

	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII -All Sections	Department: SCIENCE 2025 – 26 SUBJECT: PHYSICS	Date: 03/09/2025
Worksheet No: 7	CHAPTER: 7 ALTERNATING CURRENT	Note: A4 FILE FORMAT
NAME OF THE STUDENT	CLASS & SEC:	ROLL NO.

SECTION A[1 Marks]

1. In a pure capacitive circuit if the frequency of ac source is doubled, then its capacitive reactance will be

- (a) remains same
- (b) doubled
- (c.) halved
- (d) zero

2. 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

3. In an alternating current circuit consisting of elements in series, the current increases on increasing the frequency of supply. Which of the following elements are likely to constitute the circuit?

- (a) Only resistor
- (b) Resistor and inductor
- (c) Resistor and capacitor

(d) Only inductor

4. Alternating current can not be measured by D.C. ammeter, because

(a) A. C. is virtual

(b) A. C. changes its direction

(c) A. C. can not pass through D.C. ammeter

(d) average value of A. C for complete cycle is zero

5. A transformer works on the principle of

(a) self induction

(b) electrical inertia

(b) mutual induction

(d) magnetic effect of the electrical current

6. What happens to the quality factor of an LCR circuit if the resistance is increased?

(a) Increases

(b) Decreases

(c) Remains the same

(d) None of the above

7. For an ideal-step-down transformer, the quantity that is constant for both the coils is

(a) current in the coils

(b) voltage across the coils

(c) resistance of coils

(d) power in the coils

8. The core of any transformer is laminated so as to

(a) reduce the energy loss due to eddy currents.

(b) make it light weight.

(c) make it robust and strong.

(d) increase the secondary voltage.

9. The transformation ratio in the step-up transformer is

(a) one

(b) greater than one

(c) less than one

(d) the ratio greater or less than one depends on the other factor

10. The graph between inductive reactance and frequency is

(a) parabola

(b) straight line

(c) hyperbola

(d) an arc of a circle

11. Alternating emf $E = 220\sin 100\pi t$ is applied to a circuit containing an ideal inductor of $L = 2/\pi$ H. Instantaneous value of current is

(a) $1.1\cos 100\pi t$ (b) $-1.1\cos 100\pi t$ (c) $1.1\sin 100\pi t$ (d) $-1.1\sin 100\pi t$

12. In LCR series a.c. circuit, the current

(a) is in phase with the voltage

(b) lags behind the generator voltage

(c) leads the generator voltage

(d) None of these

13. When LCR series circuit is at resonance, then the phase angle between current and voltage is

(a) 0

(b) 2π

(c) $\pi/2$

(d) π

14. An inductor

(a) offers easy path to a.c., but blocks d.c.

- (b) . offers easy path to d.c., but blocks a.c.
- (c) offers easy path to both a.c. and d.c.
- (d) None of these .

15. Choose the correct statement

- (a) the capacitor can conduct in a d.c. circuit but not an inductor.
- (b) in d.c. circuit the inductor can conduct but not a capacitor.
- (c) in d.c. circuit both the inductor and capacitor cannot conduct.
- (d) the inductor has infinite resistance in a d.c. circuit.

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.

16. 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.

17. Assertion : The voltage and current in a series AC circuit are given by $V = V_0 \sin \omega t$ and $i = i_0 \cos \omega t$. The power dissipated in the circuit is zero.

Reason : Power in AC circuit is given by $P = V_0 I_0 \cos \Phi / 2$

SECTION B[2marks]

[1] A power transmission line feeds input power at 2300 V to a step-down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary of the transformer is 5 A and its efficiency is 90%, find the output current ?

[2] A device X is connected across an ac source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$.

- (a) Identify the device X and write the expression for its reactance.
- (b) Draw graphs showing variation of voltage and current with time over one cycle of ac, for X.
- (c) How does the reactance of the device X vary with frequency of the ac ? Show this variation graphically.
- (d) Draw the phasor diagram for the device X.

[3] A charged 30 μF capacitor is connected to a 27 mH inductor. What is the angular frequency of free oscillations of the circuit?

