PHYSICS

Q.1 In series LCR circuit voltage drop across resistance is 8 volt and across capacitor is 12 volt. Then :

(A Voltage of the source will be leading current in the circuit

(B) Voltage drop across each element will be less than the applied voltage

(C) power factor of circuit will be 4/3

(D) None of these **[D]**

Sol. Since, $\cos\theta = \frac{R}{Z} = \frac{IR}{IZ} = \frac{8}{10} = \frac{4}{5}$

($\cos\theta$ can never be greater than 1)

Also, $Ix_C > Ix_L \quad \Rightarrow X_C > X_L$

Current will be leading

In a LCR circuit

$V = \sqrt{(V_L - V_C)^2} \qquad = \sqrt{(6-12)^2 + 8^2}$

V = 10 ; which is less than voltage drop across capacitor .

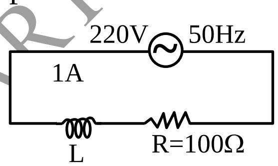
Q.2 A bulb is rated at 100 V, 100 W, it can be treated as a resistor. Find out the inductance of an inductor (called choke coil) that should be connected in series with the bulb to operate the bulb at its rated power with the help of an ac source of 200V and 50 Hz.

(A) $\frac{\pi}{\sqrt{3}}$ H (B) 100 H

(C) $\frac{\sqrt{2}}{\pi}$ H (D) $\frac{\sqrt{3}}{\pi}$ H **[D]**

Sol. From the rating of the bulb, the resistance of the bulb can be calculated.

$R = \frac{V_{rms}{}^2}{P} = 100\Omega$

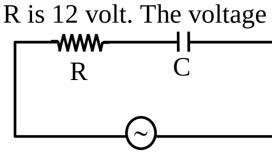


For the full to be operated at its rated value the rms current through it should be 1A

Also,

${}_{rms} = \frac{V_{rms}}{Z} \therefore 1 = \frac{200}{\sqrt{100^2 + (2\pi 50L)^2}} \Rightarrow L = \frac{\sqrt{3}}{\pi}$ H

Q.3 A 50 Hz ac source of 20 volts is connected across R and C as shown in figure. The voltage across R is 12 volt. The voltage across C is –



(A) 8 V

(B) 16 V

(C) 10 V

(D) not possible to determine unless values of R and C are given **[B]**

Sol. $V_{source} = \sqrt{V_R^2 + V_C^2}$

$\therefore V_C = \sqrt{V_{Source}^2 - V_R^2}$

$= \sqrt{(20)^2 - (12)^2}$

= 16 V

Q.4 The e.m.f E = 4 cos 1000t volts is applied to an L–R circuit containing inductance 3mH and resistance 4 Ω . The amplitude of current is -

(A) $4\sqrt{7}$ A (B) 1.0 A

(C) $\frac{4}{7}$ A (D) 0.8 A **[D]**

Sol. $i_0 = \frac{v_0}{Z}$,

$Z = \sqrt{R^2 + (\omega L)^2}$

$= \sqrt{4^2 + (1000 \times 3 \times 10^{-3})^2} = 5\ \Omega$

$i_0 = \frac{4}{5}$

$i_0 = 0.8A$

Q. 5 A 750 Hz, 20 volt source is connected to a resistance of 100 ohm, an inductance of 0.1803 henry and a capacitance of 10μF, all in series. The time in which the resistance (thermal capacity = 2 joule/ºC) will get heated by 10ºC is -

(A) 348 sec (B) 328 sec

(C) 248 sec (D) 228 sec

Sol. **[A]**

$I_{rms} = \frac{E_{rms}}{Z} = \frac{E_v}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$

= 0.023 amp

$\therefore H = I^2Rt = 2 \times 10$

or $(0.023)^2 \times 100 \times t = 20$

$$\therefore\ t = \frac{20}{(0.023)^2 \times 100} = 348 \text{ sec}$$

Q. 6 An AC ammeter is used to measure current in a circuit. When a given direct current passes through the circuit, the AC ammeter reads 3 ampere. When another alternating current passes through the circuit, the AC ammeter reads 4 ampere. Then the reading of this ammeter if DC and AC flow through the circuit simultaneously, is -

(A) 3 ampere (B) 1 ampere

(C) 7 ampere (D) 5 ampere

Sol. **[D]**

Quantity of heat liberated in the ammeter of resistance R

(i) due to direct current of 3 ampere = [(3)2 R/J]

