DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 47

SYLLABUS : ALTERNATING CURRENT - 2 (LCR series circuit, resonance, quality factor, power in AC circuits, wattless and power current)

Max. Marks : 116 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 29 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 In a series LCR circuit capacitance is changed from C to 2 C. For the resonant frequency to remain unchanged, the inductance would be changed from L to

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

Q.2 The power factor of LCR circuit at resonance is

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

Q.3 An alternating current source of frequency 100 Hz is joined to a combination of a resistance, a capacitance and a inductance in series. The potential difference across the inductance, 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

Q.4 A 10 ohm resistance, 5 mH inductance coil and 10 μF 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) is halved (b) is doubled
(c) remains unchanged (d) is quadrupled

Q.5 The phase difference between the current and voltage of LCR circuit in series combination at resonance is

(a) $0°$ (b) $\pi/2$
(c) π (d) $-\pi$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 The coefficient of induction of a choke coil is $0.1H$ and resistance is 12Ω. If it is connected to an alternating current source of frequency 60 Hz, then power factor is approximately
(a) 0.4 (b) 0.30 (c) 0.2 (d) 0.1

Q.7 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) 2f (c) f (d) f/4

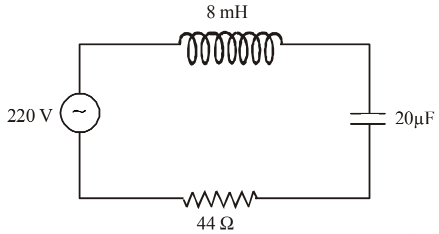
Q.8 In the non-resonant circuit, what will be the nature of the circuit for frequencies higher than the resonant frequency?
(a) Resistive (b) Capacitive
(c) Inductive (d) None of the above

Q.9 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° (b) 45° (c) 60° (d) 90°

Q.10 An alternating e.m.f. of frequency $\nu\left(=\frac{1}{2\pi\sqrt{LC}}\right)$ 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 not in phase with the applied e.m.f. and the voltage across R equals this applied emf
(c) The sum of the p.d.'s across the inductance and capacitance equals the applied e.m.f. which is 180° ahead of phase of the current in the circuit
(d) The quality factor of the circuit is $\omega L/R$ or $1/\omega CR$ 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

Q.11 In a circuit L,C and R are connected in series with an alternating voltage source of frequency f. The current leads the voltage by 45°. The value of C is
(a) $\frac{1}{2\pi f(2\pi fL+R)}$ (b) $\frac{1}{\pi f(2\pi fL+R)}$
(c) $\frac{1}{2\pi f(2\pi fL-R)}$ (d) $\frac{1}{\pi f(2\pi fL-R)}$

Q.12 For the series LCR circuit shown in the figure, what is the resonance frequency and the amplitude of the current at the resonating frequency



(a) $2500\,\text{rad s}^{-1}$ and $5\sqrt{2}A$ (b) $2500\,\text{rad s}^{-1}$ and $5A$
(c) $2500\,\text{rad s}^{-1}$ and $\frac{5}{\sqrt{2}}A$ (d) $25\,\text{rad s}^{-1}$ and $5\sqrt{2}A$

Q.13 In an ac circuit, V and I are given by $V = 100\sin(100\,t)$ volt, $I = \sin\left(100t+\frac{\pi}{3}\right)$ mA. The average power dissipated in circuit is
(a) 10^4 watt (b) 10 watt
(c) 0.025 watt (d) 2.5 watt

Q.14 For a series LCR circuit $R = X_L = 2X_C$. The impedance of the circuit and phase difference between V and I respectively will be
(a) $\frac{\sqrt{5}R}{2}, \tan^{-1}(2)$ (b) $\frac{\sqrt{5}R}{2}, \tan^{-1}(1/2)$
(c) $\sqrt{5}X_C, \tan^{-1}(2)$ (d) $\sqrt{5}R, \tan^{-1}(1/2)$

