	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**Department: SCIENCE 2022 – 23** **SUBJECT : PHYSICS**	**Date of submission: 04.10.2022**
Worksheet No:07 **WITH ANSWERS**	**Topic: Alternating Current**	**Note:** **A4 FILE FORMAT**

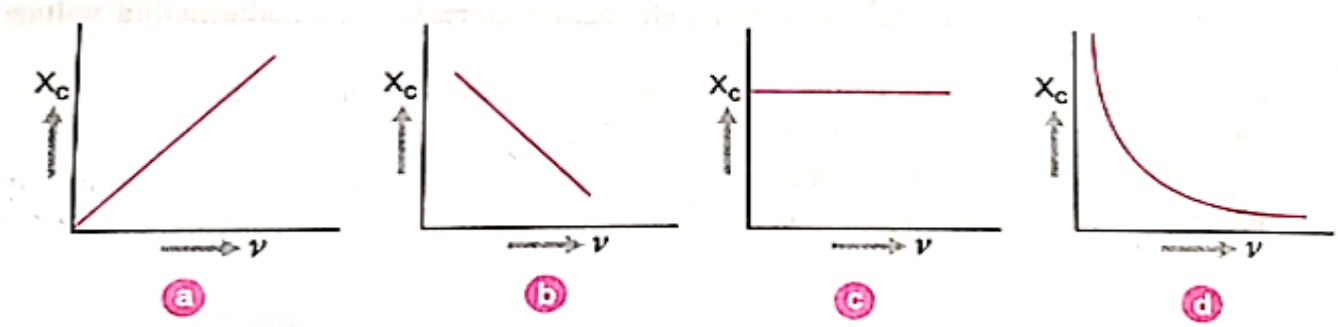
Directions (Q. No. 1-15): Select the most appropriate option from the given below each question.

1. Which of the following statements is incorrect for the alternating current?

a) It can be transmitted over a long distance.
b) Its production is cheaper
c) It has a constant value
d) Its voltage can be easily changed.

Ans. c) It has a constant value

2. The variation of the reactance of a capacitor with frequency is represented correctly by



Ans.d

3. Which of the following does not have the dimensions of time?

(a) RC (b) $\frac{L}{R}$ (c) $\frac{R}{L}$ (d) $\sqrt{LC}$

Ans. c

4. Which of the following does not have unit as ohm?
a) Impedance b) resistance c) reactance d) capacitance
Ans. d) Capacitance

5. The resistance of a coil for direct current is 10 ohm. When a.c is sent through the same coil, its resistance would be

a) 10 Ω b) >10Ω c) < 10 Ω d) cannot predict

Ans. b) >10Ω Impedance acts over here.

6. The alternating current from a source is represented by I = 0.5 sin 314t. The frequency of a.c is

a) 314Hz b) 100Hz c) 50 Hz d) zero

Ans.

$$T = \frac{2\pi}{w} = \frac{2\pi}{314}$$

$$\text{frequcey} = \frac{1}{T} = \frac{314}{2\pi}$$

$$= 50\,\text{HZ}$$

7. The Q factor of resonance is given by the equation

(a) $\frac{1}{R}\sqrt{\frac{L}{C}}$ (b) $\frac{1}{R}\sqrt{\frac{C}{L}}$ (c) $\frac{1}{L}\sqrt{\frac{R}{C}}$ (d) $\frac{1}{C}\sqrt{\frac{L}{R}}$

Ans.

(a) $\frac{1}{R}\sqrt{\frac{L}{C}}$

8. The power factor for a.c circuit is given by cos ϕ =

(a) $\frac{R}{Z}$ (b) $\frac{Z}{R}$ (c) $\frac{R}{X_L}$ (d) $\frac{R}{X_C}$

Ans.

(a) $\frac{R}{Z}$

9. A.C. power is transmitted from a power house at a high voltage as

(a) the rate of transmission is faster at high voltages

(b) it is more economical due to less power loss

(c) power cannot be transmitted at low voltages

(d) a precaution against theft of transmission lines

Ans. (b) it is more economical due to less power loss

10. The alternating current can be measured with the help of

(a) hot wire ammeter

(b) hot wire voltmeter

(c) moving magnet galvanometer

(d) suspended coil type galvanometer
Ans.
(a) hot wire ammeter

11. In a series LCR circuit, resonant frequency depends on

(a) $\frac{L}{C}$ (b) $\frac{1}{\sqrt{LC}}$ (c) $\sqrt{LC}$ (d) $\sqrt{\frac{L}{C}}$

Ans. (b) $\frac{1}{\sqrt{LC}}$

12. For an LCR circuit, the power transfer from the driving source to the driving oscillator is $P = I^2Z\cos\phi$. Which of the following is incorrect?
(a) Here, the power factor $\cos\phi \geq 0$,$P = \geq 0$.
(b) The driving force can give no energy to the oscillator (P = 0) in some cases.
(c) The driving force cannot syphon out(P<0) the energy out of oscillator.
(d) The driving force can take away energy out of the oscillator.
Ans. (a) Here, the power factor $\cos\phi \geq 0$,$P = \geq 0$.

