(1) (A). Magnetic energy, $U = \frac{1}{2}LI^2$

$\therefore L = \frac{2U}{I^2} = \frac{2\times 648}{(9)^2} = 16\,H$

Induced emf,

$\varepsilon = -L\frac{dI}{dt} = \frac{-(16H)\,(0-9A)}{0.45s} = 320V$

(2) (B). The self inductance L of a solenoid of length l and area of cross section A with fixed number of turns N is $L = \frac{\mu_0 N^2 A}{l}$

So, L increases when l decreases and A increases.

(3) (A). Here, N = 400, L = 10 mH = 10×10^{-3}H

I = 2mA = 2×10^{-3} A

Total magnetic flux linked with the coil,

$\phi = NLI = 400 \times (10 \times 10^{-3}) \times 2 \times 10^{-3}$

$= 8 \times 10^{-3}$ Wb

Magnetic flux through the cross-section of the coil = Magnetic flux linked with each turn

$= \frac{\phi}{N} = \frac{8\times 10^{-3}}{200} = 4 \times 10^{-5}$ Wb

(4) (A). Here, $\vec{A} = x^2\,\hat{k}\,m^2$

and $\vec{B} = B_0(3\hat{i} + 4\hat{j} + 5\hat{k})T$

As $\phi = \vec{B}.\vec{A} = B_0(3\hat{i} + 4\hat{j} + 5\hat{k}).x^2\hat{k}$

$\therefore \phi = 5B_0x^2$ Wb

(5) (B). In series connection

$L_1 + L_2 = 10$ H ..... (i)

and in parallel connection

$\frac{L_1L_2}{(L_1+L_2)} = 2.4H$ ..... (ii)

Substituting the value of $(L_1 + L_2)$ from (i) into (ii), we get

$L_1L_2 = (2.4)\,(L_1 + L_2) = 2.4 \times 10 = 24$

$(L_1 - L_2)^2 = (L_1 + L_2)^2 - 4L_1L_2$

$L_1 - L_2 = [(10)^2 - 4 \times 24]^{1/2} = 2H$ ....(iii)

Solving (i) and (iii), we get

$L_1 = 6H, L_2 = 4H.$

(6) (C). The energy stored in the inductor is

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

The energy stored in the inductor per second is $\frac{dU}{dt} = LI\frac{dI}{dt}$

$= 200 \times 10^{-3}\ H \times 1A \times 0.5As^{-1} = 0.1\ J\ s^{-1}$

(7) (D). As $\frac{L_1}{L_2} = \frac{N_1^2}{N_2^2}$

Self inductance of 500 turns coil = 125 mH

$\therefore$ L for the coil of 800 turns

$= \frac{125}{(500)^2}\times(800)^2 = 320$ mH.

(8) (D). Let a current I_1 flows through the outer circular coil of radius R_1. The magnetic field at the centre of the coil is $B_1 = \frac{\mu_1 I_1}{2R_1}$

As the inner coil of radius R_2 placed co-axially has small radius $(R_2 < R_1)$, therefore B_1 may be taken constant over its cross-sectional area.

Hence, flux associated with the inner coil is

$\phi_2 = B_1\pi R_2^2 = \frac{\mu_0 I_1}{2R_1}\pi R_2^2$

As $M = \frac{\phi_2}{I_1} = \frac{\mu_0\pi R_2^2}{2R_1}$ $\therefore$ $M \propto \frac{R_2^2}{R_1}$

(9) (C). $q = \int I\,dt = \frac{1}{R}\int \varepsilon dt = \frac{1}{R}\int\frac{d\phi}{dt}dt = \frac{1}{R}\int d\phi$

Hence total charge induced in the conducting loop depend upon the total change in magnetic flux and resistance.

(10) (B). Here, Area $A = l^2 = (12\text{ cm})^2$

$= 1.4 \times 10^{-2}\ m^2$

$R = 0.60\Omega$, $B_1 = 0.10T$, $\theta = 45°$

$B_2 = 0$, dt = 0.6s

Initial flux, $\phi_1 = B_1A\cos\theta$

$= 0.10 \times 1.4 \times 10^{-2} \times \cos 45°$

$= 9.8 \times 10^{-4}$ Wb

Final flux, $\phi_2 = 0$

Induced emf, $\varepsilon = \frac{|d\phi|}{dt} = \frac{|\phi_2 - \phi_1|}{dt}$

$= \frac{|9.8\times10^{-4}|}{0.6s} = 1.6 \times 10^{-3}$ V

Current, $I = \frac{\varepsilon}{R} = \frac{1.6\times10^{-3}}{0.6}$

$= 2.67 \times 10^{-3}$ A

(11) (B). Here, $l = 6$ cm $= 6 \times 10^{-2}$ m

$B = 0.4$ T, $v = 2$ cm s^{-1} $= 2 \times 10^{-2}$ ms^{-1}

Voltage developed is

$\varepsilon = Blv = 0.4 \times 6 \times 10^{-2} \times 2 \times 10^{-2}$

$= 4.8 \times 10^{-4}$ V

(12) (A). Due to change in the shape of the loop, the magnetic flux linked with the loop increases. Hence, current is induced in the loop in such a direction that it opposes the increases in flux. Therefore, induced current flows in the anticlockwise direction.

