and *i* are *r.m.s.* value of voltage and current.

(1) **Types of power**

There are three terms used for power in an ac circuit

(i) **Instantaneous power:** Suppose in a circuit $V = V_0 \sin \text{µ} t$ and $i = i_0 \sin(\text{µ} t + \text{¤})$ then $P_{\text{instantane ous}} = Vi = V_0 i_0 \sin \text{µ} t \sin(\text{µ} t + \text{¤})$

(ii) **Average power (True power) :** The average of instantaneous power in an ac circuit over a full cycle is called average power. It's unit is *watt* *i.e.*

$$P_{av} = \overline{P}_{inst} \Rightarrow P_{av} = V_{rms} i_{rms} \cos \text{¤} = \frac{V_0}{\sqrt{2}} . \frac{i_0}{\sqrt{2}} \cos \text{¤} = \frac{1}{2} V_0 i_0 \cos \text{¤} = i_{rms}^2 R = \frac{V_{rms}^2 R}{Z^2}$$

(iii) **Apparent or virtual power :** The product of apparent voltage and apparent current in an electric circuit is called apparent power. This is always positive

$$P_{app} = V_{rms} i_{rms} = \frac{V_0 i_0}{2}$$

(2) **Power factor :** It may be defined as

(i) Cosine of the angle of lag or lead

(ii) The ratio $\frac{R}{Z} = \frac{\text{Resistance}}{\text{Impedance}}$

(iii) The ratio $\frac{\text{True power}}{\text{Apparent power}} = \frac{W}{VA} = \frac{kW}{kVA} = \cos ¤$

Note : ❑ Power factor is a dimensionless quantity and it's value lies between 0 and 1.

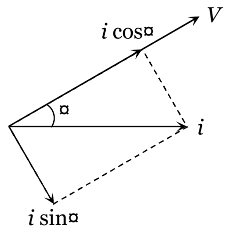
❑ For a pure resistive circuit $R = Z \Rightarrow$ p.f. = cos¤ = 1

Wattless Current

In an ac circuit $R = 0 \Rightarrow$ cos¤ = 0 so $P_{av} = 0$ *i.e.* in resistance less circuit the power consumed is zero. Such a circuit is called the wattless circuit and the current flowing is called the wattless current.

or

The component of current which does not contribute to the average power dissipation is called wattless current



(i) The average of wattless component over one cycle is zero

(ii) Amplitude of wattless current = i_0 sin¤

and *r.m.s.* value of wattless current = $i_{rms} \sin ¤ = \frac{i_0}{\sqrt{2}} \sin ¤$.

It is quadrature (90°) with voltage

Note : ❑ The component of ac which remains in phase with the alternating voltage is defined as the effective current. The peak value of effective current is i_0 cos¤ and it's r.m.s. value is $i_{rms} \cos ¤ = \frac{i_0}{\sqrt{2}} \cos ¤$.

Concepts

☞ *If ac is produced by a generator having a large number of poles then it's frequency* $¬ = \frac{\text{Number of poles} \times \text{rotation per second}}{2} = \frac{P \times n}{2}$

Where P is the number of poles; n is the rotational frequency of the coil.

☞ *Alternating current in electric wires, bulbs etc. flows 50 times in one direction and 50 times in the opposite direction in 1 second. Since in one cycle the current becomes zero twice, hence a bulb lights up 100 times and is off 100 times in one second (50 cycles) but due to persistence of vision, it appears lighted continuously.*

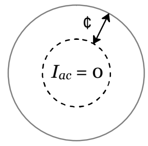
☞ *ac is more dangerous than dc.*

☞ *The rate of change of ac is minimum at that instant when they are near their peak values.*

☞ *ac equipments such as electric motors, are more durable and convenient compared to dc equipments.*

☞ ***Skin Effect***

A direct current flows uniformly throughout the cross-section of the conductor. An alternating current, on the other hand, flows



mainly along the surface of the conductor. This effect is known as skin effect. the reason is that when alternating current flows through a conductor, the flux changes in the inner part of the conductor are higher. Therefore the inductance of the inner part is higher than that of the outer part. Higher the frequency of alternating current, more is the skin effect.

The depth upto which ac current flows through a wire is called skin depth (¢).

☞ *Comparison of electricity in India and America*

India	**America**
50 *Hz*	60 *Hz*
220 *V*	110 *V*

	R	$R/4$	$R = \frac{V_R^2}{P_R} \Rightarrow R \propto V_R^2$ (V_R = rated voltage, P_R = rated power)

Example

Example: 1 The equation of an alternating current is $i = 50\sqrt{2} \times \sin 400 ®t$ *ampere* then the frequency and the root mean square of the current are respectively

(a) 200 *Hz*, 50 *amp* (b) 400 ® *Hz*, $50\sqrt{2}$ *amp* (c) 200 *Hz*, $50\sqrt{2}$ *amp* (d) 50 *Hz*, 200 *amp*

Solution: (a) Comparing the given equation with $i = i_0 \sin µ\, t$

$\Rightarrow$ µ = 400 ® $\Rightarrow$ 2®¬ = 400® $\Rightarrow$ ¬ = 200 *Hz*. Also $i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{50\sqrt{2}}{2}$ = 50 *A*.

Example: 2 If the frequency of an alternating current is 50 *Hz* then the time taken for the change from zero to positive peak value and positive peak value to negative peak value of current are respectively

(a) 1/200 *sec*, 1/ 100 *sec* (b) 1/ 100 *sec*, 1/200 *sec* (c) 200 *sec*, 100 *sec* (d) None of these

Solution: (a) Time take to reach from zero to peak value $t = \frac{T}{4} = \frac{1}{4¬} = \frac{1}{4 \times 50} = \frac{1}{200} sec$

Time take for the change from positive peak to negative peak $t' = \frac{T}{2} = \frac{1}{2¬} = \frac{1}{2 \times 50} = \frac{1}{100} sec$.

Example: 3 What will be the equation of ac of frequency 75 *Hz* if its *r.m.s.* value is 20 *A*

(a) $i = 20 \sin 150® \,t$ (b) $i = 20\sqrt{2} \sin(150® \,t)$ (c) $i = \frac{20}{\sqrt{2}} \sin(150® \,t)$ (d) $i = 20\sqrt{2} \sin(75® \,t)$

Solution: (b) By using $i = i_0 \sin µ\, t = i_0 \sin 2®¬\, t = i_{rms}\sqrt{2} \sin 2®¬\, t \Rightarrow i = 20\sqrt{2} \sin(150® \,t)$.

Example: 4 At what time (From zero) the alternating voltage becomes $\frac{1}{\sqrt{2}}$ times of it's peak value. Where *T* is the periodic time

(a) $\frac{T}{2} sec$ (b) $\frac{T}{4} sec$ (c) $\frac{T}{8} sec$ (d) $\frac{T}{12} sec$

Solution: (c) By using $V = V_0 \sin µ\, t \Rightarrow \frac{V_0}{\sqrt{2}} = V_0 \sin \frac{2® \,t}{T} \Rightarrow \frac{1}{\sqrt{2}} = \sin\left(\frac{2®}{T}\right)t \Rightarrow \sin\frac{®}{4} = \sin\left(\frac{2®}{T}\right)t$

$\Rightarrow \frac{®}{4} = \frac{2®}{T} t \Rightarrow t = \frac{T}{8} sec.$

Example: 5 The peak value of an alternating *e.m.f. E* is given by $E = E_0 \cos µ\, t$ is 10 *volts* and its frequency is $50\,Hz$. At time $t = \frac{1}{600} sec$, the instantaneous *e.m.f.* is

(a) 10 *V* (b) $5\sqrt{3} V$ (c) 5 *V* (d) 1*V*

Solution: (b) By using $E = E_0 \sin µ\, t$ = 10 cos 2®¬ *t* = 10 cos 2® × 50 × $\frac{1}{600} \Rightarrow E = 10 \cos\frac{®}{6} = 5\sqrt{3}\ V$

Example: 6 The instantaneous value of current in an ac circuit is $i = 2\sin(100® \,t + ®/3) A$. The current at the beginning $(t = 0)$ will be

(a) $2\sqrt{3}A$ (b) $\sqrt{3}A$ (c) $\frac{\sqrt{3}}{2}A$ (d) Zero

Solution: (b) At t = 0, $i = 2\sin\left(0 + \frac{®}{3}\right) = 2 \times \frac{\sqrt{3}}{2} = \sqrt{3}A$.

***Example*: 7** The voltage of an ac source varies with time according to the equation V = 100 sin(100®t) cos(100®t) where t is in seconds and V is in *volts*. Then

(a) The peak voltage of the source is 100 *volts* (b) The peak voltage of the source is 50 *volts*

(c) The peak voltage of the source is $100/\sqrt{2}\ volts$ (d) The frequency of the source is 50 *Hz*

Solution: (b) The given equation can be written as follows

$V = 50 \times 2\sin 100® t\cos 100® t = 50\sin 2(100® t) = 50\sin 200® t$ (∵ sin 2¯ = 2 sin¯ cos¯)

Hence peak voltage $V_0 = 50\ volt$ and frequency$¬ = \frac{200®}{2®} = 100\ Hz$.

***Example*: 8** If the frequency of ac is 60 *Hz* the time difference corresponding to a phase difference of 60° is

(a) 60 *sec* (b) 1*sec* (c) $\frac{1}{60}sec$ (d) $\frac{1}{360}sec$

Solution: (d) Time difference T.D. $= \frac{T}{2®} \times ¤ \Rightarrow$ T.D. $= \frac{T}{2®} \times \frac{®}{3} = \frac{T}{6} = \frac{1}{6¬} = \frac{1}{6 \times 60} = \frac{1}{360}sec$

***Example*: 9** In an ac circuit, V and i are given by $V = 100\sin(100t)\,volts$, and $i = 100\sin\left(100t + \frac{®}{3}\right)mA$. The power dissipated in circuit is

(a) $10^4\ watt$ (b) 10 *watt* (c) 2.5 *watt* (d) 5 *watt*

Solution: (c) $P = \frac{1}{2}V_0 i_0 \cos ¤ = \frac{1}{2} \times 100 \times (100 \times 10^{-3}) \times \cos\left(\frac{®}{3}\right) = 2.5\ watt.$

***Example*: 10** In a circuit an alternating current and a direct current are supplied together. The expression of the instantaneous current is given as $i = 3 + 6\sin µt$. Then the *r.m.s.* value of the current is

(a) 3*A* (b) 6*A* (c) $3\sqrt{2}A$ (d) $3\sqrt{3}A$

Solution: (d) The given current is a mixture of a dc component of 3*A* and an alternating current of maximum value 6*A*

Hence *r.m.s.* value $= \sqrt{(dc)^2 + (r.m.s.\text{ value of ac})^2} = \sqrt{(3)^2 + \left(\frac{6}{\sqrt{2}}\right)^2} = \sqrt{(3)^2 + (3\sqrt{2})^2} = 3\sqrt{3}A$.

***Example*: 11** The *r.m.s.* value of the alternating *e.m.f.* E = (8 sinµ t + 6 sin 2µ t) V is

(a) 7.05 V (b) 14.14 V (c) 10 V (d) 20 V

Solution: (a) Peak value $V_0 = \sqrt{(8)^2 + (6)^2} = 10\ volt$ so $v_{rms} = \frac{10}{\sqrt{2}} = 5\sqrt{2} = 7.05\ volt$.

***Example*: 12** Voltage and current in an ac circuit are given by $V = 5\sin\left(100® t - \frac{®}{6}\right)$ and $i = 4\sin\left(100® t + \frac{®}{6}\right)$

(a) Voltage leads the current by 30° (b) Current leads the voltage by 30°

(c) Current leads the voltage by 60° (d) Voltage leads the current by 60°

Solution: (c) Phase difference relative to current $\Delta ¤ = -\frac{®}{6} - \frac{®}{6} = -\frac{®}{3}$

In degree $\Delta ¤ = -60^o$ *i.e.* voltage lag behind the current by 60° or current leads the voltage by 60°.

***Example*: 13** The instantaneous values of current and potential difference in an alternating circuit are $i = \sin µ\ t$ and $E = 100\cos µ\ t$ respectively. *r.m.s.* value of wattless current (in *amp*) in the circuit is

(a) 1 (b) $1/\sqrt{2}$ (c) 100 (d) Zero

Solution: (b) $r.m.s.$ value of wattless current $= \frac{i_0}{\sqrt{2}} \sin ¤$

In this question $i_0 = 1\,A$ and $¤ = \frac{®}{2}$. So $r.m.s.$ value of wattless current $= \frac{1}{\sqrt{2}} A$

***Example*: 14** The $r.m.s.$ current in an ac circuit is 2 A. If the wattless current be $\sqrt{3} A$, what is the power factor

(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{1}{\sqrt{2}}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$

Solution: (c) $i_{WL} = i_{rms} \sin ¤ \Rightarrow \sqrt{3} = 2 \sin ¤ \Rightarrow \sin ¤ = \frac{\sqrt{3}}{2} \Rightarrow ¤ = 60^o$ so p.f. $= \cos ¤ = \cos 60^o = \frac{1}{2}$.

***Example*: 15** $r.m.s.$ value of alternating current in a circuit is 4 A and power factor is 0.5. If the power dissipated in the circuit is 100W, then the peak value of voltage in the circuit is

(a) 50 *volt* (b) 70 *volt* (c) 35 *volt* (d) 100 *volt*

Solution: (b) $P = V_{rms}\, i_{rms} \cos ¤ \Rightarrow 100 = V_{rms} \times 4 \times 0.5 \Rightarrow V_{rms} = 50\,V$ so $V_0 = \sqrt{2} \times 50 = 70$ *volt*

***Example*: 16** The impedance of an ac circuit is 200 Ω and the phase angle between current and $e.m.f$ is 60^o. What is the resistance of the circuit

(a) 50 Ω (b) 100 Ω (c) $100\sqrt{3}\Omega$ (d) 300 Ω

Solution: (b) By using $\cos ¤ = \frac{R}{Z} \Rightarrow \cos 60^o = \frac{R}{200} \Rightarrow \frac{1}{2} = \frac{R}{200} \Rightarrow R = 100\ \Omega$.