(ii) due to alternating current of 4 ampere

$= [(4)^2 R/J]$

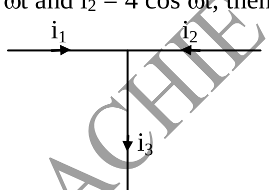
Total heat produced per second

$$= \frac{(3)^2 R}{J} + \frac{(4)^2 R}{J} = \frac{25R}{J}$$

Let the equivalent alternating current be I ampere; then $\frac{I^2 R}{J} = \frac{25R}{J}$

or I = 5 amp

Q.7 If $i_1 = 3 \sin \omega t$ and $i_2 = 4 \cos \omega t$, then i_3 is –



(A) $5 \sin (\omega t + 53^\circ)$ (B) $5 \sin (\omega t + 37^\circ)$

(C) $5 \sin (\omega t + 45^\circ)$ (D) $5 \cos (\omega t + 53^\circ)$

Sol. **[A]**

From Kirchoff's current law,

$i_3 = i_1 + i_2 = 3 \sin \omega t + 4 \sin (\omega t + 90^\circ)$

$= \sqrt{3^2 + 4^2 + 2(3)(4)\cos 90^\circ}\ \sin(\omega t + \phi)$

where $\tan \phi = \frac{4 \sin 90^\circ}{3 + 4\cos 90^\circ} = \frac{4}{3}$

$\therefore i_3 = 5\sin(\omega t + 53^\circ)$

Q. 8 For An alternating current :

(A) r.m.s value may be equal to peak value

(B) average value may be equal to peak value

(C) r.m.s value may be equal to average value

(D) All of the above

Sol. **[D]**

If AC is the square wave then all these three options are possible

Q.9 For an alternating current -

(A) r.m.s. value may be equal to peak value

(B) average value be equal to peak value

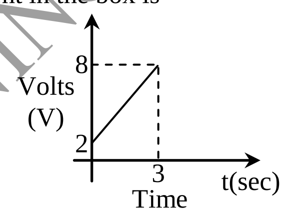
(C) r.m.s. value be equal to average value

(D) All of the above

Sol. **[D]**

If AC is the square wave then all these three options are possible.

Q.10 A circuit element is placed in a closed box. At time t = 0, a constant current generator supplying a current of I amp is connected across the box. Potential diff. across the box varies according to graph as shown in the figure. The element in the box is -



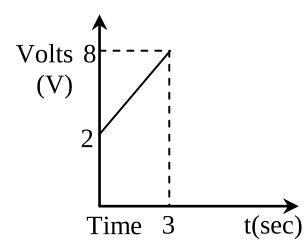
(A) a resistance of 2Ω

(B) a battery of emf 6V

(C) an inductance of 2H

(D) a capacitance

Sol. **[D]**



$$I = \frac{dq}{dt}$$

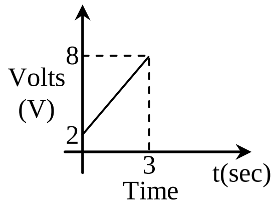
$q = it + a$

$$V = \frac{q}{c}$$

$$V = \frac{it + a}{c}$$

$\therefore$ V is proportional to time.

Q.11 A circuit element is placed in a closed box. At time t = 0, a constant current generator supplying a current of I amp is connected across the box. Potential diff. across the box varies according to graph as shown in the figure. The element in the box is -



(A) a resistance of 2Ω
(B) a battery of emf 6V
(C) an inductance of 2H
(D) a capacitance

Sol. **[D]**

$I = \frac{dq}{dt}$

$q = it + a$

$V = \frac{q}{C}$

$V = \frac{it + a}{C}$

$\therefore$ V is proportional to time

Q.12 An alternating current changes from a complete cycle in 1 μs, then the frequency in Hz will be -
(A) 10^{-6} (B) 50
(C) 100 (D) 10^{6} **[D]**

Q.13 In an ac circuit, the current is given by
$i = 4 \sin (100\pi t + 30°)$ ampere. The current becomes maximum first time (after t = 0) at t equal to –
(A) (1/200) sec (B) (1/300) sec
(C) (1/50) sec (D) None of these **[B]**

Q.14 The r.m.s. value of potential due to superposition of given two alternating potentials $E_1 = E_0 \sin \omega t$ and $E_2 = E_0 \cos \omega t$ will be -
(A) E_0 (B) $2E_0$
(C) $E_0\sqrt{2}$ (D) 0 **[A]**