13. Choose the correct statement
(a) A capacitor can conduct a dc circuit but not an inductor.
(b) In a dc circuit the inductor can conduct but not a capacitor.
(c) In ac circuit both the inductor and capacitor cannot conduct.
(d) The inductor has infinite resistance in a dc circuit.
Ans. (b) In a dc circuit the inductor can conduct but not a capacitor.

14. A coil of self-inductance 'L' is connected in series with a bulb B and an ac source. Brightness of the bulb decreases when
(a) frequency of the ac source is decreased.
(b) number of turns in the coil is reduced.
(c) the capacitance of reactance $X_C = X_L$ in included.
(d) an iron rod is inserted in the coil.
Ans. (d) an iron rod is inserted in the coil.

15. The reactance of the capacitor C is X. If both the frequency and capacitance be doubled, then new reactance will be

(a) X (b) 2X (c) 4X (d) X/4

Ans. (d) X/4

Fill in the blanks with appropriate words.

1. The.....of alternating current varies.....with time and its..... is reversed..... .
2. Ordinary d.c. ammeter and d.c. voltmeter, when used in.....record.....reading.
3. The r.m.s. value or.....value or.....value of a.c. is.....the peak value of a.c.
4. 220 V a.c. means..... And an a.c. of 1 A means..... .
5. In an a.c. circuit containing *R* only.....and.....are in.....phase.
6. In an a.c. circuit containing *L* only, alternating current.....alternating voltage by a phase angle of..... .
7. The dimensions of inductive.....and.....are the same as those of..... .
8. A condenser.....a.c. to pass through but.....d.c.
9. Ohmic resistance *R* can reduce.....but inductor *L* can reduce.....only.
10. A series resonance circuit is called an.....and a.....is called..... .

ANSWERS OF fill in the blanks: -

1.magnitude; continuously; direction; periodically.

2.a.c., circuit; zero

3.virtual; effective; 0.707 times

4.Ev = 220; Iv = 1A.

5.ac; av; same

6.lags behind; 90

7.reactance; capacitive reactance; resistance.

8.allows; blocks

9.both a.c. and d.c.; a.c

10. acceptor circuit; parallel resonance circuit; rejector/ filter,

ASSERTION REASONING QUESTIONS

Directions: Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

1) **Assertion:** In series LCR resonance circuit, the impedance is equal to the ohmic resistance.

Reason: At resonance, the inductive reactance exceeds the capacitive reactance.

Ans. (c) Assertion is correct, reason is incorrect

2) **Assertion:** A capacitor is connected to a direct current source. Its reactance is infinite.
Reason: Reactance of a capacitor is given by $\chi_c = 1/\omega C$.
Ans. a
3) **Assertion:** Average value of ac over a complete cycle is always zero.
Reason: Average value of ac is always defined over half cycle.
Answer: (b)
4) Assertion: The alternating current lags behind the emf by a phase angle of, $\pi/2$ when AC flows through an inductor.
Reason: The inductive reactance increases as the frequency of AC source increases.
Answer: (b)
5) **Assertion:** The inductive reactance limits amplitude of the current in a purely inductive circuit.
Reason: The inductive reactance is independent of the frequency of the current.
Answer: (c)

NUMERICALS: -

1. A circuit is set up by connecting inductance L= 100 mH, resistor R = 100 Ω, and capacitor of reactance 200 Ω in series. An alternating emf $150\sqrt{2}$ V, $500/\pi$ Hz is applied across this series combination. Calculate the power dissipated in the resistor.

HINTS: - $Z = \sqrt{(XL)2 + R2} = 100\sqrt{2}$ ohm.
$I = 1.5A$
$P = I^2R = 225W.$

2. In India domestic power supply is a 220 V, 50 Hz; while in USA it is 110 V, 50 Hz. Give one advantage and one disadvantage of 220 V supply over 110 V supply.
HINTS: - For transfer of power (=V×I) at higher voltage (220 V instead of 110 V), current carried by wires is just half. Therefore, such wires need not be very thick, saving lot of transmission material and reducing the cost of transmission. This is one advantage of 220 V supply.
But to design a device of particular wattage,
$P=V^2R$, $P=V^2R$ as V^2 is 4 times, R must be four times.
If not, the dissipation or power in the form of heat will be larger on 220 V supply. This is one disadvantage of this supply.

3. In a series LCR circuit with an ac source of effective voltage 50 V, frequency $\nu = 50/\pi$ Hz, R = 300 Ω, C = 20 μF and L = 1.0 H. Find the rms current in the circuit.