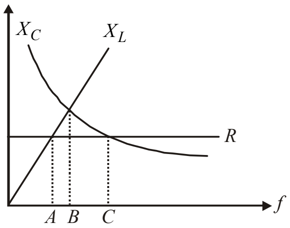
Q.15 If a current I given by $I_0\sin\left(\omega t-\frac{\pi}{2}\right)$ flows in an ac circuit across which an ac potential of $E = E_0\sin\omega t$ has been applied, then the average power consumption P in the circuit will be
(a) $P = \frac{E_0I_0}{\sqrt{2}}$ (b) $P = \sqrt{2}E_0I_0$
(c) $P = \frac{E_0I_0}{2}$ (d) $P = 0$

Q.16 An ac supply gives $30V$ *r.m.s.* which passes through a $10\,\Omega$ resistance. The power dissipated in it is
(a) $90\sqrt{2}$ W (b) 90 W (c) $45\sqrt{2}$ W (d) 45 W

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ				

Space for Rough Work

Q.17 The figure shows variation of R, X_L and X_C with frequency f in a series L, C, R circuit. Then for what frequency point, the circuit is inductive

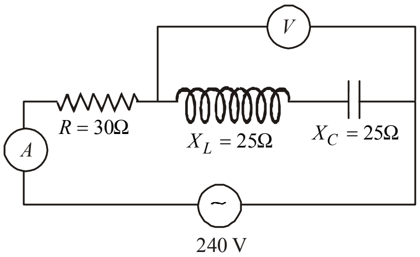


(a) A (b) B (c) C (d) All points

Q.18 An alternating e.m.f. of angular frequency ω is applied across an inductance. The instantaneous power developed in the circuit has an angular frequency

(a) $\frac{\omega}{4}$ (b) $\frac{\omega}{2}$ (c) ω (d) 2ω

Q.19 In the circuit shown in figure neglecting source resistance the voltmeter and ammeter reading will respectively, be



(a) $0V, 3A$ (b) $150V, 3A$

(c) $150V, 6A$ (d) $0V, 8A$

Q.20 In an LCR circuit, the sharpness of resonance depends on

(a) Inductance (L) (b) Capacitance (C)

(c) Resistance (R) (d) All of these

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct

(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.21 For series LCR circuit, correct statements are

(1) Applied e.m.f. and potential difference across resistance may be in phase

(2) Applied e.m.f. and potential difference at inductor coil have phase difference of $\pi/2$

(3) Potential difference across resitance and capacitor have phase difference of $\pi/2$

(4) Potential difference at capacitor and inductor have phase difference of $\pi/2$

Q.22 An ac source is connected to a resistive circuits. Which of the following statements are false?

(1) Current leads the voltage

(2) Current lags behind the voltage

(3) Any of (1) or (2) may be true depending upon the value of resistance

(4) Current and voltage are in same phase

Q.23 A series LCR arrangement with $X_L = 80\,\Omega, X_C = 50\,\Omega, R = 40\,\Omega$ is applied across a.c. source of 200 V. Choose the correct options.

(1) Wattless current = 3.2 A

(2) Power current = 3.2 A

(3) Power factor = 0.6

(4) Impedance of circuit = 50 Ω

DIRECTIONS (Q.24-Q.26) : Read the passage given below and answer the questions that follows :

A student constructs a series RLC circuit. While operating the circuit at a frequency f she uses an AC voltmeter and measures the potential difference across each device as $(\Delta V_R) = 8.8$ V, $(\Delta V_L) = 2.6$V and $(\Delta V_C) = 7.4$V.

Q.24 The circuit is constructed so that the inductor is next to the capacitor. What result should the student expect for a measurement of the combined potential difference $(\Delta V_L + \Delta V_C)$ across the inductor and capacitor ?

(a) 10.0 V (b) 7.8 V

(c) 7.4 V (d) 4.8 V

Q.25 What result should the student expect for a measurement of the amplitude E_m of the potential difference across the power supply ?

