ELECTROMAGNETIC INDUCTION

Faraday's and Lenz's law

2008

1. A circular disc of radius 0.2m is placed in a uniform magnetic field of induction $\frac{1}{\pi}\left(\frac{Wb}{m^2}\right)$ in such a way that its axis makes an angle of $60°$ with B. The magnetic flux linked with the disc is

a 0.02 Wb b) 0.06 Wb c) 0.08 Wb d) 0.01 Wb

2. When a flow flying aircraft passes over head, we sometimes notice a slight shaking of the picture on our TV screen. This is due to

a) diffraction of the signal received from the antenna

b) interference of the direct signal received by the antenna with the weak signal reflected by the passing aircraft

c) change of magnetic flux occurring due to the passage of aircraft

d) vibration created by the passage of aircraft

3. Two similar circular loops carry equal currents in the same direction. On moving coils further apart, the electric current will

a) increase in both b) decrease in both

c) remain ulaltered d) increases in one and decreases in the second

4. When the current changes from +2A to -2A in 0.05s, an emf of 8V is induced in a coil. The coefficient of self, induction of the coil is

a) 0.2 H b) 0.4 H c) 0.8 H d) 0.1 H

5. At time t = 0s, voltage of an AC generator starts from 0V and becomes 2V at time $t = \frac{1}{100\pi}s$. The voltage keeps on increasing up to 100V, after which it starts to decrease. Find the frequency of the generator

a) 2 Hz b) 5 Hz c) 100 Hz d) 1 Hz

6. According to Lenz's law of electromagnetic induction

a) the induced emf is not the direction opposing the change in magnetic flux

b) the relative motion between the coil and magnet produces change in magnetic flux

c) only the magnet should be moved towards coil

d) only the coil should be moved towards magnet

7. The inductance of a coil is L = 10H and resistance $R = 5\Omega$. If applied voltage of battery is 10V and it switches off in 1 millisecond, find induced emf of inductor

a) $2\times10^4 V$ b) $1.2\times10^4 V$ c) $2\times10^{-4} V$ d) None of these

8. A wire of length 50cm moves with a velocity of $300\,\text{m min}^{-1}$, perpendicular to a magnetic field. If the emf induced in the wire is 2V, the magnitude of the field in tesla is

a) 2 b) 5 c) 0.4

d) 2.5 e) 0.8

9. Whenever a magnet is moved either towards or away from a conducting coil, an emf is induced, the magnitude of which is independent of

a) the strength of the magnetic field

b) the speed with which the magnet is moved

c) the number of turns of the coil

d) the resistance of the coil

e) the area of cross – section of the coil

10. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by

a) $Q = \frac{1}{R}.\frac{\Delta\phi}{\Delta t}$ b) $Q = \frac{\Delta\phi}{R}$

c) $Q = \frac{\Delta\phi}{\Delta t}$ d) $Q = R.\frac{\Delta\phi}{\Delta t}$

11. If coil is open then L and R become

a) ∞, 0 b) 0, ∞ c) ∞, ∞ d) 0, 0

12. A coil of self inductance 0.5mH carries a current of 2A. The energy stored in joule is

a) 1.0 b) 0.001 c) 0.5 d) 0.05

13. What is the self inductance of a coil which produces, self induced emf of 5V, when the current changes from 3A to 2A in one millisecond?

a) 5 H b) 5 mH c) 5000 H d) 50 H

14. A circular coil of diameter 21cm is placed in a magnetic field of induction $10^{-4} T$. The magnitude of flux linked with coil when the plane of coil makes an angle $30°$ with the field is

a) $1.44\times10^{-6} Wb$ b) $1.732\times10^{-6} Wb$

c) $3.1\times10^{-6} Wb$ d) $4.2\times10^{-6} Wb$

2006

15. The north pole of a long horizontal bar magnet is being brought closer to a vertical conducting plane along the perpendicular direction. The direction of the induced current in the conducting plane will be

a) horizontal b) vertical c) clockwise d) anticlockwise

16. Induced emf in the coil depends upon

a) conductivity of coil b) amount of flux

c) rate of change of linked flux d) resistance of coil

17. If electric flux varies according to $\phi = 3t^2 + 4t + 2$, find emf at t = 2s

a) 22 V b) 18 V c) 20 V d) 16 V

18. A bar magnet is dropped between a current carrying coil. What would be its acceleration?

a) g downwards b) greater than g downwards

c) less than g downwards d) bar will be stationary

19. In a closed, 10Ω circuit, the change of flux ϕ with respect to time t is given by the equation $\phi = 2t^2 - 5t - 1$, the current at t = 0.25s will be

a) 4 A b) 0.04 A c) 0.4 A d) 1 A

20. Two circular, similar, coaxial loops carry equal currents in the same direction. If the loops are brought nearer, what will happen?