Tricky example: 1

An ac voltage source of E = 150 sin 100 t is used to run a device which offers a resistance of 20Ω and restricts the flow of current in one direction only. The $r.m.s.$ value of current in the circuit will be

(a) 1.58 A (b) 0.98 A (c) 3.75 A (d) 2.38 A

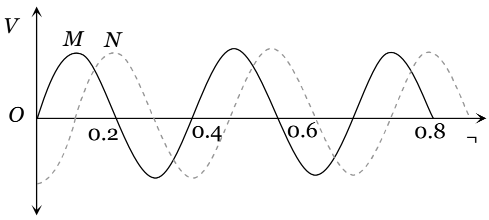
Solution : (c) As current flows in a single direction, the device allows current only during positive half cycle only

$\therefore\ i_{rms} = \frac{i_0}{2} = \frac{V_0}{2R} = \frac{150}{2 \times 20} = 3.75\,A$.

Tricky example: 2

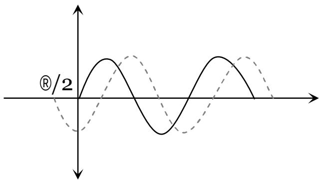
Two sinusoidal voltages of the same frequency are shown in the diagram. What is the frequency, and the phase relationship between the voltages

Frequency in Hz	Phase lead of N over M in radians
(a) 0.4	$-® / 4$
(b) 2.5	$-® / 2$
(c) 2.5	$+® / 2$
(d) 2.5	$-® / 4$



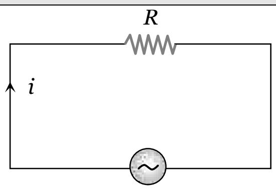
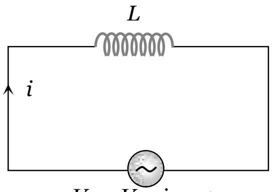
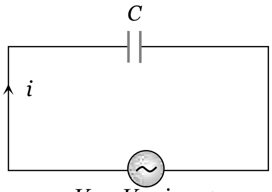
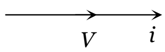
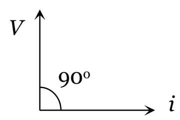
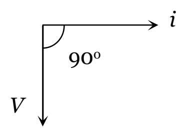
Solution : (b) From the graph shown below. It is clear that phase lead of N over M is $-\frac{®}{2}$. Since time period ($i.e.$ taken to complete one cycle) = 0.4 *sec*.

Hence frequency $\nu = \frac{1}{T} = 2.5\ Hz$

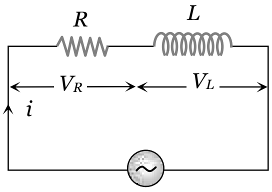
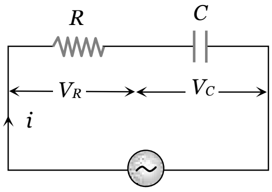
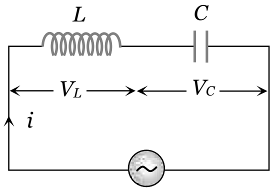
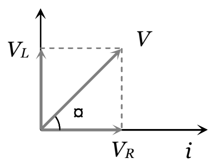
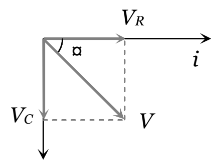
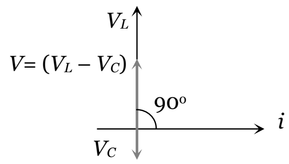


Different ac Circuit

(1) *R*, *L* and *C* circuits

Circuit characteristics	Purely resistive circuit (*R*-circuit)	Purely inductive circuit (*L*-circuit)	Purely capacitive circuit (*C*-circuit)
(i) Circuit	 $V = V_0 \sin \omega t$	 $V = V_0 \sin \omega t$	 $V = V_0 \sin \omega t$
(ii) Current	$i = i_0 \sin \omega t$	$i = i_0 \sin\left(\omega t - \frac{\pi}{2}\right)$	$i = i_0 \sin\left(\omega t + \frac{\pi}{2}\right)$
(iii) Peak current	$i_0 = \frac{V_0}{R}$	$i_0 = \frac{V_0}{X_L} = \frac{V_0}{\omega_L} = \frac{V_0}{2\pi\nu L}$	$i_0 = \frac{V_0}{X_C} = V_0 \omega C = V_0(2\pi\nu C)$
(iv) Phase difference	$\phi = 0^o$	$\phi = 90^o$ (or $+\frac{\pi}{2}$)	$\phi = 90^o$ (or $-\frac{\pi}{2}$)
(v) Power factor	$\cos\phi = 1$	$\cos\phi = 0$	$\cos\phi = 0$
(vi) Power	$P = V_{rms} i_{rms} = \frac{V_0 i_0}{2}$	$P = 0$	$P = 0$
(vii) Time difference	TD = 0	TD $= \frac{T}{4}$	TD $= \frac{T}{4}$
(viii) Leading quantity	Both are in same phase	Voltage	Current
(ix) Phasor diagram			

(2) ***RL*, *RC* and *LC* circuits**

Circuit characterstics	***RL*-circuit**	***RC*-circuit**	***LC*-circuit**
(i) Circuit	 $V_R = iR$, $V_L = iX_L$ $V = V_0 \sin \omega t$	 $V_R = iR$, $V_C = iX_C$ $V = V_0 \sin \omega t$	 $V_L = iX_L$, $V_C = iX_C$ $V = V_0 \sin \omega t$
(ii) Current	$i = i_0 \sin(\omega t - \phi)$	$i = i_0 \sin(\omega t + \phi)$	$i = i_0 \sin\left(\omega t \pm \frac{\pi}{2}\right)$
(iii) Peak current	$i_0 = \frac{V_0}{Z} = \frac{V_0}{\sqrt{R^2 + X_L^2}}$ $= \frac{V_0}{\sqrt{R^2 + 4\pi^2\nu^2 L^2}}$	$i_0 = \frac{V_0}{Z} = \frac{V_0}{\sqrt{R^2 + X_C^2}}$ $= \frac{V_0}{\sqrt{R^2 + \frac{1}{4\pi^2\nu^2 C^2}}}$	$i_0 = \frac{V_0}{Z} = \frac{V_0}{X_L - X_C}$ $= \frac{V_0}{\omega L - \frac{1}{\omega C}}$
(iv) Phasor diagram			
(v) Applied voltage	$V = \sqrt{V_R^2 + V_L^2}$	$V = \sqrt{V_R^2 + V_C^2}$	$V = V_L - V_C$
(vi) Impedance	$Z = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + \omega^2 L^2}$ $= \sqrt{R^2 + 4\pi^2\nu^2 L^2}$	$Z = \sqrt{R^2 + X_C^2} = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$	$Z = X_L - X_C = X$
(vii) Phase difference	$\phi = \tan^{-1}\frac{X_L}{R} = \tan^{-1}\frac{\omega L}{R}$	$\phi = \tan^{-1}\frac{X_C}{R} = \tan^{-1}\frac{1}{\omega CR}$	$\phi = 90^o$
(viii) Power factor	$\cos\phi = \frac{R}{\sqrt{R^2 + X_L^2}}$	$\cos\phi = \frac{R}{\sqrt{R^2 + X_C^2}}$	$\cos\phi = 0$
(ix) Leading quantity	Voltage	Current	Either voltage or current

Note : ❑In *LC* circuit if $X_L = X_C \Rightarrow V_L = V_C$ then resonance occurs and resonant frequency (natural frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ *rad/sec* or $\nu_0 = \frac{1}{2\pi\sqrt{LC}}$ *Hz*.

Example

Example: 17 In a resistive circuit R = 10 Ω and applied alternating voltage V = 100 sin 100 ® t. Find the following

(i) Peak current (ii) $r.m.s.$ current (iii) Average current (iv) Frequency

(v) Time period (vi) Power factor (vii) Power dissipated in the circuit

(viii) Time difference

Solution: (i) Peak current $i_0 = \frac{V_0}{R} = \frac{100}{10} = 10\,A$

(ii) $r.m.s.$ current $i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 5\sqrt{2}\,A$

(iii) Average current $i_{av} = \frac{2}{®}.i_0 = \frac{2}{®} \times 10 = 6.37\ A$

(iv) Frequency $¬ = \frac{\mu}{2®} = \frac{100®}{2®} = 50\,Hz$

(v) Time period $T = \frac{1}{¬} = \frac{1}{50} = 0.02\ sec$

(vi) Phase difference in resistive circuit $¤ = 0$ so p.f. = cos¤ = 1

(vii) Power dissipated in the circuit $P = \frac{1}{2} V_0 i_0 \cos ¤ = \frac{1}{2} \times 100 \times 10 \times 1 = 500\,W$

(viii) Time difference T.D. $= \frac{T}{2®} \times ¤ = \frac{T}{2®} \times 0 = 0$

Example: 18 In a purely inductive circuit if $L = \frac{100}{®} \times 10^{-3}\ H$ and applied alternating voltage is given by V = 100 sin 100 ® t. Find the followings

(i) Inductive reactance (ii) Peak value, $r.m.s.$ value and average value of current

(iii) Frequency and time period (iv) Power factor and power

(v) Time difference between voltage and current

Solution: (i) $X_L = \mu\, L = 100® \times \frac{100}{®} \times 10^{-3} = 10\ \Omega$

(ii) $i_0 = \frac{V_0}{X_L} = \frac{100}{10} = 10\,A$; $i_{rms} = \frac{10}{\sqrt{2}} = 5\sqrt{2}\,A$ and $i_{av} = \frac{2}{®} \times 10 = 6.37\,A$

(iii) Frequency $¬ = \frac{100®}{2®} = 50\,Hz$ and $T = \frac{1}{50} = 0.02\ sec$

(iv) In purely L-circuit ¤ = 90° so p.f. cos¤ = 0

(v) Time difference T.D. $= \frac{T}{2®} \times \frac{®}{2} = \frac{T}{4}$.

Example: 19 An alternating voltage $E = 200\sqrt{2}\,\sin(100\ t)$ is connected to a 1 *microfaracd* capacitor through an ac ammeter. The reading of the ammeter shall be

(a) 10 mA (b) 20 mA (c) 40 mA (d) 80 mA

Solution: (b) Ammeter reads $r.m.s.$ value so $i_{rms} = \frac{V_{rms}}{X_C} = V_{rms} \times \mu \times C$

$$\Rightarrow i_{rms} = \left(\frac{200\sqrt{2}}{\sqrt{2}}\right) \times 100 \times (1 \times 10^{-6}) = 2 \times 10^{-2} = 20\ mA.$$

***Example*: 20** An 120 *volt* ac source is connected across a pure inductor of inductance 0.70 *henry*. If the frequency of the source is 60 *Hz*, the current passing through the inductor is

(a) 4.55 *amps* (b) 0.355 *amps* (c) 0.455 *amps* (d) 3.55 *amps*

Solution: (c) $i_{rms} = \frac{V_{rms}}{X_L} = \frac{V_{rms}}{2®¬L} = \frac{120}{2® \times 60 \times 0.7} = 0.455\ A$.

***Example*: 21** The frequency for which a $5 «F$ capacitor has a reactance of $\frac{1}{1000}$ *ohm* is given by

(a) $\frac{100}{®} MHz$ (b) $\frac{1000}{®} Hz$ (c) $\frac{1}{1000} Hz$ (d) 1000 *Hz*

Solution: (a) $X_C = \frac{1}{2®¬C} \Rightarrow ¬ = \frac{1}{2®X_C(C)} = \frac{1}{2® \times \frac{1}{1000} \times 5 \times 10^{-6}} = \frac{100}{®} MHz$.

***Example*: 22** Let frequency ¬ = 50 *Hz*, and capacitance *C* = 100«*F* in an ac circuit containing a capacitor only. If the peak value of the current in the circuit is 1.57 *A*. The expression for the instantaneous voltage across the capacitor will be

(a) $E = 50 \sin (100\ ®t - \frac{®}{2})$ (b) $E = 100 \sin (50\ ®t)$ (c) $E = 50 \sin (100\ ®t)$ (d) $E = 50 \sin (100\ ®t + \frac{®}{2})$

Solution: (a) Peak value of voltage $V_0 = i_0 X_C = \frac{i_0}{2®¬C} \Rightarrow \frac{1.57}{2 \times 3.14 \times 50 \times 100 \times 10^{-6}} = 50\ V$

Hence if equation of current $i = i_0 \sin µ\, t$ then in capacitive circuit voltage is $V = V_0 \sin\left(µ\, t - \frac{®}{2}\right)$

$$\Rightarrow V = 50\left(\sin 2® \times 50 t - \frac{®}{2}\right) = 50 \sin\left(100® \, t - \frac{®}{2}\right)$$

***Example*: 23** In an *LR*-circuit, the inductive reactance is equal to the resistance *R* of the circuit. An *e.m.f.* $E = E_0 \cos(µ\, t)$ is applied to the circuit. The power consumed in the circuit is

(a) $\frac{E_0^2}{R}$ (b) $\frac{E_0^2}{2R}$ (c) $\frac{E_0^2}{4R}$ (d) $\frac{E_0^2}{8R}$

Solution: (c) Power consumed $P = E_{rms}\, i_{rms} \cos ¤ = E_{rms}\left(\frac{E_{rms}}{Z}\right)\frac{R}{Z} \Rightarrow P = \frac{E_{rms}^2 R}{Z^2}$; where $Z = \sqrt{R^2 + X_L^2}$

Given $X_L = R \Rightarrow Z = \sqrt{2}R$ also $E_{rms} = \frac{E_0}{\sqrt{2}} \Rightarrow P = \frac{E_0^2}{4R}$.