HINTS: - find impedance, and then, I = V/Z.

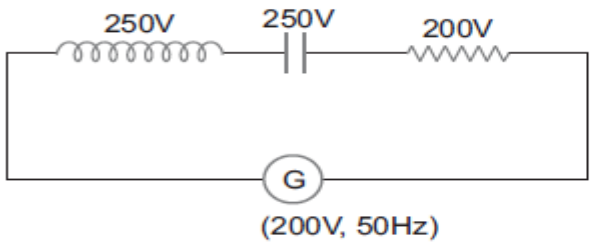
4. Determine the current quality factor at resonance for a series LCR circuit with L = 1.00 mH, C = 1.00 nF and R = 100 Ω connected to an AC source having peak voltage of 100 V.

HINTS: - $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = 10$.

5. A series LCR circuit is connected to an ac source (200 V, 50 Hz). The voltage across the resistor, capacitor and inductor are respectively 200 V, 250 V and 250 V. (i) The algebraic sum of voltages across the three elements is greater than the voltage of the source. How is this paradox resolved?
(ii) Given the value of resistor of R = 40 Ω, calculate the current in the circuit.

HINTS: - (i) voltage drop at inductor is equal and opposite to that of voltage drop at capacitor. Also, by using phasor diagram.
(ii) I = V/R = 5A.

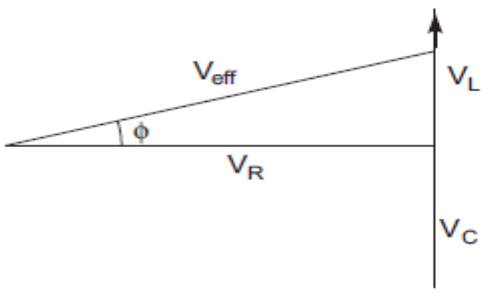
(i) From given parameters V_R = 200V, V_L = 250V and V_C = 250 V



Algebric sum of voltages = $V_R + V_L + V_C$ = 200V + 250V + 250V = 700V

However, which is > 200V of the ac source.

This paradox can be solved only by using phasor diagram, as given below:



$$(V_{eff}) = \sqrt{V_R^2 + (V_L - V_C)^2}$$

Since $V_L - V_C = 250 - 250 = 0$

$$(V_{eff}) = \sqrt{V_R^2}$$

so $V_{eff} = V_R = 200V$

(ii) Given R = 40Ω, so current in the LCR circuit.

$$I_{eff} = \frac{V_{eff}}{R} \qquad [X_L = X_C \text{ or } Z = R]$$

$$= \frac{200}{40} = 5 \text{ A}$$

6. (i) An alternating voltage given by V = 140 sin314t is connected across a pure resistor of 50 Ω. Find (a) the frequency of the source. (b) the rms current through the resistor.

(ii) How much current is drawn by the primary coil of a transformer which steps down 220 V to 22 V to operate a device with an impedance of 220 Ω?

HINTS: - (i)(a) 50 Hz (b) 2A,

(ii) current drawn in secondary coil IS = 22/220 = 0.1 A.

Power in primary = power in secondary

$V_s I_s = V_p I_p$

$I_s = V_p I_p / V_s = 0.001A.$

Given V = 140 sin 314*t*, R = 50Ω

(1) Comparing with $V = V_0 \sin \omega t$

Thus, $V_0 = 140$ V

$\omega = 314$

$2\pi\nu = 314$

$$v = \frac{314}{2 \times 3.14} Hz = 50Hz$$

(2) $$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{140}{\sqrt{2}} = 98.99V$$

$$I_{rms} = \frac{V_{rms}}{R} = \frac{98.99}{50} = 1.97A$$

Short answers type questions: -

1. Show that the current leads the voltage in phase by π/2 in ac circuit containing an ideal capacitor.

ANS.

Phase $= \frac{\pi}{2}$

If,

$V = V_0 \sin \omega t$

We know that,

$q = CV$

$q = CV_0 \sin \omega t$

Now, the current

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

$I = \frac{d(CV_0 \sin \omega t)}{dt}$

$I = \omega CV_0 \cos \omega t$

$I = \omega CV_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

Hence, the current is $\omega CV_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

2. In a series LCR circuit, obtain the conditions under which (i) the impedance of the circuit is minimum, and (ii) wattless current flows in the circuit.

Power $P = V_{rms} I_{rms} \cos\varphi$

When $\varphi = \frac{\pi}{2}$

$\text{Power} = V_{rms} I_{rms} \cos\frac{\pi}{2} = 0$

Therefore, wattless current flows when the impedance of the circuit is purely inductive or purely capacitive.

