Solution

ALTERNATING CURRENT WS 1

Class 12 - Physics

1.

(c) step-up transformer with turn ratio 1 : 2

Explanation: As, $\frac{N_p}{N_s}=\frac{V_p}{V_s}\left(=\frac{input}{output}\right)$

Thus, $\frac{N_p}{N_s}=\frac{110}{220}=\frac{1}{2}$

As, $N_p < N_s$, hence it is a step-up transformer.

2. **(a)** $\omega^2 \mathrm{LC}$

Explanation: $\omega^2 \mathrm{LC}$

3.

(c) Zero

Explanation: Power = $V_{rms} \times I_{rms} \times \cos \phi$

Here

$\phi = \frac{\pi}{2}$ So,

Power = 0

4.

(b) 127 μF

Explanation: Voltage and current will be in phase when $X_C = X_L$

Or, $\frac{1}{\omega C} = \omega L$

Or, $\frac{1}{2\pi fC} = 2\pi fL$

Or, C = $\frac{1}{4\pi^2 f^2 L}$

Or, C = $\frac{1}{4\times(3.14)^2\times(50)^2\times 80\times 10^{-3}}$

$\therefore$ C = 127 μF

5. **(a)** average value of current of complete cycle is zero

Explanation: The average value of alternating current over a complete cycle is zero

6.

(d) L/2

Explanation: The resonance frequency is given by

$f_0=\frac{1}{2\pi\sqrt{L\,C}}$

When C is changed to 2C, f_0 will remain unchanged, if L is changed to L/2.

7.

(c) 2 A

Explanation: Here, N_p = 140; N_s = 280 and I_p = 4 A

$\therefore I_s=I_p\times\frac{N_p}{N_s}=4\times\frac{140}{280}=2A$

8.

(d) 0.05 J

Explanation: U = $\frac{1}{2}LI^2$

= $\frac{1}{2}\times 100\times 10^{-3}\times(1)^2$ = 0.05 J

9.

(b) 13.3 μF

Explanation: V = 170 volt, f = 60 Hz, i = 0.85 A

$V=iX_C=i\frac{1}{\omega C}=\frac{i}{2\pi fC}$

Thus, Capacitance required,

$C=\frac{i}{2\pi fV}=\frac{0.85}{2\times3.14\times60\times170}=13.3\times10^{-6}F=13.3\mu F$

10.

(c) frequency

Explanation: Input and output voltages have same frequency in a transformer.

11. **(a)** 0.1 A

Explanation: Current in the secondary coil is given by, $i = \frac{V_s}{Z} = \frac{22}{220} = 0.1A$

12.

(d) $\sqrt{2}$

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

In first case:

$Z_1 = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + (3R)^2} = R\sqrt{10}$

$\cos\phi_1 = \frac{R}{Z_1} = \frac{R}{R\sqrt{10}} = \frac{1}{\sqrt{10}}$

In second case:

$Z_2 = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + (3R - R)^2} = R\sqrt{5}$

$\cos\phi_2 = \frac{R}{Z_2} = \frac{R}{R\sqrt{5}} = \frac{1}{\sqrt{5}}$

The ratio of new to old power factor is

$\frac{\cos\phi_2}{\cos\phi_1} = \frac{\frac{1}{\sqrt{5}}}{\frac{1}{\sqrt{10}}} = \frac{\sqrt{2}}{1}$

$\cos\phi_2 : \cos\phi_1 = \sqrt{2} : 1$

13. **(a)** soft iron

Explanation: Soft iron provides the best material for the core of a transformer as its permeability (μ) is very high. Its hysteresis curve is of small area and its coercivity is very low.

14. **(a)** 10 Ω

Explanation: 10 Ω

15. **(a)** 66 V, 210 V

Explanation: $R = 100\Omega$

$C = 10\mu F$

V = 220 volt

f = 50Hz

$Z = \sqrt{R^2 + {X_C}^2}$

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\times 3.14\times 50\times 10\times 10^{-6}} = 318.5\Omega$

$Z = \sqrt{(100)^2 + (318.5)^2} = 333.8\Omega$

Current in circuit,

$i = \frac{V}{Z} = \frac{220}{333.8} = 0.66A$

Voltage across the resistor, $V_R = iR = 0.66 \times 100 = 66V$

Voltage across the capacitor, $V_C = iX_C = 0.66 \times 318.5 = 210V$

16.