[4] An arc lamp requires a direct current of 10A at 80V to function. If it is connected to a 220V (RMS), 50 Hz AC supply, Find the value of inductor needed for it to work the circuit?

SECTION C[3 marks]

[1] Plot a graph showing variation of current with the frequency of the applied voltage. Explain briefly how the phenomenon of resonance in the circuit can be used in the tuning mechanism of a radio or a TV set

[2] Show that in an ac circuit containing a pure inductor, the voltage is ahead of current by $\pi/2$ in phase

[3] Explain with the help of a labelled diagram the underlying principle and working of a step- up transformer. Why cannot such a device be used to step – up d.c voltage?

[4] A circuit connected to an ac source of emf $e = e_0 \sin(100 t)$ with t in seconds, gives a phase difference of $\pi/4$ between the emf e and current I. Find the value of R and C

[5] In an a.c. circuit, the instantaneous e.m.f. and current is given by

$e = 100\sin 30t$, $i = 20\sin(30t - \pi/4)$. What is the average power consumed by the circuit ?

[6] A sinusoidal voltage is applied to an electric circuit containing a circuit element 'X' in which the current leads the voltage by $\frac{\pi}{2}$.

- (a) Identify the circuit element 'X' in the circuit.
- (b) Write the formula for its reactance.
- (c) Show graphically the variation of this reactance with frequency of ac voltage.
- (d) Explain the behaviour of this element when it is used in (i) an ac circuit, and (ii) a dc circuit.

[7] Distinguish between reactance and impedance of an ac circuit. Show that an ideal inductor in an ac circuit does not dissipate any power.

[8] A series AC circuit containing an inductor of 20 mH, a capacitor of $120\mu F$ and a resistor of 60 ohm is driven by an AC source of 24V/50 Hz. What is the energy dissipated in the circuit in 60 s ?

SECTION D[4 marks]

CASE STUDY QUESTIONS :

1. A transformer is an electrical device which is used for changing a.c. voltages. It is based on the phenomenon of mutual induction. It can be shown that $\frac{E_s}{E_p} = \frac{I_p}{I_s} = \frac{n_s}{n_p} = K$, where symbols have their standard meaning. For a step up transformer, $K > 1$ and for a step down transformer, $K < 1$. The numbers of turns in the primary and secondary coils of a transformer are 2000 and 50 respectively. The primary coil is connected to main of 120 V and secondary to a night bulb of 0.6 ohm. The efficiency of transformer is 80 %.

i) A transformer is used :

- (a) to transform electric energy into mechanical energy.
- (b) to obtain suitable DC voltage.
- (c) to transform AC into DC.
- (d.) to obtain suitable AC voltage.

ii) Which quantity is increased in step-down transformer ?

- (a) resistance
- (b) power
- (c) current
- (d) charge

iii) In step-up transformer, relation between number of turns in primary(N_p) and number of turns in secondary(N_s) is

- (a) $N_s > N_p$ (b) $N_p > N_s$ (c) $N_s = N_p$ (d) $N_p = 2 N_s$

iv) Voltage across the secondary of transformer is

- (a) 120 V (b) 360 V (c) 40 V (d) 3 V

v) Current in primary coil is

- (a) 15 A (b) $5/3$ A (c) $\frac{5}{32}$ A (d) 0.6 A

SECTION E[5 marks]

[1] A small town with a demand of 1200 kW of electric power at 220 V is situated 20 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5Ω per km. The town gets the power from the line through a 4000-220 V step-down transformer at a sub-station in the town. Estimate the line power loss in the form of heat.

[2][i]With the help of labelled diagram, describe briefly the underlying principle and working of a step up transformer .[ii]Write any two sources of energy loss in a transformer[iii] A step up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain

[3] [i]Derive an expression for the impedance of a series LCR circuit connected to an AC supply of variable frequency.

[4] In a series LCR circuit connected to an AC source of variable frequency and voltage $E = E_0 \sin \omega t$, draw a plot showing the variation of current $[I]$ with angular frequency $[\omega]$ for two different values of resistances R_1 and R_2 [$R_1 > R_2$]. Write the condition under which the phenomenon of resonance occurs. For which values of the resistance out of the two curves, a sharper resonance is produced ?.