***Example*: 24** A coil of resistance 300 *ohm* and self inductance 1.5 *henry* is connected to an ac source of frequency $\frac{100}{®} Hz$. The phase difference between voltage and current is

(a) 0^o (b) 30^o (c) 45^o (d) 60^o

Solution: (c) By using $\tan ¤ = \frac{X_L}{R} = \frac{2®¬L}{R} \Rightarrow \tan ¤ = \frac{2® \times \frac{100}{®} \times 1.5}{300} = 1 \Rightarrow ¤ = 45^o$.

***Example*: 25** The current and voltage in an ac circuit are respectively given by $i = \sin 314\, t$ and $e = 200 \sin (314\, t + ® / 3)$. If the resistance is 100Ω, then the reactance of the circuit is

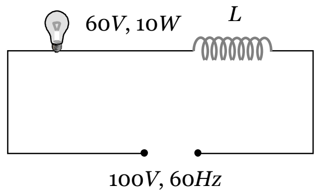
(a) $100/\sqrt{3}\,\Omega$ (b) $100\sqrt{3}\,\Omega$ (c) $200\,\Omega$ (d) $200\sqrt{3}\,\Omega$

Solution: (b) From the given equation $i_0 = 1A$ and $V_0 = 200\,volt$. Hence $Z = \frac{200}{1} = 200\,\Omega$ also $Z^2 = R^2 + X_L^2$

$\Rightarrow (200)^2 = (100)^2 + X_L^2 \Rightarrow X_L = 100\sqrt{3}\,\Omega$.

***Example*: 26** A bulb of 60 *volt* and 10 *watt* is connected with 100 *volt* of ac source with an inductance coil in series. If bulb illuminates with it's full intensity then value of inductance of coil is (ν= 60 *Hz*)

(a) 1.28 *H* (b) 2.15 *H* (c) 3.27 *H* (d) 3.89 *H*



Solution: (a) Resistance of the bulb $R = \frac{60 \times 60}{10} = 360\,\Omega$.

For maximum illumination, voltage across the bulb $V_{Bulb} = V_R = 60\,V$

By using $V = \sqrt{V_R^2 + V_L^2} \Rightarrow (100)^2 = (60)^2 + V_L^2 \Rightarrow V_L = 80\,V$

Current through the inductance (*L*) = Current through the bulb $= \frac{10}{60} = \frac{1}{6}A$

Also $V_L = iX_L = i(2\pi\nu L) \Rightarrow L = \frac{V_L}{(2\pi\nu)i} = \frac{80}{2 \times 3.14 \times 60 \times \frac{1}{6}} = 1.28\,H.$

***Example*: 27** When 100 *volt* dc is applied across a solenoid, a current of 1.0 *amp* flows in it. When 100 *volt* ac is applied across the same coil, the current drops to 0.5 *amp*. If the frequency of ac source is 50 *Hz* the impedance and inductance of the solenoid are

(a) 200 ohms and 0.5 henry (b)100 ohms and 0.86 henry

(c) 200 ohms and 1.0 henry (d)100 ohms and 0.93 henry

Solution: (a) When dc is applied $i = \frac{V}{R} \Rightarrow 1 = \frac{100}{R} \Rightarrow R = 100\Omega$. When ac is applied $i = \frac{V}{Z} \Rightarrow 0.5 = \frac{100}{Z} \Rightarrow Z = 200\Omega$.

Hence $Z = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + 4\pi^2\nu^2L^2} \Rightarrow (200)^2 = (100)^2 + 4\pi^2(50)^2L^2 \Rightarrow L = 0.55H.$

***Example*: 28** In an ac circuit, containing an inductance and a capacitor in series, the current is found to be maximum when the value of inductance is 0.5 henry and a capacitance of 8 μF. The angular frequency of the input ac voltage must be equal to

(a) 500 *rad/sec* (b) 5×10^4 *rad/sec* (c) 4000 *rad/sec* (d) 5000 *rad/sec*

Solution: (a) Current is maximum *i.e.* the given circuit is in resonance, and at resonance $\omega_0 = \frac{1}{\sqrt{LC}}$

$\Rightarrow \omega_0 = \frac{1}{\sqrt{0.5 \times 8 \times 10^{-6}}} = \frac{1}{2 \times 10^{-3}} = 500\,rad/sec.$

***Example*: 29** A resistance of 40 *ohm* and an inductance of 95.5 *millihenry* are connected in series in a 50 *cycles/second* ac circuit. The impedance of this combination is very nearly

(a) 30 *ohm* (b) 40*ohm* (c) 50 *ohm* (d) 60 *ohm*

Solution: (c) $X_L = 2\pi\nu L = 2 \times 3.14 \times 50 \times 95.5 \times 10^{-3} = 29.98\,\Omega \approx 30\Omega$

Impedance $Z = \sqrt{R^2 + X_L^2} = \sqrt{(40)^2 + (30)^2} = 50\,\Omega$

***Example*: 30** $\frac{2.5}{\pi}\,\mu F$ capacitor and 3000-*ohm* resistance are joined in series to an ac source of 200 *volt* and $50\,sec^{-1}$ frequency. The power factor of the circuit and the power dissipated in it will respectively

(a) 0.6, 0.06 W (b) 0.06, 0.6 W (c) 0.6, 4.8 W (d) 4.8, 0.6 W

Solution: (c) $Z = \sqrt{R^2 + \left(\frac{1}{2\pi\nu C}\right)^2} = \sqrt{(1000)^2 + \frac{1}{\left(2\pi \times 50 \times \frac{2.5}{\pi} \times 10^{-6}\right)^2}} \Rightarrow Z = \sqrt{(3000)^2 + (4000)^2} = 8 \times 10^3\,\Omega$

So power factor $\cos\phi = \frac{R}{Z} = \frac{3000}{5 \times 10^3} = 0.6$ and power $P = V_{rms} i_{rms} \cos\phi = \frac{V_{rms}^2 \cos\phi}{Z} \Rightarrow P = \frac{(200)^2 \times 0.6}{5 \times 10^3} = 4.8W$

***Example*: 31** A telephone wire of length 200 *km* has a capacitance of 0.014 μF per *km*. If it carries an ac of frequency 5 *kHz*, what should be the value of an inductor required to be connected in series so that the impedance of the circuit is minimum

(a) 0.35 *mH* (b) 35 *mH* (c) 3.5 *mH* (d) Zero

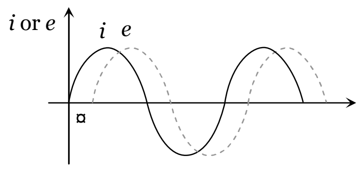
Solution: (a) Capacitance of wire $C = 0.014 \times 10^{-6} \times 200 = 2.8 \times 10^{-6}\,F = 2.8\,\mu F$

For impedance of the circuit to be minimum $X_L = X_C \Rightarrow 2\pi\nu L = \frac{1}{2\pi\nu C}$

$\Rightarrow L = \frac{1}{4\pi^2\nu^2 C} = \frac{1}{4(3.14)^2 \times (5 \times 10^3)^2 \times 2.8 \times 10^{-6}} = 0.35 \times 10^{-3}\,H = 0.35\,mH$

Tricky example: 3

When an ac source of e.m.f. $e = E_0 \sin(100\,t)$ is connected across a circuit, the phase difference between the e.m.f. *e* and the current *i* in the circuit is observed to be $\pi/4$, as shown in the diagram. If the circuit consists possibly only of *RC* or *LC* in series, find the relationship between the two elements



(a) $R = 1k\Omega, C = 10\,\mu F$

(b) $R = 1k\Omega, C = 1\,\mu F$

(c) $R = 1k\Omega, L = 10\,H$

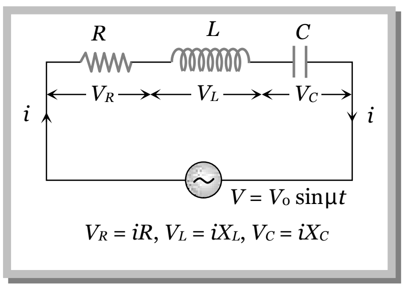
(d) $R = 1k\Omega, L = 1\,H$

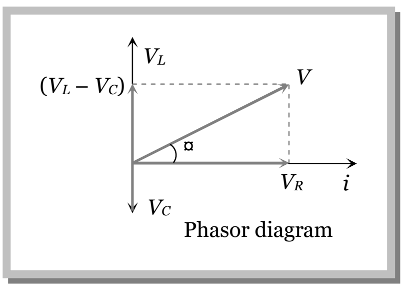
Solution : (a) As the current *i* leads the voltage by $\frac{\pi}{4}$, it is an *RC* circuit, hence $\tan\phi = \frac{X_C}{R} \Rightarrow \tan\frac{\pi}{4} = \frac{1}{\omega CR}$

$\Rightarrow \omega CR = 1$ as ω = 100 *rad/sec* $\Rightarrow CR = \frac{1}{100}\,sec^{-1}$.

From all the given options only option (a) is correct.

Series *RLC* Circuit





(1) **Equation of current :** $i = i_0 \sin(\mu t \pm ¤)$; where $i_0 = \frac{V_0}{Z}$

(2) **Equation of voltage :** From phasor diagram $V = \sqrt{V_R^2 + (V_L - V_C)^2}$

(3) **Impedance of the circuit :** $Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\mu L - \frac{1}{\mu C}\right)^2}$

(4) **Phase difference :** From phasor diagram $\tan ¤ = \frac{V_L - V_C}{V_R} = \frac{X_L - X_C}{R} = \frac{\mu L - \frac{1}{\mu C}}{R} = \frac{2®¬ L - \frac{1}{2®¬ C}}{R}$

(5) **If net reactance is inductive :** Circuit behaves as *LR* circuit

(6) **If net reactance is capacitive :** Circuit behave as *CR* circuit

(7) **If net reactance is zero :** Means $X = X_L - X_C = 0 \Rightarrow X_L = X_C$. This is the condition of resonance

(8) **At resonance** (series resonant circuit)

(i) $X_L = X_C \Rightarrow Z_{\min} = R$ *i.e.* circuit behaves as resistive circuit

(ii) $V_L = V_C \Rightarrow V = V_R$ *i.e.* whole applied voltage appeared across the resistance

(iii) Phase difference : $¤ = 0^o \Rightarrow$ p.f. = cos¤ = 1

(iv) Power consumption $P = V_{rms}\, i_{rms} = \frac{1}{2} V_0 i_0$

(v) Current in the circuit is maximum and it is $i_0 = \frac{V_0}{R}$

(vi) These circuit are used for voltage amplification and as selector circuits in wireless telegraphy.

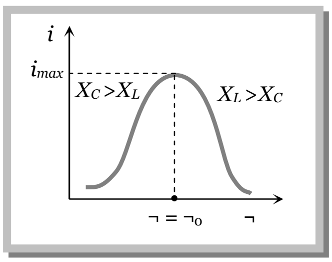
(9) **Resonant frequency** (Natural frequency)

At resonance $X_L = X_C \Rightarrow \mu_0 L = \frac{1}{\mu_0 C} \Rightarrow \mu_0 = \frac{1}{\sqrt{LC}} \frac{rad}{sec} \Rightarrow ¬_0 = \frac{1}{2®\sqrt{LC}} Hz$ (or *cps*)

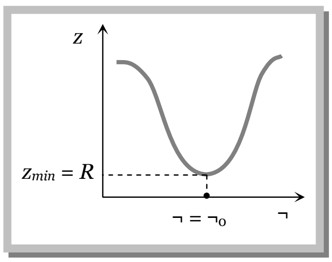
(Resonant frequency doesn't depend upon the resistance of the circuit)

(10) **Different graphs**

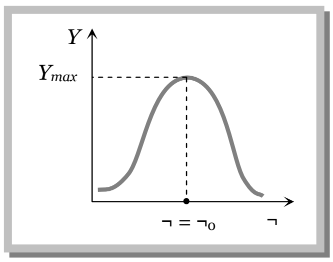
(i) *i* - ¬ graph



(ii) *z* - ¬ graph

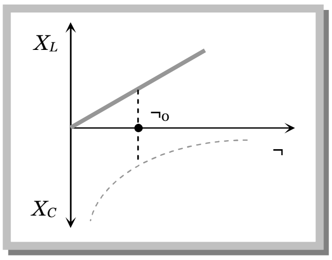


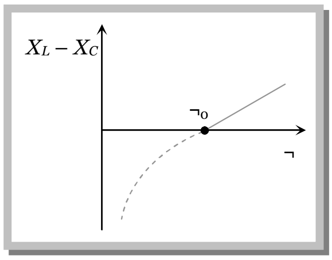
(iii) *Y* - ¬ graph



(iv) (X_L, X_C) - ¬ graph

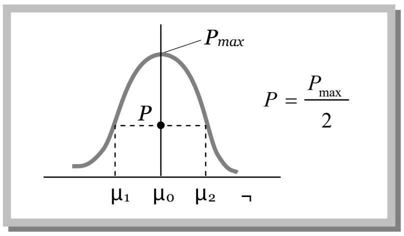
(v) *X* - ¬ graph





(11) **Half power frequencies and band width :** The frequencies at which the power in the circuit is half of the maximum power (The power at resonance), are called half power frequencies.

(i) The current in the circuit at half power frequencies (HPF) is $\frac{1}{\sqrt{2}}$ or 0.707 or 70.7% of maximum current (current at resonance).