a) Current will increase in each loop

b) Current will decrease in each loop

c) Current will remain same in each loop

d) Current will increase in one and decrease in the other

21. A coil having 500 turns of square shape each of side 10 cm is placed normal to a magnetic field which is increasing at $1Ts^{-1}$. The induced emf is

a) 0.1 V b) 0.5 V c) 1 V d) 5 V

2005

22. In a solenoid, the number of turns is doubled, then self – inductance will become

a) half b) double c) $\frac{1}{4}$ times d) quadruple

23. The Lenz's law gives

a) direction of induced current b) magnitude of induced emf

c) magnitude of induced current d) magnitude and direction of induced current

24. A copper rod of length l is rotated about one end, perpendicular to the uniform magnetic field B with constant angular velocity ω. The induced emf between two ends of the rod is

a) $\frac{1}{2}B\omega l^2$ b) $B\omega l^2$ c) $\frac{3}{2}B\omega l^2$ d) $2B\omega l^2$

25. The flux associated with coil changes from 1.35 Weber to 0.79 Weber within $\frac{1}{10}s$. Then the charge produced by the earth coil. If resistance of coil is 7Ω is

a) 0.08 C b) 0.8 C c) 0.008 C d) 8 C

26. An aeroplane having a wing space of 35m flies due north with the speed of $90\,ms^{-1}$ given $B = 4\times10^{-5}T$. The potential difference between the tips of the wings will be

a) 0.013 V b) 1.26 V c) 12.6 V d) 0.126 V

27. A straight conductor of length 4m moves at a speed of $10\,ms^{-1}$. When the conductor makes an angle of $30°$ with the direction of magnetic field of induction of $0.1Wb/m^2$ then induced emf is

a) 8 V b) 4 V c) 1 V d) 2 V

2004

28. If the current through a solenoid increases at a constant rate, then the induced current

a) Increases with time and is opposite to the direction of the inducing current

b) is a constant and is opposite to the direction of the inducing current

c) Increases with time and is in the direction of the inducing current

d) is a constant and is in the direction of the inducing current

29. Which law follows the law of conservation of energy?

a) Lenz's law b) Kirchoff's law c) Maxwell's law d) Ampere's law

30. A small piece of metal wire is dragged across the gap between the poles of a magnet is 0.4s. If the change in magnetic flux in the wire is $8\times10^{-4}Wb$, then emf induced in the wire is

a) $8\times10^{-3}V$ b) $6\times10^{-3}V$ c) $4\times10^{-3}V$ d) $2\times10^{-3}V$

Faraday's and Lenz's law

KEY

1)	**a**	2)	**c**	3)	**a**	4)	**d**	5)	**d**	6)	**b**	7)	**a**	8)	**e**	9)	**d**	10)	**b**
11)	**b**	12)	**b**	13)	**b**	14)	**b**	15)	**c**	16)	**c**	17)	**d**	18)	**c**	19)	**c**	20)	**b**
21)	**d**	22)	**d**	23)	**a**	24)	**a**	25)	**a**	26)	**d**	27)	**d**	28)	**b**	29)	**a**	30)	**a**

SOLUTIONS

1. $\phi = BA\cos\theta$

$\theta = 60°,\ B = \frac{1}{\pi} Wvm^{-2},\ A = \pi(0.2)^2$

$\therefore\ \phi = \frac{1}{\pi} \times \pi(0.2)^2 \times \cos 60°$

$(0.2) \times \frac{1}{2} = 0.02Wb$

4. Induced emf $e - L\frac{di}{dt} = -L\frac{(-2-2)}{0.05}$

$8 = L\frac{(4)}{0.05}$

$\therefore\ L = \frac{8 \times 0.05}{4} = 0.1H$

5. The produced voltage by an AC generator is 2V at

$t = \frac{1}{100\pi} s$

and maximum produced voltage $(e_o) = 100V$

But, $e = e_o \sin\omega t$

$e = 2V, t = \frac{1}{100\pi} s$

$e_o = 100V$

$\therefore 2 = 100 \sin\omega \times \frac{1}{100\pi}$

But the time $\frac{1}{100\pi} s$ is very small, so the angle ωt is also very small. Therefore, for a small angle

$\sin\theta = \theta$

$\therefore 2 = 100 \times \omega \times \frac{1}{100\pi}$

$\Rightarrow\ 2\pi = \omega$

or $2\pi = 2\pi n$ (n = frequency of the generator) or n = 1 Hz

7. $\phi = Li$

or $e - \frac{d\phi}{dt} = -\frac{d}{dt}(Li)$

or $e = -L\frac{di}{dt}$

Induced current = $\frac{V}{R} = \frac{10}{5}$ = 2A

Circuit switches off in 1 millisecond

or $dt = 1\times10^{-3}s$

and L = 10 H

$\therefore$ Induced emf in inductor is $|e| = 10\times\frac{2}{1\times10^{-3}} = 2\times10^{4}V$

