

# Ultimate KCET Crash Course 2026

## PHYSICS

### Alternating Current and Electromagnetic Waves

### DPP :- 01

**Q1** The rms value of the electric field of the light coming from the sun is  $720 \text{ N/C}$ . The average total energy density of the electromagnetic wave is

- (A)  $3.3 \times 10^{-3} \text{ J/m}^3$   
 (B)  $4.58 \times 10^{-6} \text{ J/m}^3$   
 (C)  $6.37 \times 10^{-9} \text{ J/m}^3$   
 (D)  $81.35 \times 10^{-12} \text{ J/m}^3$

**Q2** An electromagnetic wave is transposing energy in the negative  $y$  direction. At one point and one instant the magnetic field is in the positive  $x$  direction. The electric field at that point and instant is

- (A) Positive  $y$  direction  
 (B) Negative  $y$  direction  
 (C) Positive  $z$  direction  
 (D) Negative  $z$  direction

**Q3** If electric field in an electromagnetic wave is given by  $E = 6 \times 10^6 \frac{\text{V}}{\text{m}} \sin(2\pi ft - \frac{2\pi}{\lambda} x)$ . The peak value of magnetic field in the region is:

- (A) 20 T                      (B) 2 T  
 (C) 0.2 T                    (D) 0.02 T

**Q4** The electric field part of an electromagnetic wave in a medium is represented by

$$E_x = 0, E_y = 2.5 \frac{\text{N}}{\text{C}} \cos \left[ \left( 2\pi \times 10^6 \frac{\text{rad}}{\text{s}} \right) t - \left( \pi \times 10^{-2} \frac{\text{rad}}{\text{m}} \right) x \right],$$

$$E_z = 0$$

- (A) Moving along  $x$  direction with frequency  $10^6$  Hz and wavelength 100m  
 (B) Moving along  $x$  direction with frequency  $10^6$  and wavelength 200 m  
 (C) Moving along  $y$  direction with frequency  $10^6$  Hz and wavelength 200 m  
 (D) moving along  $y$  direction with frequency  $2\pi \times 10^6$  Hz and wavelength 200 m

**Q5** The electric field part of an electromagnetic wave in a medium is represented by  $E_x = 0$

$$E_y = 2.5 \frac{\text{N}}{\text{C}} \cos \left[ \left( 2\pi \times 10^6 \frac{\text{rad}}{\text{s}} \right) t - \left( \pi \times 10^{-2} \frac{\text{rad}}{\text{m}} \right) x \right]$$

$E_z = 0$ . The wave is

- (A) Moving along  $y$  direction with frequency  $2\pi \times 10^6$  Hz and wavelength 200 m.  
 (B) Moving along  $x$ -direction with frequency  $10^6$  Hz and wavelength 200 m.  
 (C) Moving along  $x$ -direction with frequency  $10^6$  Hz and wavelength 100 m.  
 (D) Moving along  $-x$  direction with frequency  $10^6$  Hz and wavelength 200 m.

**Q6** In a plane electromagnetic wave, the directions of electric field and magnetic field are represented by  $\hat{k}$  and  $2\hat{i} - 2\hat{j}$  respectively. What is the unit vector along direction of propagation of the wave?

- (A)  $\frac{1}{\sqrt{5}}(\hat{i} + 2\hat{j})$   
 (B)  $\frac{1}{\sqrt{2}}(\hat{i} + \hat{k})$   
 (C)  $\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$   
 (D)  $\frac{1}{\sqrt{5}}(2\hat{i} + \hat{j})$

**Q7** The magnetic field of an electromagnetic wave is given by  $B_y = 3 \times 10^{-7} \sin(10^3 x + 6.28 \times 10^{12} t)$ . The wavelength of the electromagnetic wave is:

- (A) 6.28 cm                      (B) 3.14 cm  
 (C) 0.63 cm                    (D) 0.32 cm

**Q8** A plane electromagnetic wave propagating in  $x$ -direction is described by

$$E_y = (200 \text{ Vm}^{-1}) \sin[1.5 \times 10^7 t - 0.05x];$$



The intensity of the wave is : (Use  $\epsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$ )  
 (A)  $35.4 Wm^{-2}$   
 (B)  $26.6 Wm^{-2}$   
 (C)  $53.1 Wm^{-2}$   
 (D)  $106.2 Wm^{-2}$

**Q9** In an electromagnetic wave in free space the root mean square value of the electric field is  $E_{rms} = 6 V/m$ . The peak value of the magnetic field is