(ii) There are two half power frequencies.

(a) $\mu_1 \rightarrow$ called lower half power frequency. At this frequency the circuit is capacitive.

(b) $\mu_2 \rightarrow$ called upper half power frequency. It is greater than μ_0. At this frequency the circuit is inductive.

(iii) Band width $(\Delta\mu)$: The difference of half power frequencies μ_1 and μ_2 is called band width $(\Delta\mu)$ and $\Delta\mu = \mu_2 - \mu_1$. For series resonant circuit it can be proved $\Delta\mu = \left(\frac{R}{L}\right)$

(12) **Quality factor (Q - factor) of series resonant circuit**

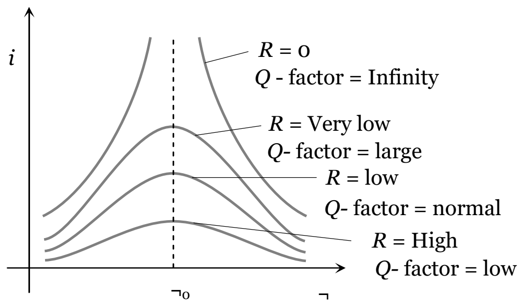
The characteristic of a series resonant circuit is determined by the quality factor (Q - factor) of the circuit.

It defines sharpness of i - ¬ curve at resonance when Q - factor is large, the sharpness of resonance curve is more and vice-versa.

Q - factor also defined as follows

$$Q\text{ - factor} = 2® \times \frac{\text{Maximum energy stored}}{\text{Energy dissipation}} = \frac{2®}{T} \times \frac{\text{Maximum energy stored}}{\text{Mean power dissipated}} = \frac{\text{Resonant frequency}}{\text{Band width}} = \frac{\mu_0}{\Delta\mu}$$

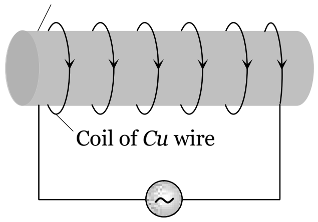
$$Q\text{ - factor} = \frac{V_L}{V_R} \text{ or } \frac{V_C}{V_R} = \frac{\mu_0 L}{R} \text{ or } \frac{1}{\mu_0 CR} \Rightarrow Q\text{ - factor} = \frac{1}{R}\sqrt{\frac{L}{C}}$$



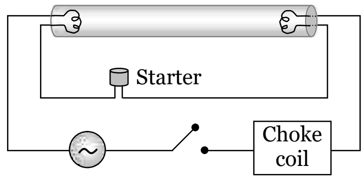
Resonance curve

Choke Coil

Choke coil (or ballast) is a device having high inductance and negligible resistance. It is used to control current in ac circuits and is used in fluorescent tubes. The power loss in a circuit containing choke coil is least.



Choke coil



Application of choke coil

(1) It consist of a *Cu* coil wound over a soft iron laminated core.

(2) Thick *Cu* wire is used to reduce the resistance (R) of the circuit.

(3) Soft iron is used to improve inductance (L) of the circuit.

(4) The inductive reactance or effective opposition of the choke coil is given by $X_L = \omega L = 2\pi\nu L$

(5) For an ideal choke coil $r = 0$, no electric energy is wasted *i.e.* average power $P = 0$.

(6) In actual practice choke coil is equivalent to a $R - L$ circuit.

(7) Choke coil for different frequencies are made by using different substances in their core.

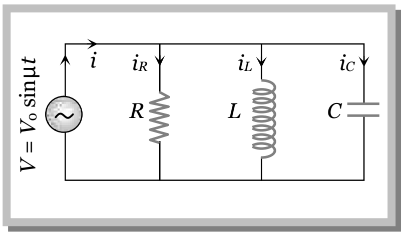
For low frequency L should be large thus iron core choke coil is used. For high frequency ac circuit, L should be small, so air cored choke coil is used.

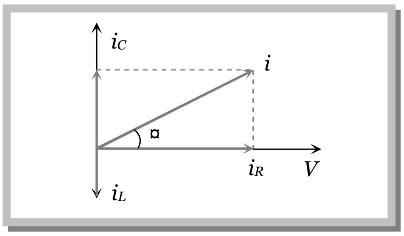
Parallel *RLC* Circuits

$$i_R = \frac{V_0}{R} = V_0 G$$

$$i_L = \frac{V_0}{X_L} = V_0 S_L$$

$$i_C = \frac{V_0}{X_C} = V_0 S_C$$





(1) **Current and phase difference**

From phasor diagram current $i = \sqrt{i_R^2 + (i_C - i_L)^2}$ and phase difference $\phi = \tan^{-1}\frac{(i_C - i_L)}{i_R} = \tan^{-1}\frac{(S_C - S_L)}{G}$

(2) **Admittance (*Y*) of the circuit**

From equation of current $\frac{V_0}{Z} = \sqrt{\left(\frac{V_0}{R}\right)^2 + \left(\frac{V_0}{X_L} - \frac{V_0}{X_C}\right)^2} \Rightarrow$

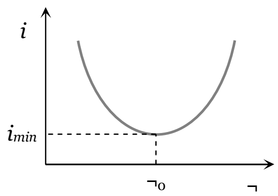
$$\frac{1}{Z} = Y = \sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2} = \sqrt{G^2 + (S_L - S_C)^2}$$

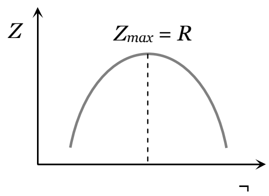
(3) **Resonance**

At resonance (i) $i_C = i_L \Rightarrow i_{\min} = i_R$ (ii) $\frac{V}{X_C} = \frac{V}{X_L} \Rightarrow S_C = S_L \Rightarrow \Sigma S = 0$

(iii) $Z_{\max} = \frac{V}{i_R} = R$ (iv) ¤ $= 0 \Rightarrow$ p.f. $= \cos$¤ $= 1 =$ maximum (v) Resonant frequency $\Rightarrow$ ¬ $= \frac{1}{2®\sqrt{LC}}$

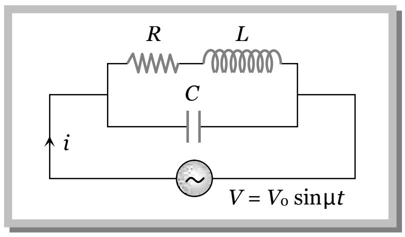
(4) **Current resonance curve**





(5) **Parallel *LC* circuits**

If inductor has resistance (R) and it is connected in parallel with capacitor as shown



(i) **At resonance**

(a) $Z_{\max} = \frac{1}{Y_{\min}} = \frac{L}{CR}$

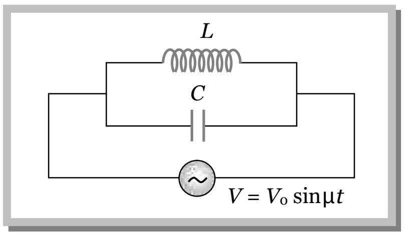
(b) Current through the circuit is minimum and $i_{\min} = \frac{V_0 CR}{L}$

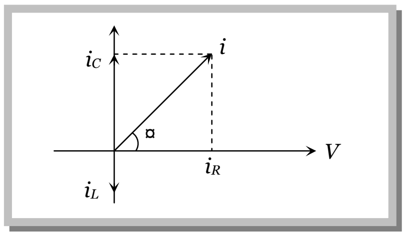
(c) $S_L = S_C \Rightarrow \frac{1}{X_L} = \frac{1}{X_C} \Rightarrow X = \infty$

(d) Resonant frequency $µ_0 = \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}\ \frac{rad}{sec}$ or $¬_0 = \frac{1}{2®}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}\ Hz$ (Condition for parallel resonance is $R < \sqrt{\frac{L}{C}}$)

(e) Quality factor of the circuit $= \frac{1}{CR} \cdot \frac{1}{\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}}$. In the state of resonance the quality factor of the circuit is equivalent to the current amplification of the circuit.

(ii) **If inductance has no resistance :** If $R = 0$ then circuit becomes parallel LC circuit as shown





Condition of resonance : $i_C = i_L \Rightarrow \frac{V}{X_C} = \frac{V}{X_L} \Rightarrow X_C = X_L$. At resonance current *i* in the circuit is zero and impedance is infinite. Resonant frequency : $\nu_0 = \frac{1}{2\pi\sqrt{LC}}\,Hz$

Note : ❑ At resonant frequency due to the property of rejecting the current, parallel resonant circuit is also known as anti-resonant circuit or rejecter circuit.

❑ Due to large impedance, parallel resonant circuits are used in radio.

Concepts

- *Series RLC circuit also known as acceptor circuit (or tuned circuits or filter circuit) as at resonance it most readily accepts that current out of many currents whose frequency is equal to it's natural frequency.*
- *The choke coil can be used only in ac circuits not in dc circuits, because for dc frequency $\nu = 0$ hence $X_L = 2\pi\nu L = 0$, only the resistance of the coil remains effective which too is almost zero.*
- *Choke coil is based on the principle of wattless current.*

Example

Example: 32 In a series circuit $R = 300\,\Omega$, $L = 0.9\,H$, $C = 2.0\,\mu F$ and $\omega = 1000\,rad/sec$. The impedance of the circuit is

(a) 1300 Ω (b) 900 Ω (c) 500 Ω (d) 400 Ω

Solution: (c) $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = \sqrt{(300)^2 + \left(1000 \times 0.9 - \frac{1}{1000 \times 2 \times 10^{-6}}\right)^2} \Rightarrow Z = \sqrt{(300)^2 + (400)^2} = 500\,\Omega$.

Example: 33 In *LCR* circuit, the capacitance is changed from *C* to 4*C*. For the same resonant frequency, the inductance should be changed from *L* to

(a) 2*L* (b) *L*/2 (c) *L*/4 (d) 4*L*

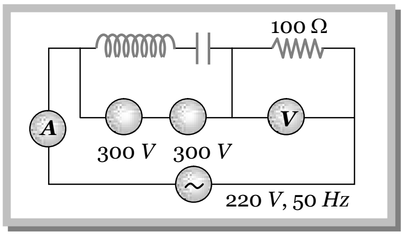
Solution: (c) By using $\nu_0 = \frac{1}{2\pi\sqrt{LC}} \Rightarrow L \propto \frac{1}{C} \Rightarrow \frac{L'}{L} = \frac{C}{C'} = \frac{C}{4C} \Rightarrow L' = \frac{L}{4}$.

Example: 34 An *LCR* series circuit is connected to an external *e.m.f.* $e = 200\sin 100\pi t$. The values of the capacitance and resistance in the circuit are $2\mu F$ and $100\,\Omega$ respectively. The amplitude of the current in the circuit will be maximum when the inductance is

(a) 100 *Henry* (b) $50/\pi^2$ *Henry* (c) $100\,\pi$ *Henry* (d) $100 \times \pi^2$ *Henry*

Solution: (b) Current will be maximum in resonance *i.e.* $X_L = X_C \Rightarrow 100\pi \times L = \frac{1}{100\pi \times 2 \times 10^{-6}} \Rightarrow L = \frac{50}{\pi^2}\,Henry$.

Example: 35 In the circuit shown below, what will be the readings of the voltmeter and ammeter



(a) 800 *V*, 2*A*

(b) 300 *V*, 2*A*

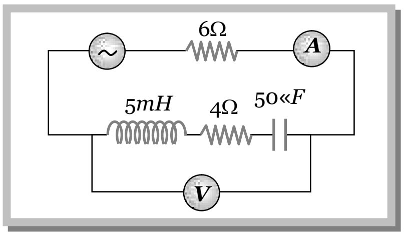
(c) 220 *V*, 2.2 *A*

(d) 100 *V*, 2*A*

Solution: (c) $V_L = V_C$; This is the condition of resonance and in resonance $V = V_R = 220\,V$.

In the condition of resonance current through the circuit $i = \frac{V_{rms}}{R} = \frac{220}{100} = 2.2\,A$.

***Example*: 36** In the circuit shown in the figure the ac source gives a voltage $V = 20\cos(2000\ t)$. Neglecting source resistance, the voltmeter and ammeter reading will be



(a) $0V, 0.47A$

(b) $1.68V, 0.47A$

(c) $0V, 1.4A$

(d) $5.6V, 1.4A$

Solution: (d) $X_L = \mu L = 2000 \times 5 \times 10^{-3} = 10\ \Omega$ and $X_C = \dfrac{1}{2000 \times 50 \times 10^{-6}} = 10\Omega$

Total impedance of the circuit $= 6 + \sqrt{(R)^2 + (X_L - X_C)^2} = 6 + \sqrt{(4)^2 + 0} = 10\Omega$

Ammeter reads *r.m.s.* current so it's value $i_{rms} = \dfrac{V_{rms}}{\text{Total impedance}} = \dfrac{20/\sqrt{2}}{10} = \sqrt{2} = 1.41A$

Since $X_L = X_C$; this is the condition of resonance and in this condition $V = V_R = iR = 1.4 \times 4 = 5.6\ V$.