(a) 18.8 V (b) 13.6 V (c) 10.0 V (d) 4.0 V

RESPONSE GRID					
	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ
	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	

Space for Rough Work

Q.26 What will happen to the value of (ΔV_L) if the frequency is adjusted to increase the current through the circuit?

(a) (ΔV_L) will increase.

(b) (ΔV_L) will decrease.

(c) (ΔV_L) will remain the same regardless of any changes to f.

(d) There is not enough information to answer the question.

DIRECTIONS (Q. 27-Q.29) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.27 Statement-1 : For an electric lamp connected in series with a variable capacitor and ac source, its brightness increases with increase in capacitance.

Statement-2 : Capacitive reactance decreases with increase in capacitance of capacitor.

Q.28 Statement-1 : When capacitive reactance is smaller than the inductive reactance in LCR current, e.m.f. leads the current.

Statement-2 : The phase angle is the angle between the alternating e.m.f. and alternating current of the circuit.

Q.29 Statement-1 : Choke coil is preferred over a resistor to adjust current in an ac circuit.

Statement-2 : Power factor for inductance is zero.

RESPONSE GRID					
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 47 - PHYSICS			
Total Questions	29	Total Marks	116
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	26	Qualifying Score	46
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

47

1. **(a)** For resonant frequency to remain same LC should be const. LC = const

$\Rightarrow LC = L' \times 2C \Rightarrow L' = \frac{L}{2}$

2. **(b)** At resonance, LCR circuit behaves as purely resistive circuit, for purely resistive circuit power factor = 1

3. **(a)** If the current is wattless than power is zero. Hence phase difference $\phi = 90°$

4. **(c)** $V_L = 46\ volts,\ V_C = 40\ volts,\ V_R = 8\ volts$

E.M.F. of source $V = \sqrt{8^2 + (46-40)^2} = 10\ volts$

5. **(c)** Resonant frequency $= \frac{1}{2\pi\sqrt{LC}}$ does not depend on resistance.

6. **(a)** At resonance LCR series circuit behaves as pure resistive circuit. For resistive circuit $\phi = 0°$

7. **(b)** $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + \omega^2 L^2}}$

$= \frac{12}{\sqrt{(12)^2 + 4\times\pi^2\times(60)^2\times(0.1)^2}} \Rightarrow \cos\phi = 0.30$

8. **(a)** $f = \frac{1}{2\pi\sqrt{LC}} \Rightarrow f \propto \frac{1}{\sqrt{C}}$

9. **(b)** In non resonant circuits

impedance $Z = \frac{1}{\sqrt{\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2}}$, with rise in frequency Z decreases *i.e.* current increases so circuit behaves as capacitive circuit.

10. **(c)** $\cos\phi = \frac{R}{Z} = \frac{10}{20} = \frac{1}{2} \Rightarrow \phi = 60°$

11. **(d)**

12. **(a)** $\tan\phi = \frac{X_C - X_L}{R} \Rightarrow \tan 45° = \frac{\frac{1}{2\pi fC} - 2\pi fL}{R}$

$\Rightarrow C = \frac{1}{2\pi f(2\pi fL + R)}$

13. **(b)** Resonance frequency

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{8\times10^{-3}\times20\times10^{-6}}} = 2500\ rad/sec$

Resonance current $= \frac{V}{R} = \frac{220}{44} = 5A$

14. **(c)** $P = V_{r.m.s.} \times i_{r.m.s.} \times \cos\phi = \frac{100}{\sqrt{2}} \times \frac{10^{-3}}{\sqrt{2}} \times \cos\frac{\pi}{3}$

$= \frac{10^2\times10^{-3}}{2} \times \frac{1}{2} = \frac{10^{-1}}{4} = 0.025\ watt$