- (A)  $1.41 \times 10^{-8} T$   
 (B)  $2.83 \times 10^{-8} T$   
 (C)  $0.70 \times 10^{-8} T$   
 (D)  $4.23 \times 10^{-8} T$

**Q10** An electromagnetic wave with frequency  $\omega$  and wavelength  $\lambda$  travels in the  $+y$  direction. Its magnetic field is along  $+x$ -axis. The vector equation for the associated electric field (of amplitude  $E_0$ ) is

- (A)  $\vec{E} = -E_0 \cos(\omega t + \frac{2\pi}{\lambda} y) \hat{x}$   
 (B)  $\vec{E} = E_0 \cos(\omega t - \frac{2\pi}{\lambda} y) \hat{x}$   
 (C)  $\vec{E} = E_0 \cos(\omega t - \frac{2\pi}{\lambda} y) \hat{z}$   
 (D)  $\vec{E} = -E_0 \cos(\omega t + \frac{2\pi}{\lambda} y) \hat{z}$

**Q11** In series LCR circuit, the capacitance is changed from  $C$  to  $4C$ . To keep the resonance frequency unchanged, the new inductance should be:

- (A) reduced by  $\frac{1}{4}L$   
 (B) increased by  $2L$   
 (C) reduced by  $\frac{3}{4}L$   
 (D) increased to  $4L$

**Q12** A  $40\mu F$  capacitor is connected to a  $200 V, 50 Hz$  ac supply. The r.m.s value of the current in the circuit is, nearly

- (A)  $1.7 A$   
 (B)  $2.05 A$   
 (C)  $2.5 A$   
 (D)  $25.1 A$

**Q13** The output of a step-down transformer is measured to be  $24 V$  when connected to a  $12$

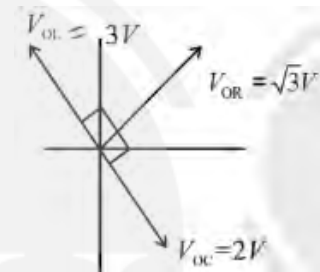
watt light bulb. The value of the peak current is

- (A)  $\frac{1}{\sqrt{2}} A$   
 (B)  $\sqrt{2} A$   
 (C)  $2 A$   
 (D)  $2\sqrt{2} A$

**Q14** In the AC circuit, the potential across a resistance is expressed as  $E = 10 \sin(20\pi t)V$ . Voltage rises from zero to peak value in time:

- (A)  $\frac{1}{40} s$  (B)  $\frac{1}{30} s$   
 (C)  $\frac{1}{10} s$  (D)  $\frac{1}{20} s$

**Q15** The given figure represents the phasor diagram of a series LCR circuit connected to an ac source. At the instant  $t'$  when the source voltage is given by  $V = V_0 \cos \omega t$ , the current in the circuit will be



- (A)  $I = I_0 \cos(\omega t' + \pi/6)$   
 (B)  $I = I_0 \cos(\omega t' - \pi/6)$   
 (C)  $I = I_0 \cos(\omega t' + \pi/3)$   
 (D)  $I = I_0 \cos(\omega t' - \pi/3)$

**Q16** The r.m.s value of current  $= [3 + 4 \sin(\omega t + \pi/3)] A$  is;

- (A)  $5 A$  (B)  $\sqrt{17} A$   
 (C)  $\frac{5}{\sqrt{2}} A$  (D)  $\frac{7}{\sqrt{2}} A$

**Q17** In an AC circuit, the current flowing in inductance is  $I = 5 \sin(100t - \pi/2) A$  and the potential difference is  $V = 200 \sin(100t) V$ .

The power consumption is equal to:

- (A) Zero  
 (B)  $20 W$   
 (C)  $40 W$   
 (D)  $1000 W$

**Q18** The potential differences across the resistance, capacitance and inductance are  $80 V, 40 V$



and  $100\text{ V}$  respectively in an L-C-R circuit. The power factor of this circuit is:-

- (A) 0.4 (B) 0.5  
(C) 0.8 (D) 1

**Q19** In LCR series circuit an ac emf of 2 volt and frequency 50 Hz is applied across the combination. If resistance is  $4\Omega$ , capacitance is  $8\mu\text{F}$  and inductance is  $10^{-2}\text{ H}$  then the voltage across inductor will be

- (A)  $(3/5\text{ V})$  (B)  $(5/3\text{ V})$   
(C)  $(2/3\text{ V})$  (D)  $(0.02\text{ V})$

**Q20** An ac source is rated at  $220\text{ V}$ ,  $50\text{ Hz}$ . 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)  $5 \times 10^{-3}\text{ sec}$

**Q21** A  $60\text{ W}$  load is connected to the secondary of a transformer whose primary draws line voltage is  $220\text{ V}$ . If a current of  $0.54\text{ A}$  flows in the load, then what is the current in the primary coil?