(c) 90 %

Explanation: The efficiency of a transformer

$\eta = \frac{\text{Output power}}{\text{Input power}} = \frac{V_s I_s}{V_p I_p}$

Here $V_S I_S$ = 100 W, V_P = 220 V, I_P = 0.5 A

$\therefore \eta = \frac{100}{220\times 0.5}$ = 0.90 = 90 %

17.

(d) 400

Explanation: N_p = no. of turns in primary coil = 4000

N_s = no. of turns in secondary coil

V_p = input voltage = 2300 V

V_s = output voltage = 230 V

Now, $\frac{V_s}{V_p} = \frac{N_s}{N_p}$
$\frac{230}{2300} = \frac{N_s}{4000}$
Thus, N_s = 400

18. **(a)** zero
Explanation: The voltage across L and C are out of phase with each other. Hence, the voltage across LC-combination is zero.

19.
(c) $5\sqrt{3}$ V
Explanation: $\varepsilon = \varepsilon_0 \cos 2\pi ft$
$= 10 \cos\left(2\pi \times 50 \times \frac{1}{600}\right)$V
$= 10 \cos \frac{\pi}{6} = 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3}$ V

20.
(c) Pure resistive circuit0
Explanation: Since in pure resistive circuit the current and voltage are in phase, the power dissipation is maximum.

21.
(c) $\frac{1}{400}$ s
Explanation: $I = I_0 \sin 2\pi ft = 100 \sin 200\pi t$
$\therefore 2f = 200$ or $f = 100$ Hz
$T = \frac{1}{f} = \frac{1}{100}$ s
Time taken by current to rise from zero to peak value
$= \frac{T}{4} = \frac{1}{4 \times 100}$ s $= \frac{1}{400}$ s

22.
(d) 311 V
Explanation: 311 V

23.
(b) 90^o
Explanation: If only inductor is present in circuit, then R = 0
$\tan \phi = \frac{X_L}{R} = \frac{X_L}{0} = \infty$
Hence, phase angle, $\phi = 90^\circ$

24.
(d) zero
Explanation: Since reactive impedance at resonance is zero and we know that,
tan ϕ = X_L - $\frac{X_C}{Z}$
but X_L - X_C = 0
therefore ϕ = 0

25. **(a)** soft iron
Explanation: Soft iron is best because of its high permeability and low hysteresis loss.

26.
(c) first decreases to become zero and then increases
Explanation: first decreases to become zero and then increases

27. **(a)** A.C. voltage
Explanation: A transformer changes the magnitude of a.c.

28. **(a)** there is no wastage of power
Explanation: A choke reduces the current in an ac circuit without dissipating any power.

29.
(c) Both $V_{rms} = \frac{V_0}{\sqrt{2}}$ and V_{rms} = 0.707 V_0
Explanation: $V_{rms} = \frac{V_0}{\sqrt{2}}$ = 0.707 V_0

30.

(c) another capacitor should be added in parallel to the first

Explanation: Resonant frequency in an L-C-R circuit is given by

$v_0 = \frac{1}{2\pi\sqrt{LC}}$, v_0 is the frequency and L is the inductor and C for the capacitor.

If L or C increases, the resonant frequency will reduce.

To increase capacitance, we must connect another capacitor parallel to the first.

31. **(a)** soft iron

Explanation: Soft iron is used for the core of a transformer because of its high permeability and low hysteresis loss.

32. **(a)** 200 V - 50 Hz

Explanation: $\varepsilon_2 = \frac{N_2}{N_1} \cdot \varepsilon_1 = \frac{500}{50} \times 20 = 200 \text{ V}$

The frequency remains unchanged.

33. **(a)** 200 V - 50 Hz

Explanation: $\varepsilon_s = \frac{N_s}{N} \cdot \varepsilon_p$

$= \frac{5000}{500} \times 20 = 200 \text{ V}$

frequency remains the same.

34.

(c) 161 V

Explanation: R = 300.0 Ω, X_C = 300.0 Ω and X_L = 500.0 Ω, $P_{av} = 60W$

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{300^2 + (500 - 300)^2} = 100\sqrt{13}\Omega$

$P_{av} = V_{rms} \times I_{rms} \times \cos\phi$

Now, $I_{rms} = \frac{V_{rms}}{Z}$

$\cos\phi = \frac{R}{Z}$

Thus, $P_{av} = \frac{(V_{rms})^2}{Z} \times \frac{R}{Z} = \frac{(V_{rms})^2 R}{Z^2}$

$60 = \frac{(V_{rms})^2 \times 300}{100\sqrt{13} \times 100\sqrt{13}}$

$V_{rms} = \sqrt{\frac{60 \times 100 \times 13}{3}} = 161V$

35.

