DAY TWENTY SEVEN

Unit Test 5

(Magnetostatics EMI and AC, EM Waves)

1 The magnetic field of a given length of wire carrying a current for a single turn circular coil at centre is B, then its value for two turns for the same wire, when same current is passing through it, is

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

2 A long solenoid carrying a current, produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of the magnetic field is

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

3 Magnetic field due to 0.1A current flowing through a circular coil of radius 0.1 m and 1000 turns at the centre of the coil is

(a) 0.2 T (b) 2×10^{-4} T
(c) 6.28×10^{-4} T (d) 9.8×10^{-4} T

4 The magnetic field at a distance r from a long wire carrying current I is 0.4 T. The magnetic field at a distance $2r$, is

(a) 0.2 T (b) 0.8 T
(c) 0.1 T (d) 1.6 T

5 A charged particle of charge q and mass m enters perpendicularly in a magnetic field **B**. If kinetic energy of the particle is E, then frequency of rotation is

(a) $\frac{qB}{m\pi}$ (b) $\frac{qB}{2\pi m}$ (c) $\frac{qBE}{2\pi m}$ (d) $\frac{qB}{2\pi E}$

6 A charge q moves in a region, where electric field **E** and magnetic field **B** both exist, then the force on it, is

(a) $q(\mathbf{v} \times \mathbf{B})$ (b) $q\mathbf{E} + q(\mathbf{v} \times \mathbf{B})$
(c) $q\mathbf{B} + q(\mathbf{B} \times \mathbf{v})$ (d) $q\mathbf{B} + q(\mathbf{E} \times \mathbf{v})$

7 A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength 20 Vm^{-1} and 0.5 T, respectively at right angles to the direction of motion of the electrons. Then, the velocity of electrons must be

(a) 8 ms^{-1} (b) 20 ms^{-1} (c) 40 ms^{-1} (d) $\frac{1}{40}$ ms^{-1}

8 A straight wire of length 0.5 m and carrying a current of 1.2 A is placed in uniform magnetic field of induction 2 T. The magnetic field is perpendicular to the length of the wire. The force on the wire is

(a) 2.4 N (b) 1.2 N (c) 3.0 N (d) 2.0 N

9 Two wires are held perpendicular to the plane of paper and are 5 m apart. They carry currents of 2.5 A and 5 A in same direction. Then, the magnetic field strength **B** at a point midway between the wires will be

(a) $\frac{\mu_0}{4\pi}$ T (b) $\frac{\mu_0}{2\pi}$ T (c) $\frac{3\mu_0}{2\pi}$ T (d) $\frac{3\mu_0}{4\pi}$ T

10 An uniform magnetic field acts right angles to the direction of motion of electrons. As a result, the electron moves in a circular path of radius 2 cm. If the speed of electrons is doubled, then the radius of the circular path will be

(a) 2.0 cm (b) 0.5 cm
(c) 4.0 cm (d) 1.0 cm

11 The work done in turning a magnet of magnetic moment M by an angle of 90° from the meridian, is n times the corresponding work done to turn it through an angle of 60°. The value of n is given by

(a) 2 (b) 1
(c) 0.5 (d) 0.25

12 Two bar magnets having same geometry with magnetic moments M and $2M$, are firstly placed in such a way that their similar poles are on the same side, then its period of oscillation is T_1. Now, the polarity of one of the magnets is reversed the time period of oscillations becomes T_2. Then,

(a) $T_1 < T_2$ (b) $T_1 > T_2$ (c) $T_1 = T_2$ (d) $T_2 = \infty$

13 In which type of material, the magnetic susceptibility does not depend on temperature?

(a) Diamagnetic (b) Paramagnetic
(c) Ferromagnetic (d) Ferrite

14 A diamagentic material in a magnetic field moves

(a) perpendicular to the field
(b) from weaker to the stronger parts of the field
(c) from stronger to the weaker parts of the field
(d) None of the above