- (A) 2.7 A (B) 0.27 A  
(C) 1.65 A (D) 2.85 A

**Q22** The reactance of an inductor at a frequency of  $60\text{ Hz}$  is  $12\Omega$ . The reactance of the same inductor when the frequency is increased to  $180\text{ Hz}$  is

- (A)  $4\Omega$  (B)  $18\Omega$   
(C)  $36\Omega$  (D)  $24\Omega$

**Q23** The rms value of an alternating voltage given by an equation  $e = (8\sin\omega t - 4\cos\omega t)$  volt is:

- (A)  $2\sqrt{5}$  volt (B)  $4\sqrt{5}$  volt  
(C)  $2\sqrt{10}$  volt (D)  $4\sqrt{10}$  volt

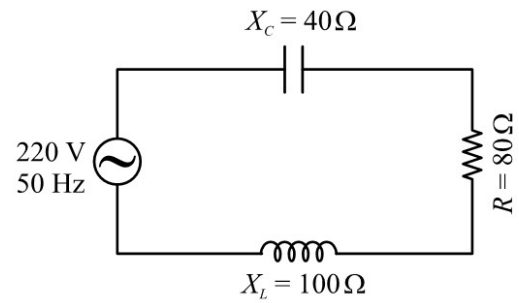
**Q24** An alternating current is given by

$$i = 6\sin\omega t + 8\cos\omega t$$

Find the r.m.s. value of the current.

- (A)  $\sqrt{52}\text{ A}$  (B)  $\sqrt{50}\text{ A}$   
(C)  $\sqrt{36}\text{ A}$  (D)  $\sqrt{20}\text{ A}$

**Q25** The power factor of the circuit shown in figure is:



- (A) 0.2  
(B) 0.6  
(C) 0.8  
(D) 0.4

**Q26** An alternating current is given by the equation  $i = i_1 \cos\omega t + i_2 \sin\omega t$ . The r.m.s current is given by

- (A)  $\frac{1}{\sqrt{2}}(i_1 + i_2)$  (B)  $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)$   
(C)  $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$  (D)  $\frac{1}{2}(i_1^2 + i_2^2)^{1/2}$

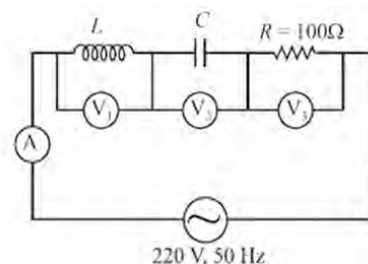
**Q27** A resistor and an inductor are connected to an ac supply of  $120\text{ V}$  and  $50\text{ Hz}$ . The current in the circuit is  $3\text{ A}$ . If the power consumed in the circuit is  $108\text{ W}$ , then the resistance in the circuit is

- (A)  $12\Omega$  (B)  $40\Omega$   
(C)  $30\Omega$  (D)  $360\Omega$

**Q28** A transformer having efficiency of 70% is working on  $200\text{ V}$  and  $5\text{ KW}$  power supply. If the current in the secondary coil is  $2\text{ A}$ , then the voltage across the secondary coil is:

- (A)  $850\text{ V}$   
(B)  $650\text{ V}$   
(C)  $2500\text{ V}$   
(D)  $1750\text{ V}$

**Q29** In the given circuit, the reading of voltmeter  $V_1$  and  $V_2$  are  $300\text{ volts}$  each. The reading of the voltmeter  $V_3$  and ammeter  $A$  are respectively



- (A) 150 V, 2.2 A
- (B) 220 V, 2.2 A
- (C) 220 V, 2.0 A
- (D) 100 V, 2.0 A

- Q30** In a series resonant  $R$ - $L$ - $C$  circuit, if  $L$  is increased by 25% and  $C$  is decreased by 20%, then the resonant frequency of the circuit will;
- (A) Increase by 10%
  - (B) Decrease by 10%
  - (C) Remain unchanged
  - (D) Increase by 2.5%



## Answer Key

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Q1 (B)  
Q2 (D)  
Q3 (D)  
Q4 (B)  
Q5 (B)  
Q6 (C)  
Q7 (C)  
Q8 (C)  
Q9 (B)  
Q10 (C)  
Q11 (C)  
Q12 (C)  
Q13 (A)  
Q14 (A)  
Q15 (B)