(13) (B). Here, $l = r = 5$ cm $= 5 \times 10^{-2}$ m,

$\omega = 2\pi\left(\frac{1800}{60}\right)$ rad s^{-1} $= 60\pi$ rad s^{-1},

$B = 1$ Wb m^{-2}

$\varepsilon = \frac{1}{2}Bl^2\omega = \frac{1}{2} \times 1 \times (5 \times 10^{-2})^2 \times 60\pi$

$= 0.23$V

(14) (B). Let $\vec{E}$ be the electric field intensity at a point on the circumference of the ring. Then, the emf induced $\varepsilon = \oint \vec{E}.d\vec{l}$ where $d\vec{l}$ is a length element of the ring since $|\vec{E}|$ is constant and $\vec{E} \parallel d\vec{l}$,

$\varepsilon = E(2\pi r)$ ....(i)

Also, the induced emf is

$\varepsilon = \frac{d\phi}{dt} = \pi r^2 \frac{dB}{dt} = \pi r^2 x$ ....(ii)

Equating (i) and (ii), we get, $E = \frac{rx}{2}$

(15) (A). Here, $A = 0.4$ m^2, $N = 100$,

$dB = 0.04$ Wb m^{-2}, $dt = 0.01$ s

As $\varepsilon = \frac{d\phi}{dt} = NA\frac{dB}{dt}$

$= 100 \times 0.4 \times \frac{0.04}{0.01} = 160$ V.

(16) (A). $e = -\frac{d\phi}{dt} = \frac{-3B_0A_0}{t}$

(17) (A). $\cos\phi = \frac{R}{Z} = \frac{12}{15} = 0.8$

(18) (B). $|e| = A.\frac{\Delta B}{\Delta t} = 2\times\frac{(4-1)}{2} = 3$ V.

(19) (B). $e = -\frac{NBA(\cos\theta_2 - \cos\theta_1)}{\Delta t}$

$= -2000\times0.3\times70\times10^{-4}\frac{(\cos180 - \cos 0)}{0.1}$

$e = 84$ V

(20) (D). $q = -\frac{N}{R}(B_2 - B_1)A\cos\theta$

$32\times10^{-6} = -\frac{100}{(160+40)}(0 - B)$

$\times\pi\times(6\times10^{-3})^2\times\cos0^o$

$B = 0.565$ T

(21) (B). This is the case of periodic EMI

(22) (C). $e = \frac{1}{2}B\ell^2\omega = \frac{1}{2}\times0.3\times(2)^2\times100 = 60$V

(23) (D). $L = \frac{e}{di/dt} = \frac{5}{(3-2)/10^{-3}}$

$= \frac{5}{1}\times10^{-3} = 5$milli henry

(24) (B). Energy stored

$E = \frac{1}{2}Li^2 = \frac{1}{2}\times50\times10^{-3}\times4 = 0.1$ J

(25) (A). Given $\frac{di}{dt} = 2A/\text{sec.}$, $L = 5$ H

$\therefore e = L\frac{di}{dt} = 5\times2 = 10$V

(26) (C). $e = M\frac{di}{dt} \Rightarrow e = 0.1\times\frac{(20-0)}{0.02} = 100$V

(27) **(C).** $L = \frac{\mu_0 N^2 A}{l}$

$= \frac{4\pi\times10^{-7}\times(1000)^2\times10\times10^{-4}}{1}$

= 1.256 mH

(28) **(D).** $\frac{V_p}{V_s} = \frac{i_s}{i_p} \Rightarrow \frac{220}{22000} = \frac{i_s}{5}$

$\Rightarrow i_s = 0.05$ amp

(29) **(B).** I_P & $I_Q \rightarrow$ anticlockwise ; $I_R = 0$

(30) **(A).** Work done = ΔQ (heat dissipated)