15 A magnetic field of 2×10^{-2} T acts at right angles to a coil of area 100 cm^2, with 50 turns. The average emf induced in the coil is 0.1 V, when it is removed from the field in t second. The value of t is

(a) 10 s (b) 0.1 s (c) 0.01 s (d) 1 s

16 A conductor of length 0.4 m is moving with a speed of 7 ms^{-1} perpendicular to a magnetic field of intensity 0.9 Wbm^{-2}. The induced emf across the conductor is

(a) 1.26 V (b) 2.52 V (c) 5.04 V (d) 25.2 V

17 If the number of turns per unit length of a coil of solenoid is doubled, the self-inductance of the solenoid will

(a) remain unchanged (b) be halved
(c) be doubled (d) become four times

18 A varying current in a coil change from 10 A to zero in 0.5 s. If the average emf induced in the coil is 220 V, the self-inductance of the coil is

(a) 5 H (b) 6 H (c) 11 H (d) 12 H

19 In an inductor of self-inductance L = 2mH, current changes with time according to relation $I = t^2 e^{-t}$. At what time emf is zero?

(a) 4 s (b) 3 s (c) 2 s (d) 1 s

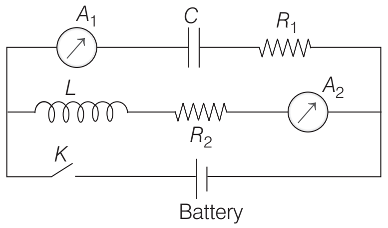
20 A 100 mH coil carries a current of 1 A. Energy stored in its magnetic field is

(a) 0.5 J (b) 1 A (c) 0.05 J (d) 0.1 J

21 Two coils have a mutual inductance of 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, $I_0 = 10$ A and $\omega = 100\,\pi \text{ rads}^{-1}$. The maximum value of emf in the second coil is

(a) 2π (b) 5π (c) π (d) 4π

22 In a circuit inductance L and capacitance C are connected as shown in figure. A_1 and A_2 are ammeters. When key K is pressed to complete the circuit, then just after closing key (K), the reading of current will be



(a) zero in both A_1 and A_2
(b) maximum in both A_1 and A_2
(c) zero in A_1 and maximum in A_2
(d) maximum in A_1 and zero in A_2

23 In an experiment, 200 V AC is applied at the ends of an L-C-R circuit. The current consists of an inductive reactance $(X_L) = 50\ \Omega$, capacitive reactance $(X_C) = 50\ \Omega$ and ohmic resistance $(R) = 10\ \Omega$. The impedance of the circuit is

(a) $10\ \Omega$ (b) $20\ \Omega$
(c) $30\ \Omega$ (d) $40\ \Omega$

24 The current in self-inductance L = 40 mH is to be increased uniformly from 1 A to 11 A in 4 ms. The emf induced in the inductor during the process, is

(a) 100 V (b) 0.4 V
(c) 4.0 V (d) 440 V

25 An L-C-R series circuit is connected to a source of alternating current. At resonance, the applied voltage and the current flowing through the circuit will have a phase difference of

(a) π (b) $\frac{\pi}{2}$
(c) $\frac{\pi}{4}$ (d) zero

26 A wire of resistance R is connected in series with an inductor of reactance ωL. Then, quality factor of R-L circuit is

(a) $\frac{R}{\omega L}$ (b) $\frac{\omega L}{R}$
(c) $\frac{R}{\sqrt{R^2 + \omega^2 L^2}}$ (d) $\frac{\omega L}{\sqrt{R^2 + \omega^2 L^2}}$

27 Which of the following combinations should be selected for better tuning of an L-C-R circuit used for communication?

(a) $R = 20\ \Omega$, $L = 1.5$ H, $C = 35\ \mu$F
(b) $R = 25\ \Omega$, $L = 2.5$ H, $C = 45\ \mu$F
(c) $R = 15\ \Omega$, $L = 3.5$ H, $C = 30\ \mu$F
(d) $R = 25\ \Omega$, $L = 1.5$ H, $C = 45\ \mu$F