Q16 (B)  
Q17 (A)  
Q18 (C)  
Q19 (D)  
Q20 (D)  
Q21 (B)  
Q22 (C)  
Q23 (C)  
Q24 (B)  
Q25 (C)  
Q26 (C)  
Q27 (A)  
Q28 (D)  
Q29 (B)  
Q30 (C)



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# Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Video Solution:



Q2 Video Solution:



Q3 Text Solution:

$$\frac{E_0}{B_0} = c, \frac{6 \times 10^6}{3 \times 10^8} = 2 \times 10^{-2} \text{ T}$$

Video Solution:



Q4 Text Solution:

Standard equation of E.M. wave is

$$E_y = E_0 \cos(\omega t - kx)$$

Given equation

$$E_y = 2$$

$$.5 \frac{N}{C} \cos$$

$$\left[ (2\pi \times 10^6 \frac{\text{rad}}{\text{s}})t - (\pi \times 10^{-2} \frac{\text{rad}}{\text{m}})x \right]$$

$$\omega = 2\pi f, \quad K = \pi \times 10^{-2}$$

$$\omega = 2\pi \times 10^6 \quad K = \frac{2\pi}{\lambda}$$

$$f = 10^6 \text{ Hz} \quad \lambda = \frac{2\pi}{K} = \frac{2\pi}{\pi \times 10^{-2}}$$

$$\lambda = 200 \text{ m}$$

Hence, the wave is moving along positive  $x$ -direction with frequency  $10^6$  Hz and wavelength 200 m.

Video Solution:



Q5 Video Solution:



Q6 Video Solution:



Q7 Text Solution:

(C)

Given,  $B_y = 3 \times 10^{-7} \sin(10^3 x + 6.28 \times 10^{12} t)$

Comparing with the general equation

$B_y = B_0 \sin(kx + \omega t)$ , we get

$$k = 10^3 \Rightarrow \frac{2\pi}{\lambda} = 10^3 \left( \because k = \frac{2\pi}{\lambda} \right)$$

Wavelength of electromagnetic wave

$$\lambda = \frac{2\pi}{10^3} = 6.28 \times 10^{-3} \text{ m} = 0.63 \text{ cm}$$

Video Solution:



Q8 Video Solution:



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Q9 Video Solution:



Q10 Video Solution:



Q11 Video Solution:



Q12 Text Solution:

The impedance of the capacitor is given by:

$$X_c = \frac{1}{2\pi fC}$$

$$I_{rms} = \frac{V}{X_c}$$

$$I_{rms} = 200 \times 2 \times \pi \times 50 \times 40 \times 10^{-6}$$

$$I_{rms} = 2.5A$$

Video Solution:



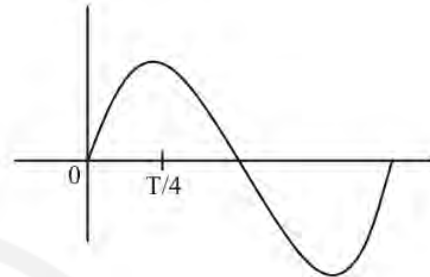
Q13 Video Solution:



Q14 Text Solution:

(1)

$$T = \frac{1}{f} = \frac{1}{10} \text{ s}$$



$$t = \frac{T}{4} = \frac{1}{40} \text{ s}$$

Video Solution:



Q15 Video Solution:



Q16 Text Solution:

(2)

$$I_{rms} = \sqrt{\frac{1}{T} \int_0^T [3 + 4 \sin(\omega t + \pi/3)]^2 dt}$$

For one complete cycle

$$\langle \sin^2 \omega t \rangle = \frac{1}{2} \text{ and } \langle \cos \omega t \rangle = \langle \sin \omega t \rangle = 0$$

$$I_{rms} = \sqrt{9 + \frac{16}{2}}$$

$$I_{rms} = \sqrt{17} \text{ A}$$

Video Solution:





**Q17 Video Solution:**



**Q18 Text Solution:**

$$V_R = 80V, V_L = 100V, V_C = 40V$$

$$\text{Power factor, } \cos\phi = \frac{R}{Z} =$$

$$\frac{V_R}{\sqrt{V_R^2 + (V_L - V_C)^2}}$$

$$\cos\phi = \frac{80}{\sqrt{80^2 + (100 - 40)^2}} = \frac{80}{100} = 0.8$$

$$\text{so the power factor} = \frac{V_R}{Z} = \frac{80}{100} = 0.8$$

**Video Solution:**



**Q19 Text Solution:**

$$I = \frac{e}{Z}, X_L = 2\pi fL = 2 \times 3.14 \times 50 \times 10^{-2}$$

$$= 3.14 \Omega$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2 \times 3.14 \times 50 \times 8 \times 10^{-6}}$$

$$= \frac{0.3185 \times 10^4}{8} = \frac{3185}{8} = 397 \Omega$$

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

$$Z = 397 \Omega$$

$$e_L = I \cdot X_L = \frac{e}{Z} \cdot X_L = \frac{2}{397} \times 3.14$$

$$= 0.02 V$$

**Video Solution:**



**Q20 Text Solution:**

$$\text{Required time } t = \frac{T}{4} = \frac{1}{4 \times 50} = 5 \times 10^{-3} \text{ sec}$$

**Video Solution:**



**Q21 Video Solution:**



**Q22 Text Solution:**

**Ans. (C)**

Inductive reactance is given by

$$X_L = 2\pi fL \Rightarrow X_L \propto f$$

Ratio of frequencies:

$$\frac{f_2}{f_1} = \frac{180}{60} = 3$$

Ratio of reactances:

$$\frac{X_2}{X_1} = 3$$

New reactance:

$$X_2 = 3 \times 12 = 36 \Omega$$

**Video Solution:**



**Q23 Text Solution:**

(3)



$$e_0 = \sqrt{(8)^2 + (4)^2} = \sqrt{80}$$

$$e_{rms} = \frac{e_0}{\sqrt{2}} = \sqrt{40} \text{ volt}$$

**Video Solution:**



**Q24 Text Solution:**

1. For  $i = i_1 \sin \omega t + i_2 \cos \omega t$ ,

$$i_{rms} = \sqrt{\frac{i_1^2 + i_2^2}{2}}$$

2. Here  $i_1 = 6, i_2 = 8$ . So

$$i_{rms} = \sqrt{\frac{6^2 + 8^2}{2}} = \sqrt{\frac{36 + 64}{2}} = \sqrt{\frac{100}{2}} = \sqrt{50}$$

3. Final answer:  $\sqrt{50}$  A.

**Video Solution:**



**Q25 Text Solution:**

(3)

$$\cos \phi = \frac{R}{Z} = \frac{80}{\sqrt{60^2 + 80^2}} = 0.8$$

**Video Solution:**



**Q26 Text Solution:**

$$i = i_2 \cos \omega t + i_2 \sin \omega t$$

$$= \sqrt{i_1^2 + i_2^2} \left[ \frac{i_1}{\sqrt{i_1^2 + i_2^2}} \cos \omega t + \frac{i_2}{\sqrt{i_1^2 + i_2^2}} \sin \omega t \right]$$

$$= \sqrt{i_1^2 + i_2^2} \sin(\omega t + \phi); \text{ where } \tan \phi = \frac{i_1}{i_2}$$

$$\Rightarrow i = i_0 \sin(\omega t + \phi); \text{ where } i_0 = \sqrt{i_1^2 + i_2^2}$$

$$\therefore i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{\sqrt{i_1^2 + i_2^2}}{\sqrt{2}}$$

**Video Solution:**



**Q27 Text Solution:**

Given,  $V = 120 \text{ V}, f = 50 \text{ Hz}$ ,

Current,  $I_{rms} = 3 \text{ A}$  and power consumed,  $P = 108 \text{ W}$

We know,  $P = (I_{rms})^2 R$

$$\Rightarrow 108 = (3)^2 \times R \Rightarrow R = \frac{108}{9} = 12 \Omega$$

**Video Solution:**



**Q28 Text Solution:**

$$P_i = V_i \times I_i$$

$$5000 = 200 \times I$$

$$I_i = 25 \text{ A}$$

$$\eta = \frac{P_0}{P_i}$$

$$P_0 = 0.70 \times 5000$$

$$P_0 = 3500 \text{ watt}$$

$$3500 = V_0 \times I_0$$

$$V_0 = \frac{3500}{2} = 1750 \text{ volt}$$

**Video Solution:**





**Q29 Video Solution:**



**Q30 Text Solution:**

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$\text{Now, } L' = L + \frac{L}{4} = \frac{5L}{4}$$

$$C' = C - \frac{C}{5} = \frac{4C}{5}$$

$$f' = \frac{1}{2\pi\sqrt{L'C'}} = \frac{1}{2\pi\sqrt{\frac{5L}{4} \times \frac{4C}{5}}}$$

$$f' = \frac{1}{2\pi\sqrt{LC}} = f$$

**Video Solution:**



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