[5]a) Draw a labelled diagram of an ac generator. Obtain the expression for induced emf. b) A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 m s^{-1} , at right angles to the horizontal component of the earth's magnetic field, $0.30 \times 10^{-4} \text{ Wb m}^{-2}$. i) What is the instantaneous value of the emf induced in the wire? ii) Which end of the wire is at a higher potential?

[6] How does the resistance differ from impedance ? With the help of a suitable phasor diagram, obtain an expression for impedance of a series LCR circuit, connected to a source $v = v_m \sin \omega t$.

[7] Find the condition for resonance in a series LCR circuit connected to a source $v = v_m \sin \omega t$, where ω can be varied. Give the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing the variation of electric current with frequency in a series LCR circuit.

SECTION A [1 marks]

1. Answer: c

2. Answer: b

3. Answer: c

4. Answer: d

5. Answer: c

6. Answer: b

7. Answer: d

8. Answer: a

9. Answer: b

10. Answer: b

11. Answer: (b)

12. Answer: (d)

13. Answer: (a)

14. Answer: (b)

15. Answer: (b)

16. Answer: (c)

17. Answer: (a)

SECTION B[2 marks]

[1] Given $e_p = 2300 \text{ V}$, $N_p = 4000$

$e_s = 230 \text{ V}$, $I_p = 5 \text{ A}$,

$\eta = 90\% = 0.9$

$\eta = P_o/P_i = (e_s I_s)/(e_p I_p)$

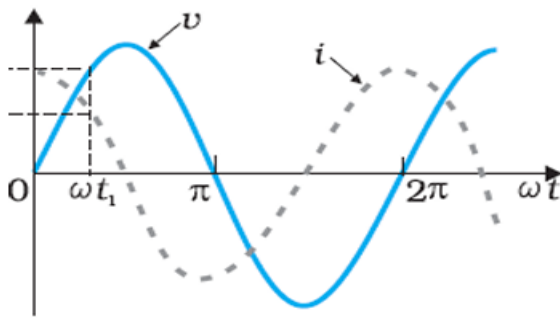
$I_s = \eta e_p I_p / e_s = (0.9 \times 2300 \times 5) / 230 = 45 \text{ A}$

[2]

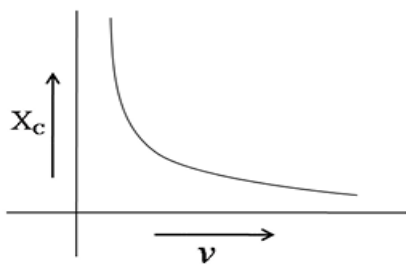
a) X : capacitor

$$\text{Reactance } X_c = \frac{1}{\omega C} = \frac{1}{2\pi\nu C}$$

b)



c) Reactance of the capacitor varies in inverse proportion to the frequency i.e. , $X_c \propto \frac{1}{\nu}$



[3] Capacitance, $C = 30\mu\text{F} = 30 \times 10^{-6}\text{F}$

Inductance, $L = 27 \text{ mH} = 27 \times 10^{-3} \text{ H}$ Angular frequency is given as:

$$\begin{aligned} \omega_r &= \frac{1}{\sqrt{LC}} \\ &= \frac{1}{\sqrt{27 \times 10^{-3} \times 30 \times 10^{-6}}} = \frac{1}{9 \times 10^{-4}} = 1.11 \times 10^3 \text{ rad/s} \end{aligned}$$

$$[4] 10 = 220 / (8^2 + X_L^2)^{1/2}$$

$$64 + X_L^2 = 484$$

$$X_L = \sqrt{420}$$

$$2\pi \times 50L = \sqrt{420}$$

$$L = \sqrt{420} / 100\pi$$

$$L = 0.065 \text{ H}$$

Answer: (a) 0.065 H

SECTION C[3marks]