$= \frac{e^2}{R}t = \frac{(N\times B\ell v)^2}{R}\times t$

$= \frac{100^2\times(0.4)^2\times2.5\times10^{-3}}{100}\times v^2\times1$

$\ell^2 = 2.5\times10^{-3}$

$\ell = \sqrt{25\times10^{-4}} = 5\times10^{-2}$ m

$v = \frac{5\times10^{-2}}{1}$

$\Rightarrow$ w = 6.25 × 10^{-6} × 16 J = 100 μJ

(31) **(C).** All three coils are parallel
So L_{eq} = 1 H

(32) **(B).** $I = -\frac{1}{R_{eq}}\left(n\frac{d\phi}{dt}\right)$

$= -\frac{1}{5R}\left[\frac{n(W_2 - W_1)}{t}\right]$

(33) **(D).** $V_L = V_C = V_R = 50$ volt
V_L and V_C have opposite phasors so voltage across LC combination is zero.

(34) **(C).** Frequency $= \frac{1}{2\pi\sqrt{LC}}$

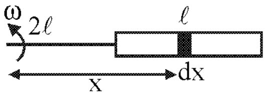
$C \rightarrow 2C$; $L \rightarrow L/2$

(35) **(B).** $I = I_0\left(1 - e^{-\frac{R}{L}t}\right)$; $\frac{I_0}{2} = I_0\left(1 - e^{-\frac{2t}{300\times10^{-3}}}\right)$

t = 0.1 sec.

(36) **(C).** Frequency $= \frac{1}{2\pi\sqrt{LC}}$

(37) **(D).**



$e = \int_{2\ell}^{3\ell}(\omega x)\,B\,dx = B\omega\frac{[(3\ell)^2 - (2\ell)^2]}{2} = \frac{5B\ell^2\omega}{2}$

(38) **(B).** Here, N = 2000, A = 80 cm^2

B = 4.8 × 10^{-2} T, ν = 200 rpm = $\frac{200}{60}$ rps

$\omega = 2\pi\nu = \frac{2\pi\times200}{60} = \frac{20\pi}{3}$ rad s^{-1}

$V_0 = NBA\omega$

= 2000 × 4.8 × 10^{-2} × 80 × 10^{-4} × $\frac{20\pi}{3}$

= 16.07 V

∴ $V_{rms} = 0.707\,V_0$ = 0.707 × 16.07
= 11.366 V = 11.37 V.

(39) **(D).** Since $\cos\theta = \frac{R}{Z} = \frac{IR}{IZ} = \frac{8}{10} = \frac{4}{5}$

(Also cos θ can never be greater than 1).
Hence (C) is wrong.
Also, $Ix_C > Ix_L$ $\Rightarrow$ $x_C > x_L$
∴ Current will be leading
In a LCR circuit,

$V = \sqrt{(V_L - V_C)^2 + v_R^2} = \sqrt{(6-12)^2 + 8^2}$

V = 10, which is less than voltage drop across capacitor.

(40) **(A).** Here, V_P = 2400V,
N_p = 4000, V_s = 240V

As $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

$\therefore N_s = \left(\frac{V_s}{V_p}\right)N_p = \frac{240}{2400}\times4000 = 400$

(41) **(A).** Here, V_s = 24V, P_s = 12W

$I_s = \frac{P_s}{V_s} = \frac{12}{24} = 0.5A$

$$I_m = \sqrt{2}\, I_s = \sqrt{2} \times 0.5 = \frac{1}{\sqrt{2}} A$$

(42) **(C).** For better tuning of an LCR circuit used for communication the circuit should possess high quality factor of resonance

i.e., $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ should be high.

For it R should be low, L should be high and C should be low, therefore combination in option (C) is correct.

(43) **(C).** Output power = 140 W

Input power = 240 × 0.7 = 168 W

$$\text{Efficiency} = \frac{\text{output power}}{\text{input power}} \times 100$$

$$= \frac{140}{168} \times 100 = 83.3\%$$

(44) **(D).** Here, $P = I^2 Z \cos\phi$

(a) If power factor $\cos\phi \geq 0 \Rightarrow P \geq 0$.

(b) For wattless component the driving force shall give no energy to the oscillator so, at $\phi = 90°$, $P = 0$.

(c) The driving force cannot syphon out the energy out of oscillator i.e. P cannot be negative.

Hence all options are correct.

(45) **(B).** Here, $I_{rms} = 5A$, $\nu = 50Hz$, $t = \frac{1}{300} s$

$I_0 = \sqrt{2}\, I_{rms} = 5\sqrt{2} A$,

From $I = I_0 \sin\omega t = I_0 \sin 2\pi\nu t$

$$I = 5\sqrt{2} \sin\left(2\pi \times 50 \times \frac{1}{300}\right)$$

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