(d) 146.0 Ω

Explanation: $R = 115\Omega$

$C = 1.25\mu F = 1.25 \times 10^{-6}F$

$L = 4.5mH = 4.5 \times 10^{-3}H$

Resonant angular frequency is given by ,

$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4.5 \times 10^{-3} \times 1.25 \times 10^{-6}}} = \frac{1}{7.5 \times 10^{-5}}$

Given that the angular frequency of the ac source, $\omega = \frac{\omega_0}{2} = \frac{1}{15 \times 10^{-5}} = 6666.6 rad/s$

Thus, Impedance is given by ,

$Z = \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2} = \sqrt{115^2 + \left[\left(\frac{1}{6666.6 \times 1.25 \times 10^{-6}}\right) - \left(6666.6 \times 4.5 \times 10^{-3}\right)\right]^2}$

$Z = 146\Omega$

36. **(a)** 0.1 J

Explanation: Energy stored in the coil is

$E = \frac{1}{2}Li^2$

$L = 50mH = 50 \times 10^{-3}$

i = 2A

Thus, $E = \frac{1}{2} \times 50 \times 10^{-3} \times 2 \times 2 = 0.1\ J$

37.

(b) L is large and R is small

Explanation: L is large and R is small

38.

(c) Power

Explanation: Energy losses be zero in transformers hence power remains constant in step down and step up transformer also.

39.

(b) 2000 W

Explanation: When the frequency of the supply equals the natural frequency of the circuit,

$X_L = X_C$

In this case, impedance Z = R

Average power,

$P_{av} = V_{rms} \times i_{rms} \times \cos\phi = V_{rms} \times \frac{V_{rms}}{Z} \times \frac{R}{Z}$

As, Z = R

$P_{av} = \frac{(V_{rms})^2}{R} = \frac{200 \times 200}{20} = 2000W$

40.

(b) 25 V

Explanation: The resultant voltage in the LCR series circuit is calculated as,

V = $\sqrt{V_R^2 + (V_c \sim V_L)^2}$

Here, all alphabets are in their usual meanings.

V_R = 20 V, V_C = 30 V and V_L = 15 V

So, V = $\sqrt{(20)^2 + (30 \sim 15)^2}$

V = $\sqrt{400 + 225}$ = $\sqrt{625}$

V = 25 V

41.

(c) 5.5 V

Explanation: $V_s = \frac{N_s}{N_p} \times V_p = \frac{100}{2000} \times 110$ = 5.5 V

42. **(a)** admittance

Explanation: The reciprocal of the impedance of an a.c. the circuit is called admittance.

43.

(b) $-X_g$

Explanation: For maximum power to be delivered from the generator (or internal reactance X_g) to the load (of reactance, X_L)

$\Rightarrow X_L + X_g = 0$ (the total reactance must vanish)

$\Rightarrow X_L = -X_g$

thus the maximum power from generator to the load X_L is given by = -Xg

44. **(a)** 3 V

Explanation: $\varepsilon_2 = \frac{N_2}{N_1} \cdot \varepsilon_1 = \frac{2}{1} \times 1.5 = 3$ V

45.

(b) 189.7 Ω

Explanation: $X_L = 2\pi fL = 2\pi \times 50 \times 0.5 = 157.08\Omega$

$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 10^{-5}} = 318.31\Omega$

$X_C - X_L = 161.23\Omega$

$Z = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{100^2 + (161.23)^2}$

$= \sqrt{35995.07}$ = 189.72 Ω

46. **(a)** 3 A

Explanation: $\eta = \frac{\text{Output}}{\text{Input}}$

$\frac{80}{100} = \frac{20 \times 120}{1000 \times I}$

I = $\frac{20 \times 120 \times 100}{1000 \times 80}$ = 3A

47.