Q.15 The r.m.s. value of alternating current is 10 amp having frequency of 50 Hz. The time taken by the current to increase from zero to maximum and the maximum value of current 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 **[D]**

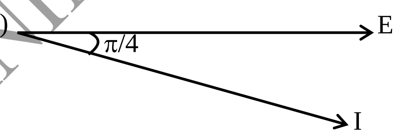
Q.16 The current through a wire changes with time according to the equation $I = \sqrt{t}$. The correct value of the rms current within the time interval t = 2 to t = 4s will be -
(A) $\sqrt{3}$ A (B) 3 A
(C) 3 A (D) None of these
[A]

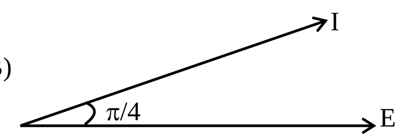
Q.17 In a circuit an A.C. current and a D. C. current are supplied together. The expression of the instantaneous current is given as

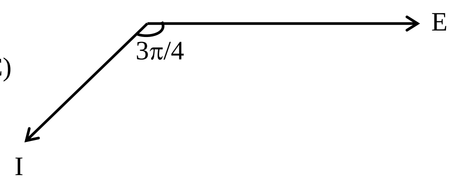
$i = 3 + 6 \sin \omega t$

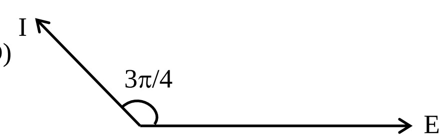
Then the rms value of the current is –
(A) 3 (B) 6
(C) $3\sqrt{2}$ (D) $3\sqrt{3}$ **[D]**

Q.18 In a certain circuit $E = 200 \cos (314t)$ and $I = \sin (314t + \pi/4)$. Their vector representation is –

(A)


(B)


(C)


(D)


[A]

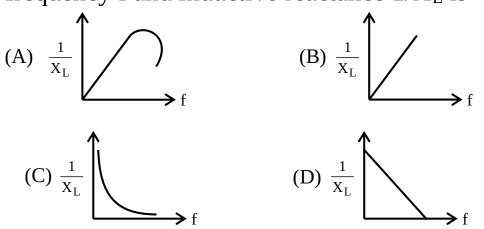
Q.19 The inductance of a resistance less coil is 0.5 Henry. In the coil the value of A.C. is 0.2 amp whose frequency is 50 Hz. The reactance of circuit is -
(A) 15.7 Ω (B) 157 Ω
(C) 1.57 Ω (D) 757 Ω **[B]**

Q.20 In an A.C. circuit, a capacitor of 1μF value is connected to a source of frequency 1000 rad/sec. The value of capacitive reactance will be –

(A) 10 Ω (B) 100 Ω

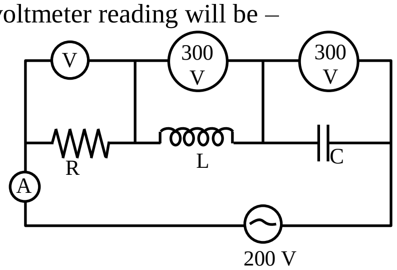
(C) 1000 Ω (D) 10,000 Ω **[B]**

Q.21 In pure inductive circuit, the curves between frequency f and inductive reactance $1/X_L$ is –



[C]

Q.22 In the series circuit shown in the figure the voltmeter reading will be –



(A) 300 V (B) 900 V

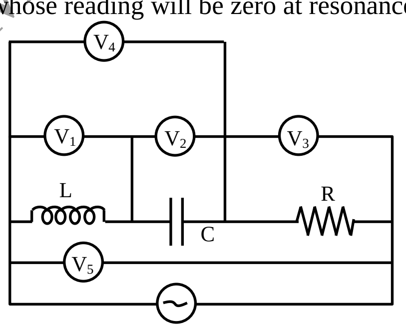
(C) 200 V (D) 100 V **[C]**

Q.23 The series combination of resistance R and inductance L is connected to an alternating source of e.m.f. e = 311 sin (100 πt). If the value of wattless current is 0.5A and the impedance of the circuit is 311 Ω, the power factor will be –