28 For a series L-C-R-circuit, the power loss at resonance is

(a) $\frac{V^2}{\omega L - \frac{1}{\omega C}}$ (b) $I^2 C\omega$
(c) $I^2 R$ (d) $\frac{V^2}{\omega C}$

29 An alternating current generator has an internal resistance R_g and an internal reactance X_g. It is used to supply power to a passive load consisting of resistance R_g and a reactance X_L. For maximum power to be delivered from the generator to the load, the value of X_L is equal to

(a) zero (b) X_g (c) $-X_g$ (d) R_g

30 The primary winding of transformer has 500 turns, whereas its secondary has 5000 turns. The primary is connected to an AC supply of 20V-50 Hz. The secondary will have an output of

(a) 2 V, 5 Hz (b) 200 V, 500 Hz
(c) 2 V, 50 Hz (d) 200 V, 50 Hz

31 If ε_0 and μ_0 are respectively, the electric permittivity and magnetic permeability of free space, ε and μ are the corresponding quantities in a medium, the index of refraction of the medium is

(a) $\sqrt{\frac{\varepsilon_0\mu_0}{\varepsilon\mu}}$ (b) $\sqrt{\frac{\varepsilon\mu}{\varepsilon_0\mu_0}}$ (c) $\sqrt{\frac{\varepsilon_0\mu}{\varepsilon\mu_0}}$ (d) $\sqrt{\frac{\varepsilon}{\varepsilon_0}}$

32 A step-up transformer operates on a 230 V line and supplies current of 2 A to a load. The ratio of the primary and secondary windings is 1 : 25. The current in the primary coil is

(a) 15 A (b) 50 A (c) 25 A (d) 12.5 A

33 Two coil of self inductance L_1 and L_2 are placed clear to each other so that focal flux in one CaCl is completely linked with other. If M is mutual inductance between them, then

(a) $M = L_1L_2$ (b) $M = \frac{L_1}{L_2}$ (c) $M = \sqrt{L_1L_2}$ (d) $M = (L_1L_2)^2$

34 An LCR series circuit with $R = 100\,\Omega$ is connected to a 200 V, 500 Hz a.c source when only the capacitance is removed, the current leads the voltage by 6s. When only the inductance is removed, the current leads the voltage by 60°. The current in the circuit is

(a) 2 A (b) 7 A (c) $\frac{\sqrt{3}}{2}$ A (d) $\frac{2}{\sqrt{3}}$ A

Direction (Q. Nos. 35-39) *In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements mark the correct answer as*

(a) If both Assertion and Reason are true and the Reason is the correct explanation of the Assertion
(b) If both Assertion and Reason are true but the Reason is not correct explanation of the Assertion
(c) If Assertion is true but Reason is false
(d) If both Assertion and Reason are false

35 **Assertion** (A) In an electromagnetic wave, the average energy density of electric field is equal to the average energy density of the magnetic field.

Reason (R) Electric and magnetic fields are related as $E = cB$.

36 **Assertion** (A) Two parallel wires carrying currents in the same direction, attract each other due to magnetic force between them.

Reason (R) They attract each other, if the currents flowing in them are in opposite direction.

37 **Assertion** (A) The torque on the coil is maximum, when coil is suspended in a radial magnetic field.

Reason (R) The torque tends to rotate the coil about its own axis.

38 **Assertion** (A) When a magnet is brought near iron nails, only translatory force act on it.

Reason (R) The field due to a magnet is generally uniform.

39 **Assertion** (A) Susceptibility is defined as the ratio of intensity of magnetisation I to magnetic intensity H.

Reason (R) Greater the value of susceptibility, smaller the value of intensity of magnetisation I.