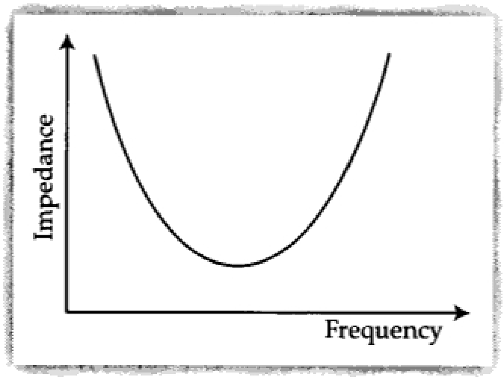
(b) $\frac{V_0}{\sqrt{2}}$

Explanation: $\frac{V_0}{\sqrt{2}}$

48.

(b) decreases at first, becomes minimum and then increases

Explanation: The frequency vs. Impedance graph of a series LCR circuit is as follows:



With increase in frequency, the impedance decreases at first, becomes minimum and then increases.

49.

(d) 1.1 V

Explanation: $\frac{V_s}{V_p} = \frac{N_s}{N_p} \Rightarrow \frac{V_s}{220} = \frac{40000}{200}$

$\therefore V_s$ = 44000 V

P.D. per turn = $\frac{44000}{40000}$ = 1.1 V

50. **(a)** frequency

Explanation: Transformer does not change the frequency of the applied AC.

51.

(d) 22 $\times$ 10^3 cal

Explanation: $H = \frac{\varepsilon_{rms}^2 t}{RJ} = \frac{\varepsilon_0^2 t}{2RJ} = \frac{(220)^2 \times 7 \times 60}{2 \times 110 \times 4.2}$

= 22 $\times$ 10^3 cal

52.

(b) 5.0 ampere

Explanation: $\eta = \frac{V_s I_s}{V_p I_p}$

$\therefore I_p = \frac{V_s I_s}{\eta V_p} = \frac{440 \times 2}{0.80 \times 220}$ = 5 A

53.

(c) eddy current

Explanation: Lamination increases the resistance and hence reduced the eddy current.

54.

(d) $\frac{X}{4}$

Explanation: The capacitive reactance X is given by,

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

Let new reactance after doubling frequency and capacitance is X'.

So, $X' = \frac{1}{2\pi(2f)(2C)}$

$\Rightarrow X' = \frac{1}{4(2\pi fC)}$

$\Rightarrow X' = \frac{X}{4}$

55.

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

Explanation: $\sqrt{R^2 + (X_L - X_C)^2}$

56.

(b) 3.2 $\times$ 10^{-3} A, 0.16 A

Explanation: $\frac{I_1}{I_2} = \frac{3.2 \times 10^{-3}}{0.16} = \frac{1}{50} = \frac{10}{500} = \frac{N_2}{N_1}$

57.

(c) 120 V

Explanation: Flux linked with the primary coil,

$\phi = \phi_0 + 4t$

Voltage across primary,

$V_p = \frac{d\phi}{dt} = 0 + 4 \times 1$ = 4 V

Voltage across secondary,

$V_s = \frac{N_s}{N_p} \cdot V_p = \frac{1500}{50} \times$ 4 = 120 V

58.

(d) $\frac{1}{4}$

Explanation: $\omega = \frac{1}{\sqrt{LC}}$

For, ω = constant $\rightarrow \sqrt{LC}$ = constant

Therefore, C is inversely proportional to L

So, if C is made 4C then L should be reduced to $\frac{L}{4}$ to keep ω constant.

59.

(c) only L

Explanation: When a circuit inductance only, then the current lags behind the voltage by the phase difference of $\pi/2$.

60.

(c) 10 W

Explanation: Let P = actual power used

W = power specified = 40 W

V_A = Applied voltage = 100 V

V_S = Specified voltage = 200 V

Now,

$P = \left(\frac{V_A}{V_S}\right)^2 W$

$P = \left(\frac{100}{200}\right)^2 \times 40 = 10W$

61.

(c) lags behind the applied emf by an angle $\frac{\pi}{2}$

Explanation: lags behind the applied emf by an angle $\frac{\pi}{2}$

62. **(a)** Current

Explanation: Current increases in a step-down transformer.

63.

(b) lags voltage in phase by $\frac{\pi}{2}$.

Explanation: lags voltage in phase by $\frac{\pi}{2}$.

64. **(a)** 90%

Explanation: $\eta = \frac{output\ power}{input\ power} = \frac{V_s I_s}{V_p I_p} \times 100 = \frac{100}{220 \times 0.5} \times 100 = 90\%$

65.