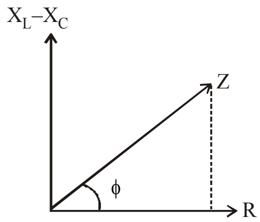
15. (b) $R = X_L = 2X_C$

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

$= \sqrt{(2X_C)^2 + (2X_C - X_C)^2}$

$= \sqrt{4X_C^2 + X_C^2}$

$= \sqrt{5}X_C = \frac{\sqrt{5}R}{2}$



$\tan\phi = \frac{X_L - X_C}{R} = \frac{2X_C - X_C}{2X_C}$

$\tan\phi = \frac{1}{2}$; $\phi = \tan^{-1}\left(\frac{1}{2}\right)$

16. **(d)** Phase angle $\phi = 90°$, so power $P = V_{rms} I_{rms} \cos\phi = 0$

17. **(b)** $P = \frac{V_{rms}^2}{R} = \frac{(30)^2}{10} = 90\ W$

18. **(c)** At $A: X_C > X_L$

At $B: X_C = X_L$

At $C: X_C < X_L$

19. **(d)** The instantaneous values of emf and current in inductive circuit are given by $E = E_0 \sin at$ and $i = i_0 \sin\left(\omega - \frac{\pi}{2}\right)$ respectively.

So, $P_{inst} = Ei = E_0 \sin\omega t \times i_0 \sin\left(\omega t - \frac{\pi}{2}\right)$

$= E_0 i_0 \sin\omega t \cos\omega t$

$= \frac{1}{2}E_0 i_0 \sin 2\omega t \quad (\sin 2\omega t = 2\sin\omega t\cos\omega t)$

Hence, angular frequency of instantaneous power is 2ω.

20. **(d)** The voltage V_L and V_C are equal and opposite so voltmeter reading will be zero.

Also $R = 30\Omega, X_L = X_C = 25\Omega$

So $i = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}} = \frac{V}{R} = \frac{240}{30} = 8A$

21. **(d)** Since quality factor, $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

22. **(d)**

23. **(a)**

24. **(c)** Reactance $Z = \sqrt{(X_L - X_C)^2 + R^2}$

$= \sqrt{(80-50)^2 + 40^2}$

$= 50\ W$

Power factor $= \cos\phi = \frac{R}{Z} = \frac{40}{50} = 0.8$

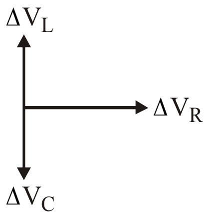
$I_{rms} = \frac{V_{rms}}{Z} = \frac{200V}{50\Omega} = 4\,A$

Power current $= I_{rms}.\cos\phi = 4 \times 0.8$
$= 3.2\,A$

Wattless current $= I_{rms}.\sin\phi = 4 \times 0.6$
$= 2.4\,A$

Sol. **25-27**

25. **(d)**



$(\Delta V_L + \Delta V_C)_{max} = \Delta V_C - \Delta V_L = 7.4 - 2.6 = 4.8$ volt

26. **(c)** $E_m = \sqrt{(\Delta V_R)^2_{max} + (\Delta V_C - \Delta V_L)^2_{max}}$

$= \sqrt{(8.8)^2 + (4.8)^2} = 10$ volt

27. **(a)** If f ↑ then $(\Delta V_L)_{max}$ ↑

28. **(a)** Capacitive reactance XC = $\frac{1}{\omega C}$. When capacitance (C) increase, the capacitive reactance decreases. Due to decrease in its values, the current in the circuit will increase $\left(I = \frac{E}{\sqrt{R^2 + X_C^2}}\right)$ and hence brightness of source (or electric lamp) will also increase.

29. **(b)** The phase angle for the *LCR* circuit is given by

$$\tan\phi = \frac{X_L - X_C}{R} = \frac{\omega L - \frac{1}{\omega C}}{R}$$

where X_L, X_C are inductive reactance and capacitive reactance respectively when $X_L > X_C$ then $\tan\phi$ is positive i.e. ϕ is positive (between 0 and $\pi/2$). Hence emf leads the current.

30. **(a)** If resistor is used in controlling ac supply, electrical energy will be wasted in the form of heat energy across the resistance wire. However, ac supply can be controlled with choke without any wastage of energy. This is because, power factor ($\cos\phi$) for resistance is unity and is zero for an inductance. [$P = EI\cos\phi$].