ANSWERS

1 (d)	**2** (d)	**3** (c)	**4** (a)	**5** (b)	**6** (b)	**7** (c)	**8** (b)	**9** (b)	**10** (c)
11 (a)	**12** (a)	**13** (a)	**14** (c)	**15** (b)	**16** (b)	**17** (d)	**18** (c)	**19** (c)	**20** (c)
21 (b)	**22** (d)	**23** (a)	**24** (a)	**25** (d)	**26** (b)	**27** (c)	**28** (c)	**29** (c)	**30** (d)
31 (b)	**32** (b)	**33** (c)	**34** (a)	**35** (b)	**36** (c)	**37** (b)	**38** (d)	**39** (c)	

Hints and Explanations

1 Magnetic field at the centre of circular coil, $B = \frac{\mu_0 NI}{2r}$.

***Case* I** $N = 1, L = 2\pi r \Rightarrow r = \frac{L}{2\pi}$

$\therefore \quad B = \frac{\mu_0 \times 1 \times I}{2r} = \frac{\mu_0 I}{2r}$

***Case* II** $N = 2, L = 2 \times 2\pi r'$

$\Rightarrow \quad r' = \frac{L}{4\pi} = \frac{r}{2}$

$\therefore B' = \frac{\mu_0 \times 2 \times I}{2r'} = \frac{\mu_0 \times 2I}{2 \times (r/2)} = \frac{4\mu_0 I}{2r} = 4B$

2 For a solenoid, $B = \mu_0 nI$

where, n = number of turns per unit length

or $\quad B \propto nI$

$\therefore \quad \frac{B_1}{B_2} = \frac{n_1 I_1}{n_2 I_2}$

Here, $\quad n_1 = n, n_2 = \frac{n}{2}$,

$I_1 = I, I_2 = 2I, B_1 = B$

Hence, $\frac{B}{B_2} = \frac{n}{n/2} \times \frac{I}{2I} = 1$ or $B_2 = B$

3 At the centre of circular coil carrying current, the magnetic field,

$$B = \frac{\mu_0 NI}{2r}$$

Given, $N = 1000, I = 0.1$ A, $r = 0.1$ m

Substituting the values, we get

$$B = \frac{4 \times 10^{-7} \times 1000 \times 0.1}{2 \times 0.1}$$

$$= 2\pi \times 10^{-4} = 6.28 \times 10^{-4}\ \text{T}$$

4 Magnetic field due to a long current carrying wire at distance r, is given by

$$B = \frac{\mu_0}{4\pi} \cdot \frac{2I}{r} \text{ or } B \propto \frac{1}{r}$$

When r is doubled, the magnetic field becomes halved i.e. now the magnetic field will be 0.2 T.

5 Here, magnetic force = centripetal force

i.e. $\quad qvB = \frac{mv^2}{r}$

or $\quad qvB = mr\omega^2 \quad [\because v = r\omega]$

or $\quad \omega = \frac{qB}{m}$

If ν is the frequency of rotation, then

$$\omega = 2\pi\nu \Rightarrow \nu = \frac{\omega}{2\pi}$$

$\therefore \quad \nu = \frac{qB}{2\pi m}$

6 When a charged particle moves in region of $\mathbf{E} \propto \mathbf{B}$, then the net force will be $= F_F + F_B = q\mathbf{E} + q(\mathbf{v} + \mathbf{B})$