***Example*: 37** In a series resonant *LCR* circuit, if *L* is increased by 25% and *C* is decreased by 20%, then the resonant frequency will

(a) Increase by 10% (b) Decrease by 10% (c) Remain unchanged (d) Increase by 2.5 %

Solution: (c) $\nu_0 = \dfrac{1}{2\pi\sqrt{LC}} \Rightarrow$ In this question $L' = L + 25\%$ of $L = L + \dfrac{L}{4} = \dfrac{5L}{4}$ and $C' = C - 20\%$ of $C = C - \dfrac{C}{5} = \dfrac{4C}{5}$

Hence $\nu_0' = \dfrac{1}{2\pi\sqrt{L'C'}} = \dfrac{1}{2\pi\sqrt{\dfrac{5L}{4} \times \dfrac{4C}{5}}} = \dfrac{1}{2\pi\sqrt{LC}} = \nu_0$

***Example*: 38** The self inductance of a choke coil is 10 *mH*. When it is connected with a 10*V* dc source, then the loss of power is 20 *watt*. When it is connected with 10 *volt* ac source loss of power is 10 *watt*. The frequency of ac source will be

(a) 50 *Hz* (b) 60 Hz (c) 80 *Hz* (d) 100 *Hz*

Solution: (c) With dc : $P = \dfrac{V^2}{R} \Rightarrow R = \dfrac{(10)^2}{20} = 5\,\Omega$; With ac : $P = \dfrac{V_{rms}^2 R}{Z^2} \Rightarrow Z^2 = \dfrac{(10)^2 \times 5}{10} = 50\,\Omega^2$

Also $Z^2 = R^2 + 4\pi^2\nu^2L^2 \Rightarrow 50 = (5)^2 + 4(3.14)^2\nu^2(10 \times 10^{-3})^2 \Rightarrow \nu = 80\ Hz$.

***Example*: 39** An ideal choke takes a current of 8*A* when connected to an ac source of 100 *volt* and 50*Hz*. A pure resistor under the same conditions takes a current of 10*A*. If two are connected in series to an ac supply of 100*V* and 40 *Hz*, then the current in the series combination of above resistor and inductor is

(a) 10*A* (b) 8*A* (c) $5\sqrt{2}\ amp$ (d) $10\sqrt{2}\ amp$

Solution: (c) $X_L = \dfrac{V_{rms}}{i_{rms}} = \dfrac{100}{8} = 2\pi \times 50 \times L \Rightarrow L = \dfrac{1}{8\pi}\ Henry$ and $R = \dfrac{100}{10} = 10\Omega$

So impedance of the series *RC* circuit at a frequency of 40 *Hz* is $Z = \sqrt{\left(\dfrac{1}{8\pi} \times 2\pi \times 40\right)^2 + 10^2} = 10\sqrt{2}$

Hence current in the *RC* circuit now $i = \dfrac{E}{Z} = \dfrac{100}{10\sqrt{2}} = \dfrac{10}{\sqrt{2}} = 5\sqrt{2}A$.

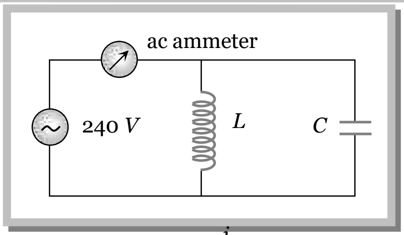
***Example*: 40** In the following circuit diagram inductive reactance of inductor is 24Ω and capacitive reactance of capacitor is 48Ω, then reading of ammeter will be

(a) 5 A

(b) 2.4 A

(c) 2.0 A

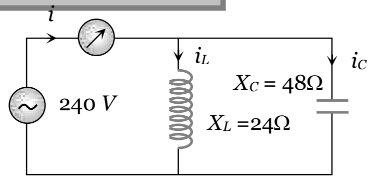
(d) 10 A



Solution: (a) $i_L = \frac{240}{24} = 10\,A$

$i_C = \frac{240}{48} = 5\,A$

Hence $i = i_L - i_C = 5\,A$



Tricky example: 4

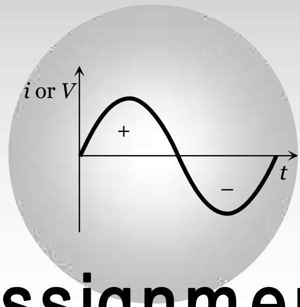
In an LCR circuit $R = 100$ *ohm*. When capacitance C is removed, the current lags behind the voltage by $\text{®}/3$. When inductance L is removed, the current leads the voltage by $\text{®}/3$. The impedance of the circuit is

(a) 50 *ohm* (b) 100 *ohm* (c) 200 *ohm* (d) 400 *ohm*

Solution : (b) When C is removed circuit becomes RL circuit hence $\tan \frac{\text{®}}{3} = \frac{X_L}{R}$ .....(i)

When L is removed circuit becomes RC circuit hence $\tan \frac{\text{®}}{3} = \frac{X_C}{R}$ .....(ii)

From equation (i) and (ii) we obtain $X_L = X_C$. This is the condition of resonance and in resonance $Z = R = 100\Omega$.



Assignment

Alternating Current, Voltage and Power

Basic Level

1. Alternating current can not be measured by dc ammeter because

(a) Average value of current for complete cycle is zero (b) ac changes direction

(c) ac can not pass through dc ammeter (d) dc Ammeter will get damaged

2. The peak value of an ac emf E given by $E = E_0$ cosμ t is 10 V and its frequency is 50Hz. At a time $t = \frac{1}{600} S$, the instantaneous value of emf is

(a) 10 V (b) $5\sqrt{3}\ V$ (c) 5V (d) 1 V

3. A lamp consumes only 50% of peak power in an ac circuit. What is the phase difference between the applied voltage and the circuit current

(a) $\frac{®}{6}$ (b) $\frac{®}{3}$ (c) $\frac{®}{4}$ (d) $\frac{®}{2}$

4. For high frequency, a capacitor offers

(a) More reactance (b) Less reactance (c) Zero reactance (d) Infinite reactance

5. The power loss in an ac circuit will be minimum, when

(a) Resistance is high, inductance is high (b) Resistance is high, inductance is low

(c) Resistance is low, inductance is low (d) Resistance is low, inductance is high

6. An ac source is rated at 220 V, 50 Hz. The time taken for voltage to change from its peak value to zero is

(a) 50 *sec* (b) 0.02 *sec* (c) 5 *sec* (d) 5×10^{-3} *sec*

7. The *r.m.s.* value of an ac of $50\,Hz$ is 10 amp. The time taken by the alternating current in reaching from zero to maximum value and the peak value will be

(a) 2×10^{-2} *sec* and $14.14\,amp$ (b) 1×10^{-2} *sec* and $7.07\,amp$

(c) 5×10^{-3} *sec* and $7.07\,amp$ (d) 5×10^{-3} *sec* and $14.14\,amp$

8. The ratio of peak value and *r.m.s.* value of an alternating current is

(a) 1 (b) $\frac{1}{2}$ (c) $\sqrt{2}$ (d) $1/\sqrt{2}$

9. An alternating voltage is represented as $E = 20 \sin 300\,t$. The average value of voltage over one cycle will be

(a) Zero (b) 10 *volt* (c) $20\sqrt{2}\,volt$ (d) $\frac{20}{\sqrt{2}}volt$

10. If an ac main supply is given to be 220V. What would be the average *e.m.f.* during a positive half cycle

(a) 198V (b) 386V (c) 256V (d) None of these

11. The inductive reactance of an inductor of $\frac{1}{®}$ *henry* at 50 Hz frequency is

(a) $\frac{50}{®}ohm$ (b) $\frac{®}{50}ohm$ (c) 100 *ohm* (d) 50 *ohm*

12. The frequency of an alternating voltage is 50 *cycles/sec* and its amplitude is 120 V. Then the *r.m.s.* value of voltage is

(a) 101.3 V (b) 84.8 V (c) 70.7 V (d) 56.5 V

13. An ac supply gives 30 V *r.m.s.* which passes through a 10 Ω resistance. The power dissipated in it is

(a) $90\sqrt{2}W$ (b) 90 W (c) $45\sqrt{2}W$ (d) 45 W

14. The reactance of a coil when used in the domestic ac power supply (220 *volts.* 50 cycles per second) is 50 *ohms*. The inductance of the coil is nearly

(a) 2.2 *henry* (b) 0.22 *henry* (c) 1.6 *henry* (d) 0.16 *henry*

15. The capacity of a pure capacitor is 1 *farad*. In dc circuits, its effective resistance will be

(a) Zero (b) Infinite (c) 1 *ohm* (d) 1/2 *ohm*

16. If instantaneous current is given by $i = 4\cos(\text{µ}\ t + \text{¤})$ *amperes*, then the *r.m.s.* value of current is

(a) 4 *amperes* (b) $2\sqrt{2}$ *amperes* (c) $4\sqrt{2}$ *amperes* (d) Zero *amperes*

17. The potential difference V across the current i flowing through an instrument in an ac circuit of frequency f are given by $V = 5\cos \text{µ}t$ volts and $i = 2\ \sin\ \text{µ}t$ amperes (where $\text{µ} = 2\text{®}f$). The power dissipated in the instrument is

(a) Zero (b) 10 *watt* (c) 5 *watt* (d) 2.5 *watt*

18. In an ac circuit with voltage V and current i, the power dissipated is

(a) Vi (b) $\frac{1}{2}Vi$

(c) $\frac{1}{\sqrt{2}}Vi$ (d) Depends on the phase between V and i

19. In an ac circuit, the instantaneous values of *e.m.f.* and current are $e = 200\ \sin\ 314\,t\ volt$ and $i = \sin\left(314\,t + \frac{\text{®}}{3}\right) amp$. The average power consumed in *watt* is

(a) 200 (b) 100 (c) 50 (d) 25

20. An electric lamp is connected to 220 V, 50 Hz supply. Then the peak value of voltage is

(a) 210 V (b) 211 V (c) 311 V (d) 320 V

21. The voltage of domestic ac is 220 *volt*. What does this represent

(a) Mean voltage (b) Peak voltage

(c) Root mean voltage (d) Root mean square voltage

22. If a current i given by $i_0\sin\left(\text{µ}\ t - \frac{\text{®}}{2}\right)$ flows in an ac circuit across which an ac potential of $E = E_0\sin \text{µ}\ t$ has been applied, then the power consumption P in the circuit will be

(a) $P = \frac{E_0 i_0}{\sqrt{2}}$ (b) $P = \sqrt{2}E_0 i_0$ (c) $P = \frac{E_0 i_0}{2}$ (d) $P = 0$

23. What will be the phase difference between virtual voltage and virtual current, when the current in the circuit is wattless

(a) 90^o (b) 45^o (c) 180^o (d) 60^o

24. An alternating current is given by the equation $i = i_1\cos \text{µ}t + i_2\sin \text{µ}t$. The *r.m.s.* current is given by

(a) $\frac{1}{\sqrt{2}}(i_1 + i_2)$ (b) $\frac{1}{\sqrt{2}}(i_1 + i_2)^2$ (c) $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$ (d) $\frac{1}{2}(i_1^2 + i_2^2)^{1/2}$

25. In general in an alternating current circuit

(a) Average value of current is zero (b) Average value of square of current is zero

(c) Average power dissipation is zero (d) Phase difference between voltage and current is zero

26. A generator produces a voltage that is given by $V = 240\ \sin 120\,t$, where t is in seconds. The frequency and *r.m.s.* voltage are

(a) 60 Hz and 240 V (b) 19 Hz and 120 V (c) 19 Hz and 170 V (d) 754 Hz and 70 V

27. The ratio of the mean value over half cycle to the *r.m.s.* value of an ac is

(a) $2:\text{®}$ (b) $2\sqrt{2}:\text{®}$ (c) $\sqrt{2}:\text{®}$ (d) $\sqrt{2}:1$

28. An ac voltage $e = 240 \sin 2® \times 50 \times t$ has a peak-to-peak value of

(a) 240 *V* (b) $240\sqrt{2}V$ (c) 480 *V* (d) $240/\sqrt{2}V$

29. The time required for a 50 *Hz* alternating current to increase from zero to 70.7% of its peak value is

(a) 2.5 *ms* (b) 10 *ms* (c) 20 *ms* (d) 14.14 *ms*

30. An ac circuit draws 5*A* at 160 *V* and the power consumption is 600 *W*. Then the power factor is

(a) 1 (b) 0.75 (c) 0.50 (d) Zero

31. What is the equation of an alternating current of frequency 60 *Hz* and *r.m.s.* value 10 *A* ? Given that current *i* = 0 at *t* = 0

(a) $i = 10 \sin (120 ®t)$ (b) $i = 10 \cos (120 ®t)$ (c) $i = 10\sqrt{2} \sin(120 ®t)$ (d) $i = 10\sqrt{2} \cos(120 ®t)$

32. Indicate the correct statements

(1) 50 *Hz* ac changes its direction 100 times in a second

(2) A 200 *V*, 60 *W* bulb can withstand upto 281*V* dc

(3) In ac circuits voltage across an element may greater than supply

(4) To increase the frequency of ac number of poles should be increased

(a) 1, 2, 3 (b) 2, 3, 4 (c) 3, 4, 1 (d) All

33. If instantaneous value of current is $i = 10 \sin (314\, t)\, A$ then the average current for the half cycle will be

(a) 10 *A* (b) 7.07 *A* (c) 6.37 *A* (d) 3.53 *A*

34. The voltage of an ac source varies with time according to the equation *V* = 120 sin 100®*t* cos(100 ®*t*) then

(a) The peak voltage of the source is 120 *volts* (b) The peak voltage of the source is 60 *volts*

(c) The peak voltage of the source is $\frac{120}{\sqrt{2}}$ *volts* (d) The frequency of the source is 50 *Hz*

35. An ac source is of 120 *volts* – 60 *Hz*. the value of the voltage after $\frac{1}{720}$ *sec* from the start will be

(a) 84.8 *volts* (b) 42.4 *volts* (c) 106.8 *volts* (d) 20.2 *volts*

36. The phase difference between the alternating current and voltage represented by the following equation $i = i_0 \sin µ t$, $E = E_0 \cos\left(µ t + \frac{®}{3}\right)$, will be

(a) $\frac{®}{3}$ (b) $\frac{4®}{3}$ (c) $\frac{®}{2}$ (d) $\frac{5®}{6}$

37. What should be the value of capacitive reactance for a capacitance of 10^{-6} *farad* while the angular frequency of alternating current becomes 10^6 *rad/sec*