In another way we can say, for wattless current to flow, circuit should not have any ohmic resistance (R = 0)

3.Can a capacitor be used instead of a choke coil for controlling a.c.?

Hints: - A choke coil is a device that reduces current in the circuit without power dissipation.

A capacitor is a device for which the average power dissipation over one full cycle of ac is zero.

Hence, a capacitor can be used as a choke coil.

4. What is meant by back emf in a motor?

Hints: -it is the emf induced in the coil of a motor as it rotates in the magnetic field. It opposes the rotation of the coil in magnetic field.

5. What is the use of a motor starter?

Hints: - A motor starter is a variable resistance. When the motor is switched on, the starter offers maximum resistance so that a small current flow through the motor coil in the absence of back emf. This prevents damage to the motor when it is switched on.

Long answers type questions: -

1. (i) What is impedance?

(ii) A series LCR circuit is connected to an ac source having voltage $V = V_{\circ}\sin\omega t$. Derive expression for the impedance, instantaneous current and its phase relationship to the applied voltage. Find the expression for resonant frequency.

Hints: - refer to notebook.

2.Describe briefly with the help of a labelled diagram the basic elements of an ac generator.

State its underlying principle.

Show diagrammatically how an alternating emf is generated by a loop of wire rotating in a magnetic field.

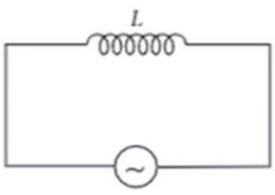
Write the expression for the instantaneous value of the emf induced in the rotating loop.

Hints: - refer to notebook.

CASE STUDY BASED QUESTIONS

AC Voltage Applied to an Inductor

Let a source of alternating e.m.f. $E = E_0\sin\omega t$ be connected to a circuit containing a pure inductance L. If I is the value of instantaneous current in the circuit, then $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The inductive reactance limits the current in a purely inductive circuit and is given by $X_L = \omega L$.



(i) A 100 hertz a.c. is flowing in a 14 mH coil. The reactance is

(a) 15 Ω (b) 7.5 Ω (c) 8.8 Ω (d) 10 Ω

(ii) In a pure inductive circuit, resistance to the flow of current is offered by

(a) resistor (b) inductor (c) capacitor (d) resistor and inductor

(iii) In a inductive circuit, by what value of phase angle does alternating current lags behind e.m.f.?

(a) 45° (b) 90° (c) 120° (d) 75°

(iv) How much inductance should be connected to 200 V, 50 Hz a.c. supply so that a maximum current of 0.9 A flows through it?

(a) 5 H (b) 1 H (c) 10 H (d) 4.5 H

(v) The maximum value of current when inductance of 2 H is connected to 150 volt, 50 Hz supply is

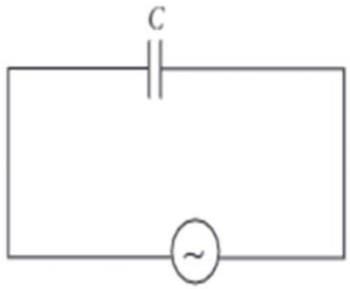
(a) 0.337 A (b) 0.721 A (c) 1.521 A (d) 2.522 A

ANS. 1, (i)c (ii)b (iii)b (iv)b (v)a

2.

AC Voltage Applied to a Capacitor

Let a source of alternating e.m.f. $E = E_0 \sin\omega t$ be connected to a capacitor of capacitance C. If 'I' is the instantaneous value of current in the circuit at instant t, then $I = \frac{E_0}{1/\omega C}\sin\left(\omega t + \frac{\pi}{2}\right)$. The capacitive reactance limits the amplitude of current in a purely capacitive circuit and it is given by $X_C = \frac{1}{\omega C}$.



A resistor of 12 Ω, a capacitor of reactance 14 Ω and a pure inductor of inductance 0.1 H are joined in series and placed across 200 V, 50 Hz a.c. supply.

(i) The value of inductive reactance is

(a) 15 Ω (b) 31.4 Ω (c) 20 Ω (d) 30 Ω

(ii) The value of impedance is

(a) 20 Ω (b) 15 Ω (c) 30 Ω (d) 21.13 Ω

(iii) What is the value of current in the circuit?

(a) 5 A (b) 15 A (c) 10 A (d) 9.46 A

(iv) What is the value of the phase angle between current and voltage?

(a) 53°9′ (b) 63°9′ (c) 55°4′ (d) 50°

(v) From graph, which one is true from following?

(a) $V_L \geq V_C$ (b) $V_L < V_C$ (c) $V_L > V_C$ (d) $V_L = V_C$

(a) 6.28×10^{-2} A (b) 7.5×10^{-4} A (c) 10.52×10^{-2} A (d) 15.25×10^{-2} A

ANS. 2, (i)c (ii)a (iii)b (iv)b (v)a

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