7 When **v**, **E** and **B** are mutually perpendicular to each other and particle pass undeflected then,

$$qvB = qE \Rightarrow v = \frac{E}{B}$$

Here, $\quad E = 20\ \text{Vm}^{-1}$ and $B = 0.5$ T

$\therefore \quad v = \frac{20}{0.5} = 40\ \text{ms}^{-1}$

8 A magnetic force is given by

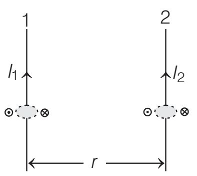
$$F = Il B \sin\theta$$

For $\theta = 90°$, $F_{max} = IlB$

Here, $\quad I = 1.2$ A, $l = 0.5$ m, $B = 2$ T

$F = 2 \times 1.2 \times 0.5 = 1.2$ N

9 According to Maxwell's right handed screw rule.



Therefore, net magnetic field

$$B = B_1 - B_2 = \frac{\mu_0 I_1}{2\pi r_1} - \frac{\mu_0 I_2}{2\pi r_2}$$

At mid point, $r_1 = r_2 = \frac{r}{2} = \frac{5}{2} = 2.5$ cm

Hence,

$$B = \frac{\mu_0}{2\pi}\left(\frac{I_1}{r/2} - \frac{I_2}{r/2}\right) = \frac{\mu_0}{2\pi}\left(\frac{5}{2.5} - \frac{2.5}{2.5}\right)$$

$$= \frac{\mu_0}{2\pi}(2 - 1) = \frac{\mu_0}{2\pi}\ \text{T}$$

10 The force F on the charged particle due to magnetic field provides the required centripetal force $(= mv^2/r)$ necessary for motion along the circular path of radius r.

$\therefore \quad qvB = \frac{mv^2}{r}$ or $r = \frac{mv}{qB}$

$\therefore \quad r \propto v$

As, v is doubled, then the radius also becomes double.

Hence, radius = 2 × 2 = 4 cm.

11 Work done in rotating the dipole from $\theta = \theta_1$ to $\theta = \theta_2$, is

$$W = -MB(\cos\theta_2 - \cos\theta_1)$$

***Case* I**

$W_1 = -MB(\cos 90° - \cos 0°) = MB$

***Case* II** $\quad W_2 = -MB(\cos 60° - \cos 0°)$

$$= -MB\left(\frac{1}{2} - 1\right) = \frac{1}{2}MB = \frac{1}{2}W_1$$

As, $\quad W_1 = nW_2 \Rightarrow n = 2$

12 The time period of bar magnet,

$$T = 2\pi\sqrt{\frac{I}{MH}}$$

When same poles of magnets are placed on same side, then net magnetic moment

$$M_1 = M + 2M = 3M$$

$\therefore \quad T_1 = 2\pi\sqrt{\frac{I}{M_1 H}} = 2\pi\sqrt{\frac{I}{3MH}} \quad \ldots\text{(i)}$

When opposite poles of magnets are placed on same side, then net magnetic moment

$$M_2 = 2M - M = M$$

$\therefore \quad T_2 = 2\pi\sqrt{\frac{I}{M_2 H}} = 2\pi\sqrt{\frac{I}{MH}} \quad \ldots\text{(ii)}$

From Eqs. (i) and (ii), we observe that, $T_1 < T_2$.

13 For diamagnetic substance, magnetic susceptibility is independent of temperature.

14 Diamagnetic substance moves from stronger to weaker field.

15 Emf induced in the coil is

$$e = -\frac{d\phi}{dt} = -\frac{(\phi_2 - \phi_1)}{dt}$$

$\therefore \quad e = -\frac{(0 - NBA)}{dt}$

or $\quad dt = \frac{NBA}{e} = \frac{50 \times 2 \times 10^{-2} \times 10^{-2}}{0.1}$

$= 0.1$ s

16 Length of conductor $(l) = 0.4$ m

Speed $(v) = 7\ \text{ms}^{-1}$

Magnetic field $B = 0.9\ \text{Wbm}^{-2}$

Induced emf, $e = Blv\sin\theta$

$= 0.9 \times 0.4 \times 7 \times \sin 90° = 2.52$ V

17 Self-inductance of solenoid is given by

$$L = \frac{\mu_0 N^2 A}{l}$$

$\therefore \quad L \propto N^2$

when N is doubled, L becomes 4 times.