[1] refer notes

[2] refer notes

[3] refer notes

[4] $X_c = R$

$$1/\omega C = R$$

$$\omega = 100 \text{ rad/s}$$

Therefore, $1/100 = RC$

Substituting values from option (a)

$$R = 1 \text{ k}\Omega = 10^3 \Omega$$

$$C = 10 \mu\text{F} = 10 \times 10^{-6} \text{ F}$$

$$RC = 10^3 \times 10 \times 10^{-6} = 1/100$$

$R = 1 \text{ k}\Omega$ and $C = 10 \mu\text{F}$

[5] $P_{\text{avg}} = (V_0/\sqrt{2}) (I_0/\sqrt{2}) \cos\theta$

$$= (100/\sqrt{2}) (20/\sqrt{2}) \cos 45^\circ$$

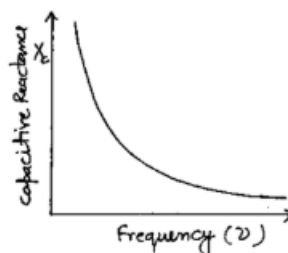
$$P_{\text{avg}} = 1000/\sqrt{2} \text{ watt}$$

[6]

(a) Capacitor

(b) $X_c = \frac{1}{\omega C}$

(c)



(d) (i) For ac X_c is finite and therefore allows the ac to pass.

(ii) For dc X_c is infinite and therefore does not allow the dc to pass.

[7] refer notes.

[8]

$$Z = (R^2 + (X_C - X_L)^2)^{1/2}$$

$$X_L = \omega L = (2\pi\nu L)$$

$$X_L = 6.28 \times 50 \times 20 \times 10^{-3} = 6.28 \Omega$$

$$X_C = (1/\omega C) = 1/(2\pi\nu C) = 1/(6.28 \times 120 \times 10^{-6} \times 50) = 26.54 \Omega$$

$$X_C - X_L = 26.54 - 6.28 = 20.26$$

$$Z = ((60)^2 + (20.26)^2)^{1/2}$$

$$Z^2 = 4010 \Omega^2$$

$$\text{Average power dissipated, } P_{av} = \epsilon_{rms} I_{rms} \cos \Phi$$

$$P_{av} = \epsilon_{rms} \times (\epsilon_{rms}/Z) \times (R/Z)$$

$$P_{av} = (\epsilon_{rms}^2/Z^2) \times R = [(24)^2/4010] \times 60 \text{ W} = 8.62 \text{ W}$$

$$\text{Energy dissipated in 60 s} = 8.62 \times 60 = 5.17 \times 10^2 \text{ J}$$

SECTION D[4marks]

[1] d [2] c [3] a [4] d [5] a

SECTION E (5 marks)

[1]

$$R = \frac{V_{rm}}{I_{rms}} = \frac{200}{1} = 200 \Omega$$

Impedance of the inductor

$$Z = \frac{V_{rms}}{I_{rms}} = \frac{200}{0.5} = 400 \Omega$$

$$\text{Since } Z = \sqrt{R^2 + (X_L)^2}$$

$$\therefore (400)^2 - (200)^2 = (X_L)^2$$

$$X_L = \sqrt{600 \times 200} = 346.4 \Omega$$

$$\text{Inductance (L)} = \frac{X_L}{\omega} = \frac{364.4}{2 \times 3.14 \times 50} = 1.1 \text{ H}$$

(b) Total resistance of the line = length X resistance per unit length = 40 km x 0.5 Ω/km = 20 Ω

Current flowing in the line $I = P/V$

$$I = \frac{1200 \times 10^3}{4000}$$

$$= 300\text{A}$$

$\therefore$ Line power loss in the form of heat

$$P = I^2 R$$

$$= (300)^2 \times 20$$

$$= 1800 \text{ kW}$$

[2] REFER NOTES

[3] REFER NOTES

[4] REFER NOTES

[5][1] REFER NOTES

i) The core of the transformer is laminated to minimize energy loss due to eddy currents ii) thick copper wires are used in the windings to minimize energy loss as heat due to Joule heating.

$$[b][i] \text{Emf } e = Blv = 0.4 \times 0.2 \times 0.1 = 0.008 \text{ V}$$

$$(ii) I = e/R = 0.008/0.1 = 0.08\text{A}$$

[6]REFER NOTES

[7]REFER NOTES

<i>Prepared by:</i> <i>Mr William Donald Seemanthy</i>	<i>Checked by:</i> <i>HOD Science</i>
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