(a) 2 Ω (b) 1 Ω (c) 100 Ω (d) 10 Ω

38. The reactance of a capacitor is X_1 for frequency n_1 and X_2 for frequency n_2 then $X_1 : X_2$ is

(a) 1 : 1 (b) $n_1 : n_2$ (c) $n_2 : n_1$ (d) $n_1^2 : n_2^2$

39. By how much percentage the impedance be increased in an ac circuit keeping the resistance constant so that the power factor changes from $\frac{1}{2}$ to $\frac{1}{4}$

(a) 100% (b) 200% (c) 50% (d) 25%

40. If the *r.m.s.* value of ac is i_{rms} then peak to peak value is

(a) $\sqrt{2}\, i_{rms}. / 2$ (b) $i_{rms} / \sqrt{2}$ (c) $2\sqrt{2}\, i_{rms}$ (d) $2\, i_{rms}$

Advance Level

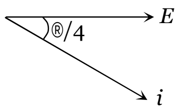
41. A group of electric lamps having a total power rating of 1000 *watt* is supplied by an ac voltage $E = 200\ \sin(310\,t + 60^o)$. Then the *r.m.s.* value of the circuit current is

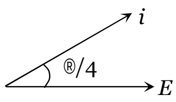
(a) 10 A (b) $10\sqrt{2}\ A$ (c) 20 A (d) $20\sqrt{2}\ A$

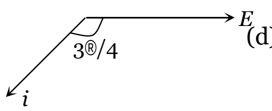
42. The instantaneous values of alternating current and *e.m.f.* in an ac circuit are $i = \frac{1}{\sqrt{2}} \sin 314\,t.A$ and $E = \sqrt{2}\ \sin(314\,t - \frac{®}{6})$ *volt* respectively. The phase difference between E and i will be

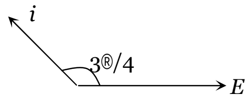
(a) $\frac{®}{6}$ *radian* (b) $-\frac{®}{6}$ *radian* (c) $\frac{®}{3}$ *radian* (d) $-\frac{®}{3}$ *radian*

43. In a certain circuit $E = 200\ \cos(314\ t)$ and $i = \sin(314\ t + ® / 4)$. Their vector representation is

(a) 

(b) 

(c) 

(d) 

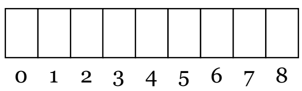
44. In a certain circuit current changes with time according to $i = 2\sqrt{t}$. *r.m.s.* value of current between $t = 2$ to $t = 4s$ will be

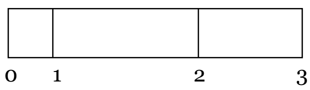
(a) $3A$ (b) $3\sqrt{3}A$ (c) $2\sqrt{3}A$ (d) $(2 - \sqrt{2})A$

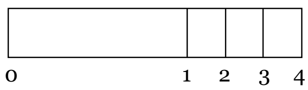
45. An ac current is given by $i = i_0 + i_1 \sin \mu t$ then its *r.m.s.* value will be

(a) $\sqrt{i_0^2 + 0.5 i_1^2}$ (b) $\sqrt{i_1^2 + 0.5 i_0^2}$ (c) 0 (d) $i_0 / \sqrt{2}$

46. The correctly marked ammeter for ac current is shown in

(a) 

(b) 

(c) 

(d) None of these

47. Heat is produced in a wire by allowing the ac of peak value 14 A to flow in it. If dc of i ampere is used for producing the same amount of heat, then the value of I will be approximately

(a) 7 A (b) 10 A (c) 12 A (d) 14 A

48. If the instantaneous value of current is i = 10 sin 314t *amp*. then the average value of i^2 will be

(a) 100 (b) 70.7 (c) 50.0 (d) 25.0

49. A square wave current switching rapidly between 0.4 A and – 0.4 A is passed through an ac ammeter. The reading of the ammeter will be

(a) 0 A (b) $0.4\sqrt{2}A$ (c) 0.8 A (d) 0.4 A

50. Match the following

Currents	**r.m.s. values**
(1) $x_0 \sin \mu\ t$	(i) x_0
(2) $x_0 \sin \mu\ t \cos \mu\ t$	(ii) $\frac{x_0}{\sqrt{2}}$
(3) $x_0 \sin \mu\ t + x_0 \cos \mu\ t$	(iii) $\frac{x_0}{(2\sqrt{2})}$

(a) 1. (i), 2. (ii), 3. (iii) (b) 1. (ii), 2. (iii), 3. (i) (c) 1. (i), 2. (iii), 3. (ii) (d) None of these

51. Consider two cables A and B. In A, a single copper wire of cross-sectional area x is used, while in B, a bunch of 15 wires each of cross-sectional are $\frac{x}{15}$ is used. Then for the flow of high frequency ac, the

(a) Cable A is more suitable than B (b) Cable B is more suitable then A

(c) Both cables are equally suitable (d) Nothing specific can be predicted

Different ac circuits (Series)

Basic Level

52. In an *LCR* series ac circuit, the voltage across each of the components, *L, C* and *R* is 50 *V*. The voltage across the *LC* combination will be

(a) 100 *V* (b) $50\sqrt{2}\ V$ (c) 50 *V* (d) 0 *V* (zero)

53. In a *LCR* circuit capacitance is changed from *C* to 2*C*. For the resonant frequency to remain unchanged, the inductance should be changed from *L* to

(a) $L/2$ (b) $2\,L$ (c) $4\,L$ (d) $L/4$

54. Radio frequency choke uses core of

(a) Air (b) Iron (c) air and iron (d) None of these

55. In *LR* circuit, resistance is 8Ω and inductive reactance is 6Ω, then impedance is

(a) 2Ω (b) 14Ω (c) 4Ω (d) 10Ω

56. The current in *LCR* series circuit will be maximum when μ is

(a) As large as possible (b) Equal to natural frequency of *LCR* system

(c) $\sqrt{LC}$ (d) $\sqrt{\frac{1}{LC}}$

57. A coil has $L = 0.04\ H$ and $R = 12\Omega$. When it is connected to 220 *V*, 50 *Hz* supply the current flowing through the coil, in amperes is

(a) 10.7 (b) 11.7 (c) 14.78 (d) 12.7

58. In a ac circuit of capacitance the current from potential is

(a) Forward (b) Backward (c) Both are in the same phase (d) None of these

59. There is a 5 Ω resistance in an ac circuit. Inductance of 0.1 *H* is connected with it in series. if equation of ac *e.m.f.* is $5\sin 50t$ then the phase difference between current and *e.m.f.* is

(a) $\frac{®}{2}$ (b) $\frac{®}{6}$ (c) $\frac{®}{4}$ (d) 0

60. A coil of 200 Ω resistance and 1.0 *H* inductance is connected to an ac source of frequency $200/2®Hz$. Phase angle between potential and current will be

(a) 30^o (b) 90^o (c) 45^o (d) 0^o

61. A 280 *ohm* electric bulb is connected to 200 *V* electric line. The peak value of current in the bulb will be

(a) About one ampere (b) Zero (c) About two ampere (d) About four ampere

62. An inductive circuit contains a resistance of 10 *ohm* and an inductance of 2.0 *henry*. If an ac voltage of 120 *volt* and frequency of 60 *Hz* is applied to this circuit, the current in the circuit would be nearly

(a) 0.32 *amp* (b) 0.16 *amp* (c) 0.48 *amp* (d) 0.80 *amp*

63. The power factor of an ac circuit having resistance (*R*) and inductance (*L*) connected in series and an angular velocity μ is

(a) $R/μL$ (b) $R/(R^2+μ^2L^2)^{1/2}$ (c) $μL/R$ (d) $R/(R^2-μ^2L^2)^{1/2}$

64. Reactance of a capacitor of capacitance $C«F$ for ac frequency $\frac{400}{®}Hz$ is 25 Ω. The value *C* is

(a) $50\,«F$ (b) $25\,«F$ (c) $100\,«F$ (d) $75\,«F$

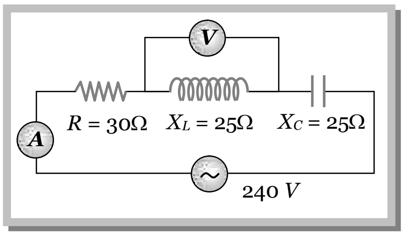
65. A circuit has resistance of 11 Ω an inductive reactance of 25 Ω and a capacitate reactance of 18Ω. It is connected to an ac source of 260 *V* and 50 *Hz*. The current through the circuit (in amperes) is

(a) 11 (b) 15 (c) 18 (d) 20

66. In a circuit, the current lags behind the voltage by a phase difference of $® / 2$. The circuit contains which of the following

(a) Only R (b) Only L (c) Only C (d) R and C

67. In the circuit shown in fig. neglecting source resistance the voltmeter and ammeter reading will respectively will be



(a) 0V, 3A

(b) 150 V, 3A

(c) 150 V, 6A

(d) 0V, 8A

68. A resistance of 40 *ohm* and an inductance of 95.5 *millihenry* are connected in series in a 50 *cycle/sec* ac circuit. The impedance of this combination is very nearly

(a) 30 *ohm* (b) 40 *ohm* (c) 50 *ohm* (d) 60 *ohm*

69. In an ac circuit, the power factor

(a) Is zero when the circuit contains an ideal resistance only

(b) Is unity when the circuit contains an ideal resistance only

(c) Is zero when the circuit contains an ideal inductance only

(d) Is unity when the circuit contains an ideal inductance only

70. The value of the current through an inductance of 1H and of negligible resistance, when connected through an ac source of 200 V and 50 Hz is

(a) 0.637 A (b) 1.637 A (c) 2.637 A (d) 3.637 A

71. An inductance L having a resistance R is connected to an alternating source of angular frequency μ . The quality factor (Q) of the inductance is

(a) $\frac{R}{\mu L}$ (b) $\left(\frac{R}{\mu L}\right)^{1/2}$ (c) $\left(\frac{\mu L}{R}\right)^{2}$ (d) $\frac{\mu L}{R}$

72. In an ac circuit the reactance of a coil is $\sqrt{3}$ times its resistance, the phase difference between the voltage across the coil to the current through the coil will be

(a) $® / 3$ (b) $® / 2$ (c) $® / 4$ (d) $® / 6$

73. Power factor is maximum in an LCR circuit when

(a) $X_L = X_C$ (b) $R = 0$ (c) $X_L = 0$ (d) $X_C = 0$

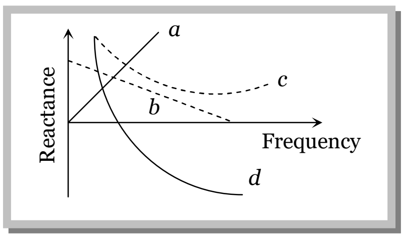
74. A coil of inductance L has an inductive reactance of X_L in an A.C circuit in which the effective current is i. The coil is made from a superconducting material and has no resistance. The rate at which power is dissipated in the coil is

(a) 0 (b) LX_L (c) $i^2 X_L$ (d) LX_L^2

75. The phase difference between the current and voltage at resonance in RLC series circuit is

(a) 0 (b) $\frac{®}{2}$ (c) $®$ (d) $-®$

76. Which of the following plots may represent the reactance of a series LC combination



(a) a

(b) b

(c) c

(d) d

77. A series ac circuit consist of an inductor and a capacitor. The inductance and capacitance is respectively 1 *henry* and 25 «*F*. If the current is maximum in circuit then angular frequency will be

(a) 200 (b) 100 (c) 50 (d) 200/2®

78. An alternating *e.m.f.* of frequency ¬ $\left(=\frac{1}{2® \sqrt{LC}}\right)$ is applied to a series *LCR* circuit. For this frequency of the applied *e.m.f.*

(a) The circuit is at resonance and its impedance is made up only of a reactive part

(b) The current in the circuit is in phase with the applied *e.m.f.* and the voltage across *R* equals this applied *e.m.f.*

(c) The sum of the p.d.'s across the inductance and capacitance equals the applied *e.m.f.* which is 180^o ahead of phase of the current in the circuit

(d) The quality factor of the circuit is µ L/R or $1/$µ CR and this is a measure of the voltage magnification (produced by the circuit at resonance) as well as the sharpness of resonance of the circuit

79. In a series *LCR* circuit, resistance $R = 10\Omega$ and the impedance $Z = 20\Omega$. The phase difference between the current and the voltage is

(a) 30^o (b) 45^o (c) 60^o (d) 90^o

80. The average power dissipated in a pure inductor of inductance *L* when an ac current is passing through it, is (Inductance of the coil = *L* and current *i*)

(a) $\frac{1}{2}Li^2$ (b) $\frac{1}{4}Li^2$ (c) $2Li^2$ (d) Zero

81. In an ac circuit, a resistance of *R ohm* is connected in series with an inductance *L*. If phase angle between voltage and current be 45^o, the value of inductive reactance will be

(a) $\frac{R}{4}$ (b) $\frac{R}{2}$

(c) R (d) Cannot be found with the given data

82. In an ac circuit, the potential difference across an inductance and resistance joined in series are respectively 16 *V* and 20 *V*. The total potential difference across the circuit is

(a) 20.0 *V* (b) 25.6 *V* (c) 31.9 *V* (d) 53.5 *V*

83. A 220 *V*, 50 *Hz* ac source is connected to an inductance of 0.2 *H* and a resistance of 20 *ohm* in series. What is the current in the circuit