(d) 50 amp

Explanation: $\frac{N_s}{N_p} = \frac{i_p}{i_s} = \frac{V_s}{V_p} = r$

Given that $\frac{N_p}{N_s} = \frac{1}{25}$

i_s = 2 amp

Thus, $\frac{25}{1} = \frac{i_p}{2}$

i_p = 50 amp

66.

(d) mutual induction

Explanation: A transformer works on the principle of mutual induction.

67. **(a)** 84.8 V

Explanation: V_{rms} = 0.707 V_0 = 0.707 × 120 V = 84.8 V

68.

(c) $\frac{1}{\sqrt{2}\mathrm{A}}$

Explanation: According to the problem output/secondary voltage V_s = 24V

Power associated with secondary P_s = 12W

$I_S = \frac{P_S}{V_S} = \frac{12}{24} = 0.5\mathrm{A}$

The amplitude of the current in the secondary winding

$I_0 = I_S\sqrt{2}$

= (0.5) (1.414) = 0.707 $= \frac{1}{\sqrt{2}}\mathrm{A}$

thus the value of peak current is given by = 0.707A = $\frac{1}{\sqrt{2}}$A

69.

(b) 50.0 V

Explanation: $V_R = 30V$, V_C = 90V, V_L = 50V

$V = \sqrt{\left(V_C - V_L\right)^2 + V_R^2} = \sqrt{(90-50)^2 + 30^2} = \sqrt{40^2 + 30^2}$

V = 50 volt

70.

(d) the meter reads not v but <v^2> and is calibrated to read $\sqrt{< v^2 >}$

Explanation: the meter reads not v but <v^2>. The voltmeter connected to AC mains calibrated to read rms value $\sqrt{< v^2 >}$

71.

(c) step-down transformer with turn ratio 2 : 1

Explanation: The ratio between the number of primary turns to the number of secondary turns being called the "turns ratio" or "transformer ratio".

Thus, $\frac{N_p}{N_s} = \frac{V_p}{V_s}\left(= \frac{input}{output}\right)$

$\frac{N_p}{N_s} = \frac{220}{110} = \frac{2}{1}$

Turn ratio is $N_p : N_s = 2 : 1$

As $N_p > N_s$, hence it is a step down transformer.

72.

(d) 0.124 H

Explanation: $R = 48\Omega$

f = 80Hz

$\phi = 53^\circ$

Now, $\omega = 2\pi f = 2 \times 3.14 \times 80$

In series LR circuit,

$\tan\phi = \frac{\omega L}{R}$

$\tan 53^\circ = \frac{2\times 3.14\times 80\times L}{48}$

$\frac{4}{3} = \frac{2\times 3.14\times 80\times L}{48}$

Thus, L = 0.124 H

73.

(b) $5\sqrt{\frac{3}{2}}$ A

Explanation: According to the problem, frequency , v = 50 Hz, I_{rms}= 5A

$t = \frac{1}{300}\mathrm{s}$

I_0 = Peak value of $\sqrt{2}\left(I_{\mathrm{rms}}\right) = 5\sqrt{2}$

$= 5\sqrt{2}\mathrm{A}$

From, I = I_0 sin $\omega t = 5\sqrt{2}\sin 2\pi vt\ = 5\sqrt{2}\sin 2\pi \times 50 \times \frac{1}{300}$

$= 5\sqrt{2}\sin\frac{\pi}{3} = 5\sqrt{2} \times \frac{\sqrt{3}}{2} = 5\sqrt{\frac{3}{2}}\mathrm{A}$

74. **(a)** 146 Ω

Explanation: $R = 115\Omega$

$C = 1.25\mu F = 1.25 \times 10^{-6} F$

$L = 4.5mH = 4.5 \times 10^{-3} H$

Resonant angular frequency,

$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4.5\times10^{-3}\times1.25\times10^{-6}}} = \frac{1}{7.5\times10^{-5}}$

Given that the angular frequency of the ac source, $\omega = 2\omega_0 = \frac{2}{7.5\times10^{-5}} = 26666.6 rad/s$

impedance,

$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = \sqrt{115^2 + \left[(26666.6 \times 4.5 \times 10^{-3}) - \left(\frac{1}{26666.6\times1.25\times10^{-6}}\right)\right]^2}$

$Z = 146\Omega$

75.

(b) 220 V, 50 Hz

Explanation: In India, we use electricity at 220 volt and 50 hertz.