18 Emf induced in the coil is given by

$$e = -L\frac{dI}{dt}$$

Here, $dI = I_2 - I_1 = 0 - 10 = -10$ A

$dt = 0.5$ s, $e = 220$V

$\therefore 220 = -L\frac{(-10)}{0.5}$ or $L = \frac{220}{20} = 11$ H

19 It is given that emf is zero i.e.

$e = -L\frac{dI}{dt} = 0$ or $L\frac{dI}{dt} = 0$ or $\frac{d}{dt}(t^2 e^{-t}) = 0$

or $\quad 2t \times e^{-t} + t^2 \times (-1)e^{-t} = 0$

or $\quad te^{-t}(2 - t) = 0 \Rightarrow t = 2\text{s} \quad (\because te^{-t} \neq 0)$

20 Energy stored in coil is $E = \frac{1}{2}LI^2$

where, L is self-inductance of coil and I is current induced.

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

21 The given equation of current changing in the first coil is $I = I_0 \sin\omega t$ ...(i)

Differentiating Eq. (i) with respect to time, we have

$\frac{dI}{dt} = \frac{d}{dt}(I_0 \sin\omega t)$ or $\frac{dI}{dt} = I_0 \omega\cos\omega t$

For maximum $\frac{dI}{dt}$, the value of $\cos\omega t$ should be equal to 1.

So, $\left(\frac{dI}{dt}\right)_{\max} = I_0\omega$

The maximum value of emf is given by

$\therefore \quad e_{\max} = M\left(\frac{dI}{dt}\right)_{\max} = MI_0\omega$

Here, $M = 0.005$ H,

$I_0 = 10\text{A}, \omega = 100\pi \text{ rads}^{-1}$

$\therefore \quad e_{\max} = 0.005 \times 10 \times 100\pi = 5\pi$

22 Initially, there is no DC current in inductive circuit and maximum DC current in capacitive circuit. Hence, the current is zero in A_2 and maximum in A_1.

23 Total effective resistance of L-C-R circuit is

$$Z = \frac{V_0}{I_0} = \sqrt{R^2 + (X_L - X_C)^2}$$

Given, $V_{AC} = 200$ V, $X_L = 50\Omega$, $X_C = 50\Omega$, $R = 10\Omega$, $Z = ?$

$\therefore Z = \sqrt{(10)^2 + (50-50)^2}$ or $Z = 10\Omega$

24 Emf induced in the coil is given by

$|e| = L\frac{dI}{dt}$

$\therefore |e| = 40 \times 10^{-3} \times \left(\frac{10}{4 \times 10^{-3}}\right) = 100$ V

25 The impedance (Z) of an L-C-R circuit is given by

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

At resonance, $X_L = X_C$

i.e. $\omega L = \frac{1}{\omega C}$

As, $\tan\phi = \frac{\omega L - \frac{1}{\omega c}}{R} = 0 \Rightarrow \phi = \text{Zero}$

So, circuit behaves as, if it contains R only. So, phase difference = 0

26 Quality factor $= Q = \frac{X_L}{R} = \frac{\omega L}{R}$

27 The L-C-R circuit used for communication should posses high quality factor (Q factor) of resonance. which is given by $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$.

To make Q high ; R should be low ; L should be high and C should be low. Therefore, choice (c) is the best suited.

28 In series L-C-R circuit at resonance,

Capacitive reactance (X_C)

= Inductive reactance (X_L)

i.e. $\frac{1}{\omega C} = \omega L$

Total impedance of the circuit,

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

i.e. $Z = R$

So, power factor $\cos\phi = \frac{R}{Z} = \frac{R}{R} = 1$

Thus, power loss at resonance is given by $P = V_{\text{rms}} I_{\text{rms}} \cos\phi = V_{\text{rms}} I_{\text{rms}} \times 1$

$= (I_{\text{rms}} R) I_{\text{rms}} = (I_{\text{rms}})^2 R = I^2 R$

29 For delivering maximum power from the generator to the passive load, total reactance must vanish, i.e. or $X_L = -X_g$.