8. $e = Blv$

l = 50cm = 0.5m

$v = 300\,\text{m min}^{-1}$

= $\frac{300}{60} = 5\,ms^{-1}$

and e = 2V

Magnetic field $B = \frac{e}{lv} = \frac{2}{0.5\times5} = 0.8T$

9. $e = -N\frac{d\phi}{dt}$

$e = -N\frac{d(BA)}{dt}$

Time interval dt, depends on the speed with which the magnet is moved.

Therefore, the induced emf is independent of the resistance of the coil.

10. $e = \frac{\Delta\phi}{\Delta t}$ and $i = \frac{e}{R} = \frac{\Delta\phi}{R\Delta t}$

Charge passes through the circuit $Q = i\times\Delta t$

$$\Rightarrow Q = \frac{\Delta\phi}{R\Delta t} \times \Delta t \Rightarrow \; Q = \frac{\Delta\phi}{R}$$

11. $\phi = Li$

Where L is proportionality constant known as self inductance.

$$\therefore \; L = \frac{\phi}{i} = 0$$

Again since I = 0, hence, $R = \infty$

12. When current in a coil is changing, due to opposition by the coil through its self inductance L, work done in time dt is

$$dW = P \; dt = eI \; dt = LI \; dt \qquad \left(\text{as } \; e = L\frac{dI}{dt}\right)$$

So, work done in establishing a current I in the coil is

$$W = \int_o^I LI\,dI = \frac{1}{2}LI^2$$

This work is stored as magnetic potential energy U

Here I = 2A, L = 0.5 mH

$$\therefore \; U = \frac{1}{2} \times 0.5 \times 10^{-3} \times (2)^2 = 0.001 \text{ J}$$

13. e = 5V, dI = 2 – 3 = - 1A

$$dt = 1ms = 1 \times 10^{-3} s$$

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

$$\therefore \; L = -e\frac{dt}{dI} = \frac{5 \times 1 \times 10^{-3}}{1}$$

$$5 \times 10^{-3} H = 5mH$$

16. $e = -\frac{d\phi_B}{dt}$

17. $\phi = 3t^2 + 4t + 2 \Rightarrow \; emf = \frac{d\phi}{dt} = 6t + 4$

$$\therefore \; \left|\frac{d\phi}{dt}\right|_{t=2} = 16V$$

19. $\phi = 2t^2 - 5t + 1$

Induced emf $e = -\frac{d\phi}{dt}$

$= -\frac{d}{dt}\left(2t^2 - 5t + 1\right) = -\left(4t - 5\right)$

$\therefore$ Current $i = \frac{e}{R} = -\frac{\left(4t - 5\right)}{10}$

At t = 0.25s $\quad i = -\frac{\left(4 \times 0.25 - 5\right)}{10} = -\frac{\left(-4\right)}{10} = 0.4A$

21. $\phi = BA\cos\theta$

$\theta = 0°,\ B = 1Ts^{-1}$

$A = \left(10\right)^2 cm^2 = 10^{-2} m^2$

$\therefore\ \theta = 1 \times 10^{-2}$

$e = -N\frac{\Delta\phi}{\Delta r} = -500 \times 10^{-2} = -5V$

22. For a solenoid of length l, area of cross – section A, having B closed wound turns,

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

When $N' = 2N$

$L' = \frac{\mu_o \left(2N\right)^2 A}{l} = \frac{4\mu_o N^2 A}{l} = 4L$

Hence, when number of turns is doubled then self inductance becomes quadruple.

24 e = B × (rate of change of area of loop)

If θ is the angle between the rod and the radius of circle at P at time t, area of the arc formed by the rod and radius at $P = \frac{1}{2}l^2\theta$

where l is radius of the circle

$$e = B \times \frac{d}{dt}\left(\frac{1}{2}l^2\theta\right)$$

$$= \frac{1}{2} B.l^2 \frac{d\theta}{dt}$$

$$= \frac{1}{2} Bl^2 \omega \qquad \left(\because \ \omega = \frac{d\theta}{dt}\right)$$