(a) 10 *A* (b) 5 *A* (c) 33.3 *A* (d) 3.33 *A*

84. The phase angle between *e.m.f.* and current in *LCR* series ac circuit is

(a) 0 to ® / 2 (b) ® / 4 (c) ® / 2 (d) ®

85. For series *LCR* circuit, wrong statement is

(a) Applied *e.m.f.* and potential difference across resistance are in same phase

(b) Applied *e.m.f.* and potential difference at inductor coil have phase difference of ® / 2

(c) Potential difference at capacitor and inductor have phase difference of ® / 2

(d) Potential difference across resistance and capacitor have phase difference of ® / 2

86. A 20 *volts* ac is applied to a circuit consisting of a resistance and a coil with negligible resistance. If the voltage across the resistance is 12 *V*, the voltage across the coil is

(a) 16 *volts* (b) 10 *volts* (c) 8 *volts* (d) 6 *volts*

87. An *e.m.f.* $E = 4$ cos (1000 *t*) *volt* is applied to an LR-circuit of inductance 3 *mH* and resistance 4 *ohms*. The amplitude of current in the circuit is

(a) $\frac{4}{\sqrt{7}} A$ (b) $1.0 A$ (c) $\frac{4}{7} A$ (d) 0.8 A

88. In a *LR* circuit, the value of *L* is $\left(\frac{0.4}{®}\right)$ *henry* and the value of *R* is 30 *ohm*. If in the circuit, an alternating *e.m.f.* of 200 *volt* at 50 *cycles per sec* is connected the impedance of the circuit and current will be

(a) 11.4 Ω, 17.5 A (b) 30.7 Ω, 6.5 A (c) 40.4 Ω, 5 A (d) 50 Ω, 4A

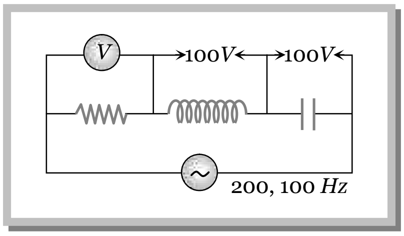
89. The resonant frequency of a circuit is *f*. If the capacitance is made 4 times the initial values, then the resonant frequency will become

(a) $f/2$ (b) 2*f* (c) *f* (d) $f/4$

90. In a series *LCR* circuit, operated with an ac of angular frequency μ , the total impedance is

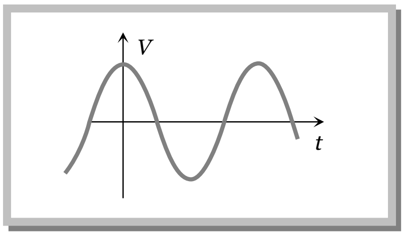
(a) $[R^2+(L\mu-C\mu)^2]^{1/2}$ (b) $\left[R^2+\left(L\mu-\frac{1}{C\mu}\right)^2\right]^{1/2}$ (c) $\left[R^2+\left(L\mu-\frac{1}{C\mu}\right)^2\right]^{-1/2}$ (d) $\left[(R\mu)^2+\left(L\mu-\frac{1}{C\mu}\right)^2\right]^{1/2}$

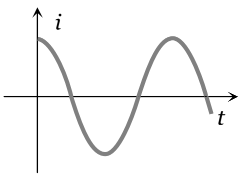
91. In the circuit given below. What will be reading of the voltmeter

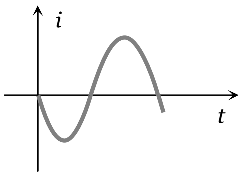


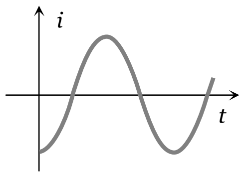
(a) 300 V
(b) 900 V
(c) 200 V
(d) 400 V

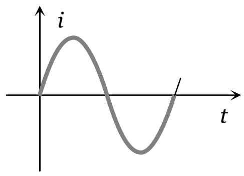
92. The voltage across a pure inductor is represented by the following diagram. Which one of the following diagrams will represent the current



(a) 

(b) 

(c) 

(d) 

93. An *LCR* circuit contains $R = 50\,\Omega, L = 1\,mH$ and $C = 0.1$«F. The impedance of the circuit will be minimum for a frequency of

(a) $\frac{10^5}{2®} s^{-1}$ (b) $\frac{10^6}{2®} s^{-1}$ (c) $2® \times 10^5 s^{-1}$ (d) $2® \times 10^6 s^{-1}$

94. An alternating current source of frequency 100 *Hz* is joined is a combination of a resistance, a capacitance and a coil in series. The potential difference across the coil, the resistance and the capacitor is 46, 8 and 40 *volt* respectively. The electromotive force of alternating current source in *volt* is

(a) 94 (b) 14 (c) 10 (d) 76

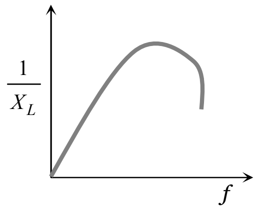
95. A 10 *ohm* resistance, 5 *mH* coil and 10 «*F* capacitor are joined in series. When a suitable frequency alternating current source is joined to this combination, the circuit resonates. If the resistance is halved, the resonance frequency

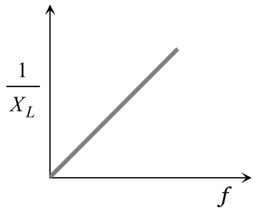
(a) In halved (b) In doubled (c) Remains unchanged (d) In quadrupled

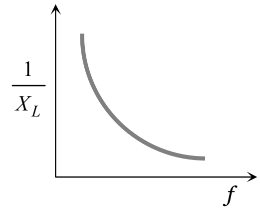
96. The power factor of *LCR* circuit at resonance is

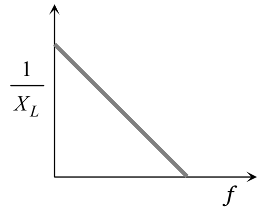
(a) 0.707 (b) 1 (c) Zero (d) 0.5

97. In pure inductive circuit, the curves between frequency f and reciprocal of inductive reactance $1/X_L$ is

(a) 

(b) 

(c) 

(d) 

Advance Level

98. The ac current through a capacitor $C = \frac{10^{-4}}{314}$ *farad* is given by $i = 25\cos(314t + 30^o)mA$ then the *e.m.f.* across the capacitor will be given by

(a) $e = 250\cos(314t - 60^o)$ *volt* (b) $e = 250\sin(314t + 30^o)\,volt$

(c) Both of the above (d) None of the above

99. One 10 V, 60 W bulb is to be connected to 100 V line. The required induction coil has self inductance of value (f = 50 Hz)

(a) 0.052 H (b) 2.42 H (c) 16.2 mH (d) 1.62 mH

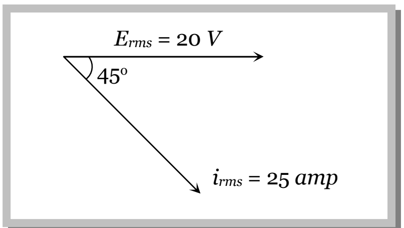
100. Al alternating *e.m.f.* of angular frequency μ is applied across an inductance. The instantaneous power developed in the circuit has an angular frequency

(a) $\frac{\mu}{4}$ (b) $\frac{\mu}{2}$ (c) μ (d) 2μ

101. In a circuit current leads the voltage by a phase of ® / 3 . The components of the circuit are (where R is resistance, L is inductance and C is capacitance)

(a) R and L (b) Only R (c) R and C (d) L and C

102. The vector diagram of current and voltage for a circuit is as shown. The components of the circuit will be



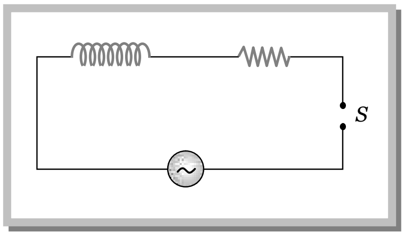
(a) *L-C-R*

(b) *L-R*

(c) *L-C-R* or *L-R*

(d) None of these

103. In the circuit shown here a 30 V dc source gives a current 2.0 A, and a 30 V ac source of frequency 100 Hz gives a current 1.2 A. The inductive reactance is



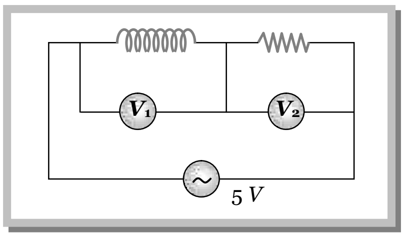
(a) 10 *ohm*

(b) 20 *ohm*

(c) $5\sqrt{34}\,ohm$

(d) 40 *ohm*

104. What is the reading of the voltmeter V_2 in the circuit below, if the reading of V_1 is 3V



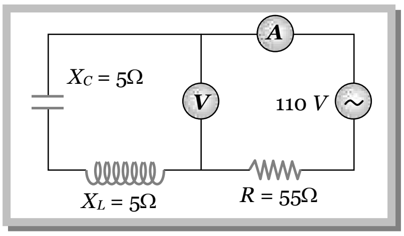
(a) 2V

(b) 3V

(c) 4V

(d) $5V$

105. The reading of ammeter in the circuit shown will be



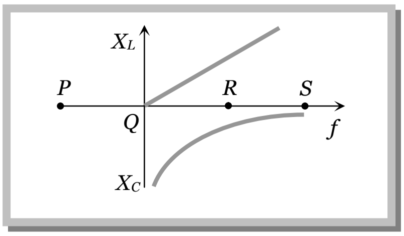
(a) $2A$

(b) $2.4\,A$

(c) Zero

(d) $1.7\,A$

106. The resonance point in $X_L - f$ and $X_C - f$ curves is



(a) P

(b) Q

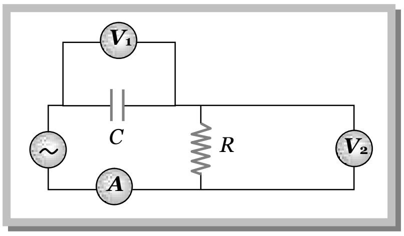
(c) R

(d) S

107. An ac source of angular frequency µ is fed across a resistor r and a capacitor C in series. The current registered is I. If now the frequency of source is changed to µ / 3 (but maintaining the same voltage), the current in then circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency µ

(a) $\sqrt{\frac{3}{5}}$ (b) $\sqrt{\frac{2}{5}}$ (c) $\sqrt{\frac{1}{5}}$ (d) $\sqrt{\frac{4}{5}}$

108. The diagram shows a capacitor C and a resistor R connected in series to an ac source. V_1 and V_2 are voltmeters and A is an ammeter



Consider now the following statements

I. Readings in A and V_2 are always in phase

II. Reading in V_1 is ahead in phase with reading in V_2

III. Readings in A and V_1 are always in phase which of these statements are/is correct

(a) I only (b) II only (c) I and II only (d) II and III only

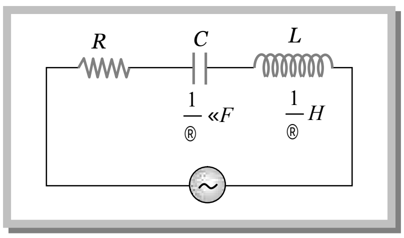
109. A circuit drawn a power of 550 *watt* from a source of 220 *volt*, 50 *Hz*. The power factor of the circuit is 0.8 and the current lags in phase behind the potential difference. To make the power factor of circuit as 1.0 , the capacitance required to be connected with it, will be

(a) 70.4 «*F* (b) 75 «*F* (c) 7.5 «*F* (d) 750 «*F*

110. The sharpness of resonance increases on

(a) Decreasing R (b) Increasing R (c) Decreasing X_L (d) Increasing X_L

111. In the circuit shown in fig. the supply has constant *r.m.s.* value V but variable frequency f. Calculate the frequency at which the voltage drop across R is maximum



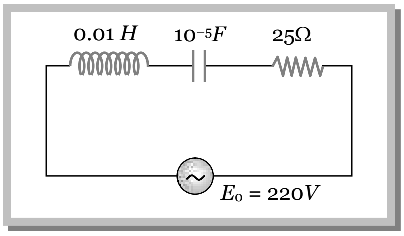
(a) 100 *Hz*

(b) 500 *Hz*

(c) 300 *Hz*

(d) None of these

112. In the following circuit the values of L, C, R and E_0 are 0.01 H, $10^{-5} F$, 25Ω and 220 *volt* respectively. The value of current flowing in the circuit at $¬ = 0$ and $f = \infty$ will respectively be



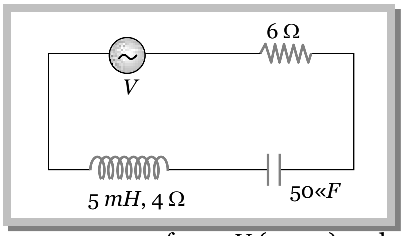
(a) 8 A and 0 A

(b) 0 A and 0 A

(c) 8 A and 8 A

(d) 0 A and 8 A

113. In the circuit shown below, the ac source has voltage $V = 20\cos(\mu\ t)$ volts with $\mu = 2000\ rad/sec$. the amplitude of the current will be nearest to



(a) 2A

(b) 3.3A

(c) $2/\sqrt{5}\,A$

(d) $\sqrt{5}\,A$

114. An LCR series circuit with a resistance of 100 *ohm* is connected to an ac source of 200 V (*r.m.s.*) and angular frequency 300 *rad/s*. When only the capacitor is removed, the current lags behind the voltage by 60^o. When only the inductor is removed the current leads the voltage by 60^o. The average power dissipated is

(a) 50 W (b) 100 W (c) 200 W (d) 400 W

115. A 2.5/® «F capacitor and a 3000 *ohm* resistance are joined in series to an ac source of 200 *volt* and 50 sec^{-1} frequency. The power factor of the circuit and the power dissipated in it will respectively be