30 The transformation ratio of transformer is given by

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

Making substitution, we obtain

$$V_s = \frac{N_s}{N_p} V_p = \frac{5000}{500} \times 20 = 200\text{V}$$

Also, frequency of AC remains unchanged. Thus, option (d) has voltage 200 V and frequency 50 Hz.

31 Refractive index of medium is given by $n = c/v$

Here, $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ and $v = \frac{1}{\sqrt{\mu\varepsilon}}$

$\therefore \quad n = \sqrt{\frac{\mu}{\mu_0} \cdot \frac{\varepsilon}{\varepsilon_0}} = \sqrt{\frac{\varepsilon\mu}{\varepsilon_0 \mu_0}}$

32 For a transformer, $\frac{V_P}{V_s} = \frac{N_P}{N_S}$

Also the power remains constant, if $\eta = 100\%$

So, $V_P I_P = V_S I_S \Rightarrow \frac{I_P}{I_S} = \frac{V_P}{V_S} = \frac{N_S}{N_P}$

Here, $\frac{N_p}{N_s} = \frac{1}{25}$, $I_s = 2$ A

$\therefore \quad \frac{I_p}{2} = \frac{25}{1}$

or $\quad I_p = 25 \times 2 = 50$ A

33 $M = -\frac{e_2}{di_1/dt} = -\frac{e_1}{di_1/dt}$

Also, $e_1 = -L_1 \frac{di_1}{dt} \Rightarrow L_1 = \frac{e_1}{di/dt}$

$e_2 = -L_2 \frac{di_2}{dt} \Rightarrow L_2 = \frac{e_2}{di/dt}$

$M^2 = \frac{e_1 e_2}{\left(\frac{di}{dt}\right)\left(\frac{di_2}{dt}\right)} = L_1 L_2 \Rightarrow M = \sqrt{L_1 L_2}$

34 If the capacitance is removed, it is an L-R circuit $\phi = 60°$.

$\tan\phi = \frac{X_L}{R} = \tan 65° = \sqrt{3}$

If inductance is removed, it is a capacitative circuit or R-C circuit. $|\phi|$ is the same

$\therefore \quad L\omega = \frac{L}{C\omega}$ this is resistance circuit.

$z = R, I_{\text{rms}} = \frac{E_{\text{rms}}}{R} \Rightarrow E_{\text{rms}} = 200V$

$I_{\text{rms}} = \frac{200}{100} = 2$ A

35 Energy density in electric field is

$$U_E = \frac{1}{2}\varepsilon_0 E^2$$

Energy density in magnetic field is

$$U_B = \frac{1}{2\mu_0} B^2$$

We know that,

$E = cB$

and $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

$\therefore \quad U_E = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\varepsilon_0 (cB)^2$

$= \frac{1}{2}\varepsilon_0 \times \frac{1}{\mu_0 \varepsilon_0} \times B^2 = \frac{B^2}{2\mu_0} = U_B$

Therefore, $\quad U_E = U_B$

36 We know that, when two parallel wires carrying currents in same direction attract each other due to magnetic interaction but, if they carry currents in opposite directions, they repel each other.

37 The torque on the coil is given by

$$\tau = nIBA\cos\theta$$

When the magnetic field is radial, then coil is set with its plane parallel to magnetic field i.e. $\theta = 0$, hence $\cos\theta = 1$,

$$\tau_{\max} = nIBA \times 1 = nIBA$$

38 The field due to a magnet is non-uniform. Therefore, it exerts both, a net force and a torque on the nails which will translate and also rotate the nails before striking to North pole of magnet with their induced South poles and *vice-versa*.

39 From the relation, susceptibility of the material is $\chi_m = \frac{I}{H} \Rightarrow \chi_m \propto I$

Thus, it is obvious that greater the value of susceptibility of a material greater will be the value of intensity of magnetisation.