(A) $\frac{1}{2}$ (B) $\frac{\sqrt{3}}{2}$

(C) $\frac{1}{\sqrt{3}}$ (D) $\frac{1}{\sqrt{5}}$ **[B]**

Q.24 In the adjoining A.C. circuit the voltmeter whose reading will be zero at resonance is-



(A) V_1 (B) V_2

(C) V_3 (D) V_4 **[D]**

Q.25 In the above problem, the two voltmeters whose readings are equal, will be –

(A) V_4 and V_1 (B) V_1 and V_3

(C) V_4 and V_5 (D) V_1 and V_2 **[D]**

Q.26 When 100 V dc is applied across a solenoid, a current of 1.0 A flows in it. When 100 V and 50 Hz ac is applied across it, the current drops to 0.5 A. The inductance and the impedance of the solenoid are respectively-

(A) 0.45 H, 100 ohm

(B) 0.045 H, 100 ohm

(C) 0.55 H, 200 ohm

(D) 0.055 H, 200 ohm **[C]**

Q.27 The inductance of the motor of a fan is 1.0 H. To run the fan at 50 Hz the capacitance of the capacitor that will cancel its inductive reactance, will be -

(A) 10 μF (B) 40 μF

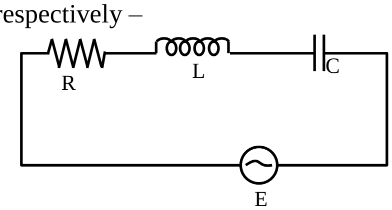
(C) 0.4 μF (D) 0.04 μF **[A]**

Q.28 The potential difference between the ends of a resistance R is V_R between the ends of capacitor is $V_C = 2V_R$ and between the ends of inductance is $V_L = 3V_R$, then the alternating potential of the source in terms of V_R will be -

(A) $\sqrt{2}\, V_R$ (B) V_R

(C) $V_R/\sqrt{2}$ (D) $5V_R$ **[A]**

Q.18 If E_0 = 200 volt, R = 25 ohm, L = 0.1 H and C = 10^{-5} F and the frequency is variable, then the current at f = 0 and f = ∞ will be respectively –



(A) 0 A, 8 A (B) 8 A, 0 A

(C) 8 A, 8 A (D) 0 A, 0 A **[D]**

Q.29 The frequency of an alternating current is 50 Hz, then the time to complete one cycle for current vector will be-

(A) 20 ms (B) 50 ms

(C) 100 ms (D) 1 s **[A]**

Q.30 The sinusoidal voltage wave changes from 0 to maximum value of 100 volt. The voltage when the phase angle is 30º will be -

(A) 70.7 volt (B) 50 volt

(C) 109 volt (D) – 100 volt **[B]**

Q.31 If the frequency of ac is 60 Hz the time difference corresponding to a phase difference of 60º is –

(A) 60 s (B) 1 s

(C) 1/60 s (D) 1/360 s **[D]**

Q.32 An LCR series circuit with 100 Ω resistance is connected to an AC source of 200 V and angular frequency 300 radians per second. When only the capacitance is removed, the current lags behind the voltage by 60º. When only the inductance is removed, the current leads the voltage by 60º. Then the current and power dissipated in LCR circuit are respectively

(A) 1A, 200 watt (B) 1A, 400 watt

(C) 2A, 200 watt (D) 2A, 400 watt **[D]**

Sol. When capacitance is removed

$\tan\theta = \dfrac{\omega L}{R}$ or $\omega L = 100 \tan 60º$ …(1)

when inductance is removed

$\tan\phi = \dfrac{1}{(\omega C)(R)}$ or $\dfrac{1}{\omega C} = 100 \tan 60º$ ….(2)

So Z = R = 100 Ω

I = V/R = 200/100 = 2A

Power $P = I^2 R = 4 \times 100 = 400$ W

Q.33 A 100 volt AC source of frequency 500 Hz is connected to a L–C-R circuit with L = 8.1 mH, C = 12.5 μF and R = 10 Ω, all connected in series. The potential difference across the resistance is -

(A) 100 V (B) 200 V

(C) 300 V (D) 400 V **[A]**

Sol. $Z = \sqrt{R^2 + (X_L - X_C)^2}$

Here $X_L = 2\pi fL = 2 \times 3.14 \times 500 \times (8.1 \times 10^{-3})$
$= 25.4\ \Omega$

and $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{2\times3.14\times500\times12.5\times10^{-6}}$
$= 25.4\ \Omega$