(a) 0.6, 0.06 W (b) 0.06, 0.6 W (c) 0.6, 4.8 W (d) 4.8, 0.6 W

116. A virtual current of 4A and 50 Hz flows in an ac circuit containing a coil. The power consumed in the coil is 240 W. If the virtual voltage across the coil is 100 V its inductance will be

(a) $\frac{1}{3®}H$ (b) $\frac{1}{5®}H$ (c) $\frac{1}{7®}H$ (d) $\frac{1}{9®}H$

117. A bulb and a capacitor are connected in series to a source of alternating current. If its frequency is increased, while keeping the voltage of the source constant, then

(a) Bulb will give more intense light (b) Bulb will give less intense light

(c) Bulb will give light of same intensity as before (d) Bulb will stop radiating light

118. A 110 V, 60 W lamp is run from a 220 V ac mains using a capacitor in series with the lamp, instead of a resistor then the voltage across the capacitor is about

(a) 110 V (b) 190 V (c) 220 V (d) 311 V

119. When an ac generator of 100 V is connected in series with a capacitor and a resistor of 30 *ohm*, the circuit carries a current 2 A. The potential difference across the capacitor will be

(a) 100 V (b) 80 V (c) Zero (d) 120 V

120. An alternating voltage $V = 200\sqrt{2}$ sin 100 t where V is in *volts* and t in seconds, is connected to a series combination of 1 «F capacitor and 10 $k\Omega$ resistor through an ac ammeter. The reading of the ammeter will be

(a) $\sqrt{2}\ mA$ (b) $10\sqrt{2}\ mA$ (c) 2 mA (d) 20 mA

121. The band width of a series resonant circuit is 500 Hz and the resonant frequency is 5000 Hz. The quality factor of the circuit will be

(a) 40 (b) 20 (c) 10 (d) 5

122. For a series RLC circuit $R = X_L = 2X_C$. The impedance of the circuit and phase difference (between) V and i and

(a) $\frac{\sqrt{5}R}{2}, \tan^{-1}(2)$ (b) $\frac{\sqrt{5}R}{2}, \tan^{-1}\left(\frac{1}{2}\right)$ (c) $\sqrt{5}X_C, \tan^{-1}(2)$ (d) $\sqrt{5}R, \tan^{-1}\left(\frac{1}{2}\right)$

123. If the voltages across resistor R, capacitor C and inductor L are $V_C = 2V_R$ and $V_L = 3V_R$ respectively, then the supply voltage in terms of V_R will be

(a) $\sqrt{2}\ V_R$ (b) V_R (c) $\frac{V_R}{\sqrt{2}}$ (d) $5V_R$

124. An LCR circuit with 100 *ohm* resistance is connected to an ac source of 200 *volt* and angular frequency 300 *rad/sec*. On removing the capacity from the circuit, the current lags behind the voltage by 60°. On removing the inductance from the circuit, the current leads the voltage by 60°. The current flowing in the circuit will be

(a) 1 *amp* (b) 1.5 *amp* (c) 2.5 *amp* (d) 2 *amp*

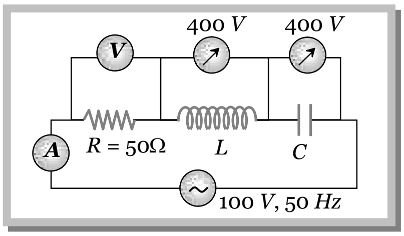
125. In the LCR series circuit the voltmeter and ammeter reading are

(a) V = 100 *volt*, i = 2 *amp*

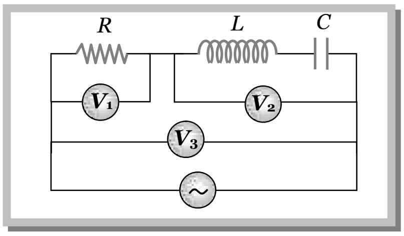
(b) V = 100 *volt*, i = 5 *amp*

(c) V = 300 *volt*, i = 2 *amp*

(d) V = 300 V, i = 1 *amp*



126. A resistor R, an inductor L, a capacitor C and voltmeters V_1, V_2 and V_3 are connected to an oscillator in the circuit as shown in the adjoining diagram. When the frequency of the oscillator is increased, then at resonant frequency the reading of voltmeter V_3 is equal to



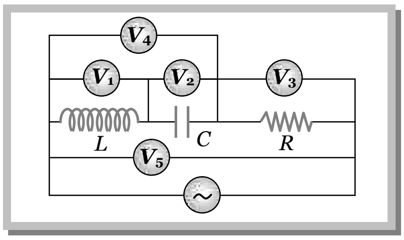
(a) That of voltmeter V_1

(b) That of voltmeter V_2

(c) Both of the voltmeters V_1 and V_2

(d) None of these

127. In the adjoining ac circuit the voltmeter whose reading will be zero at resonance is



(a) V_1

(b) V_2

(c) V_3

(d) V_4

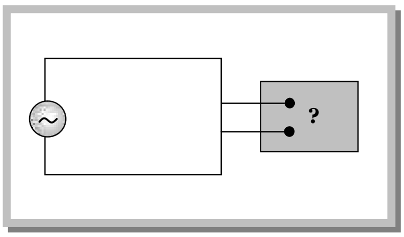
128. When V = 100 sin μ t is applied across a series (RLC) circuit at resonance the current in resistance (R = 100 Ω) is $i = i_0 \sin \mu\, t$, then power dissipation in circuit is

(a) 50 W (b) 100 W (c) 25 W (d) Can't be calculated

129. Following figure shows an ac generator connected to a "block box" through a pair of terminals. The box contains possible R, L, C or their combination, whose elements and arrangements are not known to us. Measurements outside the box reveals that

e = 75 sin (sin μ t) *volt*, i = 1.5 sin (μ t + 45°) *amp*

then, the wrong statement is



(a) There must be a capacitor in the box

(b) There must be an inductor in the box

(c) There must be a resistance in the box

(d) The power factor is 0.707

130. An ideal choke takes a current of 10 *amp* when connected to an ac supply of 125 *volt* and 50 *Hz*. A pure resistor under the same conditions takes a current of 12.5 *amp*. If the two are connected to an ac supply of $100\sqrt{2}$ *volt* and 40 *hertz*, then the current in a series combination of the above resistor and inductor is

(a) 1 *amp* (b) 12.5 *amp* (c) 20 *amp* (d) 25 *amp*

131. An iron choke and an electric bulb are connected in series with ac mains. On introducing a soft iron bar in the coil, the intensity of light bulb will

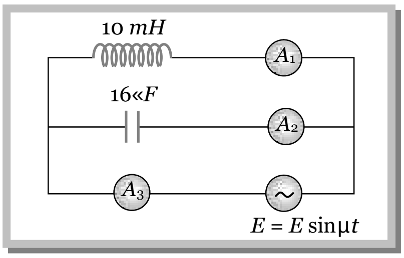
(a) Decrease (b) Increase (c) Fluctuate (d) Remain unchanged

Parallel ac circuit

132. A LC circuit is in the state of resonance. If $C = 0.1$«F and $L = 0.25$ *henry*. Neglecting ohmic resistance of circuit what is the frequency of oscillations

(a) 1007 *Hz* (b) 100 *Hz* (c) 109 *Hz* (d) 500 *Hz*

133. An inductor of 10 *mH* and a capacitor of 16 «*F* are connected in the circuit as shown in the fig. The frequency of the power supply is equal to the resonant frequency of the circuit. Which ammeter will read zero ampere



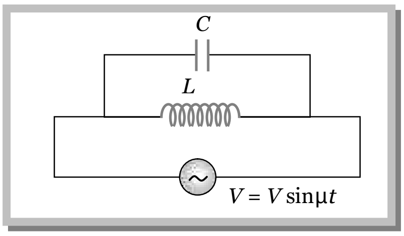
(a) A_1

(b) A_2

(c) A_3

(d) None of these

134. For the circuit shown in the fig. the current through the inductor is 0.9 *A* while the current through the condenser is 0.4 *A*



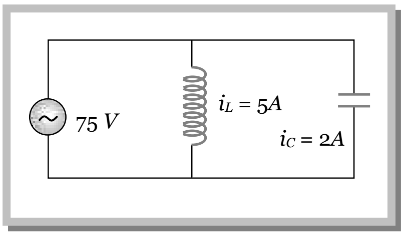
(a) The current drawn from the generator is $i = 1.3\,A$

(b) $\mu = \dfrac{1}{1.5\,LC}$

(c) $i = 0.5\,A$

(d) $i = 0.6\,A$

135. What will be the impedance of the circuit shown below



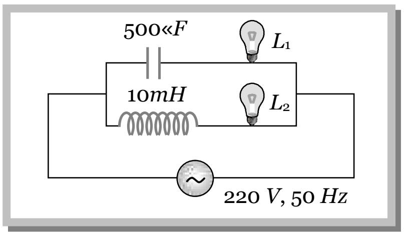
(a) 5 Ω

(b) 10 Ω

(c) 25 Ω

(d) 75 Ω

136. In the circuit shown in the fig. if both the lamps L_1 and L_2 are identical



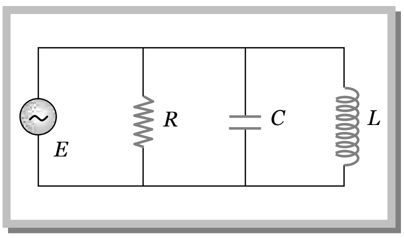
(a) Their brightness will be the same

(b) L_2 will be brighter than L_1

(c) As frequency of supply voltage is increased, brightness of L_1 will increase and that of L_2 will decrease

(d) Only L_2 will glow because the capacitor has infinite resistance

137. In a parallel *L-C-R* circuit shown in the fig, at resonance



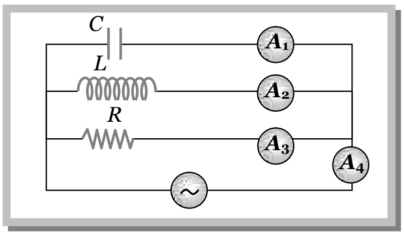
(a) The source current is maximum

(b) The impedance of the circuit is minimum and is equal to *R*

(c) The resonance frequency will be the same as for a series resonance circuit with the same values of *L*, *C* and *R*

(d) The voltage across *L* and *C* are in phase

138. A resistor R, an inductor L, a capacitor C and ammeter A_1, A_2, A_3 and A_4 are connected to an oscillator as shown in diagram. When the frequency of the oscillator is increased, then at resonant frequency, the reading of ammeter A_4 is equal to



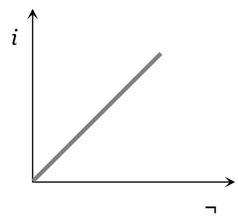
(a) That of ammeter A_3

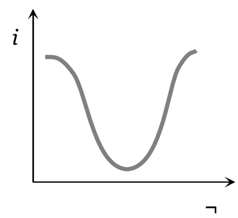
(b) That of ammeter A_2

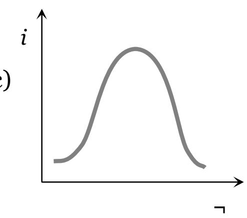
(c) That of ammeter A_1

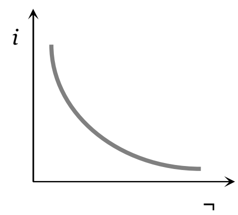
(d) All the three ammeters A_1, A_2 and A_3

139. The i - ¬ curve for anti-resonant circuit is

(a) 

(b) 

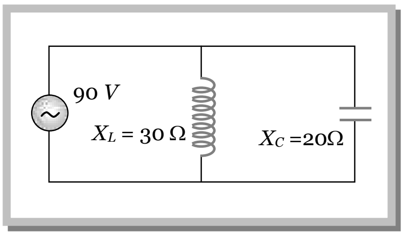
(c) 

(d) 

140. In the non-resonant circuit, what will be the nature of the circuit for frequencies higher than the resonant frequency

(a) Resistive (b) Capacitive (c) Inductive (d) None of these

141. In the adjoining figure the impedance of the circuit will be



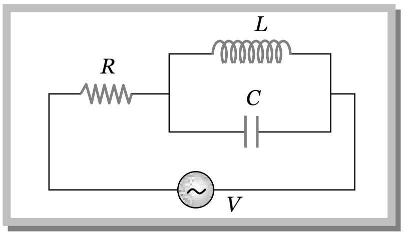
(a) 120 *ohm*

(b) 50 *ohm*

(c) 60 *ohm*

(d) 90 *ohm*

142. Current through R at resonance

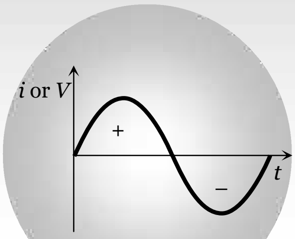


(a) Infinite

(b) Zero

(c) $\frac{V}{R}$

(d) Can't be calculated



Answer Sheet

Assignment (Basic & Advance Level)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
a	b	b	b	d	d	d	c	a	a	c	b	b	d	b	b	a	d	c	c
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
d	d	a	c	a	c	b	c	a	b	c	d	c	b	a	d	b	c	a	c
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
b	b	a	c	a	b	b	c	d	b	b	d	b	b	d	d	d	a	c	c
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
a	b	b	a	d	b	d	c	b,d	a	d	a	a	a	a	d	a	b,d	c	d
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
c	b	d	a	c	a	d	d	a	b	c	d	a	c	c	b	c	c	a	d
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
c	c	b	c	c	c	a	b	b	a	b	b	a	d	c	b	a	b	b	b
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
c	b	a	d	a	a	d	a	b	a	a	a	c	c	c	b,c	c	a	b	b
141	142																		
c	b																		