$\therefore$ $Z = \sqrt{(10)^2 + (25.4-25.4)^2} = 10\ \Omega$

Now $i_{rms} = \dfrac{E_{rms}}{Z} = \dfrac{100}{10} = 10$ A

$\therefore$ $V_R = i_{rms} \times R$
$= 10 \times 10$
$= 100$ V

Q.34 RMS value of ac $i = i_1 \cos\omega t + i_2 \sin\omega t$ will be–

(A) $\dfrac{1}{\sqrt{2}}(i_1 + i_2)$ (B) $\dfrac{1}{\sqrt{2}}(i_1 + i_2)^2$

(C) $\dfrac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$ (D) $\dfrac{1}{2}(i_1^2 + i_2^2)^{1/2}$

[C]

Q.35 Alternating current lead the applied e.m.f. by π/2 when the circuit consists of -

(A) only resistance

(B) only capacitor

(C) only an inductance coil

(D) capacitor and resistance both **[B]**

Q.36 The percentage increase in the impedance of an ac circuit, when its power factor changes form 0.866 to 0.5 is -

(A) 73.2% (B) 86.6%

(C) 90.8% (D) 66.6% **[A]**

Q.37 The time required for a 50Hz 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 **[A]**

Q.38 The peak value of the following A.C. current $i = 4\sin\omega t + 4\sin(\omega t + 2\pi/3)$ is –

(A) $4\sqrt{2}$ (B) $2\sqrt{2}$

(C) 8 (D) 4 **[D]**

Q.39 In a series A.C. circuit $X_L = 300\Omega$, $X_C = 200\Omega$ and $R = 100\Omega$ the impedance of circuit is -

(A) 600Ω (B) 200Ω
(C) 141Ω (D) None of these

[C]

Q.40 When a material is inserted inside the inductor, current increases then the nature of material is –

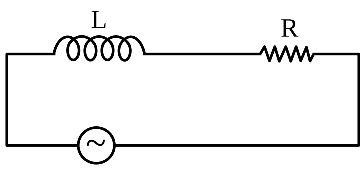


Fig.

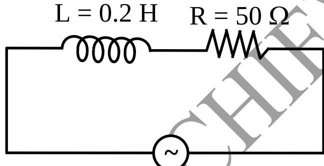
(A) ferromagnetic (B) paramagnetic
(C) diamagnetic (D) ferrimagnetic

[C]

Sol. L should decrease so that z

$= \sqrt{X_L^2 + R^2}$ decreases.

Q.41 In the given circuit the average power developed is –



V = 200 sin(250 t) volt

(A) $50\sqrt{2}$ watt

(B) 200 watt

(C) $150\sqrt{2}$ watt

(D) $200\sqrt{2}$ watt **[B]**

Sol. $P = V_{rms} I_{rms} \cos\phi$

$$P = V_{rms}\frac{V_{rms}}{Z}\frac{R}{Z}$$

$$= \frac{V_{rms}^2}{Z^2}R$$

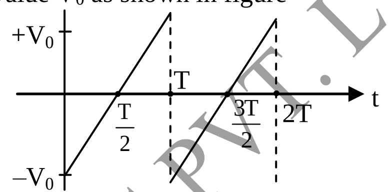
$$Z = \sqrt{R^2 + (L\omega)^2} = \sqrt{(50)^2 + (0.2\times 250)^2}$$

$$= \sqrt{2500 + (50)^2} = 50\sqrt{2}$$

$$\therefore P = \left(\frac{200}{\sqrt{2}}\right)^2 \times \frac{50}{50\sqrt{2}} \times \frac{1}{50\sqrt{2}}$$

= 200 watt

Q.42 Rms value of the saw-tooth voltage of peak value V_0 as shown in figure –



(A) $\frac{V_0}{2}$ (B) $\frac{V_0}{\sqrt{2}}$

(C) $\frac{V_0}{3}$ (D) $\frac{V_0}{\sqrt{3}}$ **[D]**

Sol.

$$v_{rms} = \sqrt{\frac{\int_0^T v^2 dt}{T}} = \sqrt{\frac{\int_0^T \left(-v_0 + \frac{2v_0 t}{T}\right)^2 dt}{T}}$$

Q.43 The voltage E and the current I in an instrument are represented by the equations:

E = 2 cos ωt Volt

I = 2 sin ωt Amp.

The power dissipated in the instrument will be-

(A) Zero (B) 1.0 W
(C) 4 W (D) 2.0 W **[A]**

Q.44 The ratio of apparent power and average power in an A.C. circuit is equal to -

(A) Reciprocal of power factor
(B) Efficiency
(C) Power factor
(D) Form factor **[A]**

Q.45 An ac circuit resonates at a frequency of 10 kHz. If its frequency is increased to 11 kHz, then :

(A) Impedance will increase by 1.1 times
(B) Impedance will remain unchanged

(C) Impedance will increase and become inductive

(D) Impedance will increase and become capacitive **[C]**

Q.46 In a series LCR circuit with an AC source R = 300 Ω, C = 20 μF, L = 1 H, E_{rms} = 50 V and $\nu = \frac{50}{\pi}$ Hz . The potential difference across the capacitor is –

(A) 50 V (B) $\frac{50}{\sqrt{2}}$ V

(C) 40 V (D) $\frac{40}{\sqrt{2}}$ V **[A]**

Sol. $X_C = \frac{1}{C\omega} = \frac{1}{20\times10^{-6}\times2\pi\times\frac{50}{\pi}} = 500\ \Omega$

$X_L = L\omega = L\times2\pi\times\frac{50}{\pi} = 100\ \Omega$

$I_{rms} = \frac{E_{rms}}{2} = \frac{50}{\sqrt{R^2+(X_C-X_L)^2}}$

$= \frac{50}{\sqrt{(300)^2+(500-100)^2}}$

$= \frac{50}{500} = \frac{1}{10}$ A

$V_C = I_{rms}\times X_C$

$= \frac{1}{10}\times 500$ V

= 50 V

Q.47 A 60 W/120 V bulb is connected to a 240/60 Hz supply with an inductance in series. Find the value of inductance so that bulb gets correct voltage –

(A) $\frac{2.3}{\pi}$ H (B) $2\sqrt{3}$ H

(C) π H (D) $\frac{2\sqrt{3}}{\pi}$ H **[D]**

Sol. $R = \frac{(120)^2}{60} = 240\ \Omega$ we require i = 0.5 A

or |Z| = 480 Ω

$X_L = \sqrt{480^2-240^2} = 240\sqrt{3}\ \Omega$

$L = \frac{240\sqrt{3}}{60\times2\pi} = \frac{2.\sqrt{3}}{\pi}$ H

Q.48 An inductor 10 Ω/60º is connected to a 5Ω resistance in series. Find net impedance –

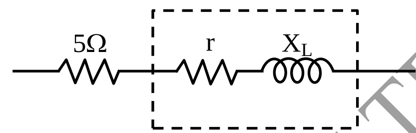


Fig.

(A) 15 Ω (B) 12 Ω

(C) 13.2 Ω (D) 18 Ω **[C]**

Sol. $10 = \sqrt{r^2+X_L^2}$ and $\frac{X_L}{r} = \tan 60$

$10 = \sqrt{r^2+(r\sqrt{3})^2}$ or r = 5 Ω, $X_L = 5\sqrt{3}\ \Omega$

$Z = \sqrt{(5+5)^2+(5+\sqrt{3})^2} = \sqrt{175} = 13.2\ \Omega$

$\tan\phi = \frac{X_L}{R+r} = \frac{5\sqrt{3}}{10}$

or $\phi = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$.

Q.49 We have two cables of copper of same length. In one, only one wire of cross-section area A and in second ten wires each of cross-section area A/10 are present. When A.C. and D.C. flow in it. Choose the correct cable for better efficiency–

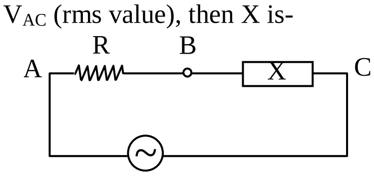
(A) Only one wire for D.C. and the other for A.C

(B) Only one wire for A.C. and the other for D.C.

(C) Any wire for D.C. but only multy-wire cable for A.C.

(D) Only one wire for D.C. and only multy-wire packet for A.C. **[C]**

Q.50 A unknown circuit element X is connected in series with a resistor R to an ac source. If $V_{AB} = V_{AC}$ (rms value), then X is-



(A) Pure resistor

(B) Pure capacitor

(C) Pure conductor

(D) Combination of conductor & capacitor at resonance **[D]**

Sol. At resonance

$V_{BC} = 0$

$\therefore$ V_{AB} become equal to V_{AC}