25. As $I = \frac{e}{R} = \frac{d\phi}{Rdt}$

or $Idt = \frac{d\phi}{R}$

Integrating $\int Idt = \int \frac{d\phi}{R}$

or $q = \frac{\phi}{R}$

If coil contains N turns, then $q = \frac{N\phi}{R}$

If there is flux change $\Delta\phi$, then $q = \frac{N\Delta\phi}{R}$

$$= \frac{1}{7} \times (1.35 - 0.79)$$

= 0.08 V

26. The induced emf is given by

$$= Bvl = 4 \times 10^{-5} \times 90 \times 35$$

= 0.126 V

27. Induced emf is given by

$$e = Bvl \sin\theta = 0.1 \times 10 \times 4 \sin 30°$$

e = 2V

30. $e = -\frac{d\phi}{dt}$

$d\phi - 8 \times 10^{-4} Wb, \ dt = 0.4s$

$$\Rightarrow \quad e = -\frac{8 \times 10^{-4}}{0.4} = -2 \times 10^{-3} V$$

SELF AND MUTUAL INDUCTIONS

2011

1. What is the self inductance of solenoid of length 31.4cm, area of cross – section $10^{-3} m^2$ and total number of turns 10^3 ?

a) 4 mH b) 4 H c) 40 H d) 0.4 H

2. What should be the value of self inductance of an inductor that should be connected to 220V, 50Hz supply so that a maximum current of 0.9A flows through it?

a) 11 H b) 2 H c) 1.1 H d) 5 H

3. In Hertz's experiment, the rods connected with an induction coil behave as

a) an inductor b) capacitor c) resistor d) an induction coil

4. A transformer has 500 primary turns and 10 secondary turns. If the secondary has a resistive load of 15Ω, the currents in the primary and secondary respectively, are

a) $0.16A, 3.2\times10^{-3}A$ b) $3.2\times10^{-3}A, 0.16A$

c) 0.16A, 0.16A d) $3.2\times10^{-3}A, 3.2\times10^{-3}A$

2008

5. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon

a) the rates at which currents are changing in the two coils

b) relative position and orientation of the two coils

c) the material of the wires of the coils

d) the currents in the two coils

6. X and T, two metallic coils are arranged in such a way that, when steady change in current flowing in X coil is 4A, change in magnetic flux associated with coil Y is 0.4Wb. Mutual inductance of the system of these coils is

a) 0.2 h b) 5 H c) 0.8 H d) 0.1 H

7. According to phenomenon of mutual inductance

a) the mutual inductance does not depend on the geometry of the two coils involved

b) the mutual inductance depends on the intrinsic magnetic property, like relative permeability of the material

c) the mutual inductance is independent of the magnetic property of the material

d) ratio of magnetic flux produced by the coil 1 at the place of the coil 2 and the current in the coil 2 will be different from that of the ratio defined by interchanging the coils

2007

8. Two coils of self – inductances 2mH and 8mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

a) 10mH b) 6mH c) 4mH d) 16mH

2006

9. A current of $I = 10\sin(100\pi t)A$ is passed in first coil, which induce a maximum emf $5\pi V$ in second coil. The mutual inductance between the coils is

a) 10mH b) 15mH c) 25mH d) 20mH
e) 5mH

2005

10. The induction coil works on the principle of

a) Self induction b) mutual induction
c) Ampere's rule d) Fleming's right hand rule

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

a) 12π b) 8π c) 5π d) 2π

12. Two inductors each of inductance L are joined in parallel. Their equivalent inductance will be

a) Zero b) $\frac{L}{2}$ c) L d) 2L

13. For a solenoid having a primary coil of N_1 turns and a secondary coil of N_2 turns, the coefficient of mutual inductance is

a) $\mu_o\mu_r \frac{N_1N_2}{l}$ b) $\frac{\mu_o\mu_r N_1N_2}{Al}$ c) $\mu_o\mu_r N_1N_2Al$ d) $\frac{\mu_o\mu_r N_1N_2A}{l}$

SELF AND MUTUAL INDUCTIONS

KEY

1) b 2) d 3) a 4) b 5) b 6) d 7) b 8) c 9) e 10) b

11) c 12) b 13) d

SOLUTIONS

1. $A = 10^{-3} m^2$

$l = 31.4cm = 31.4 \times 10^{-2} m$ and $n = 10^3$

$\phi = Lo$

BA = Li

$\mu_o ni\, A = Li$

$L = \dfrac{4\pi \times 10^{-7} \times 10^3 \times 10^{-3}}{31.4 \times 10^{-2}}$ = 4 mH

2. $|e| = \dfrac{Ldi}{dt} = 220 = L \times \dfrac{0.9}{1/50}$

4. $\dfrac{N_s}{N_p} = \dfrac{i_p}{i_s}$ Or $\dfrac{10}{500} = \dfrac{i_p}{i_s}$

$\Rightarrow \dfrac{i_p}{i_s} = \dfrac{1}{50} \Rightarrow \quad i_s = 50 i_p$

This condition is satisfied only when current in primary $3.2 \times 10^{-3} A$ and in secondary 0.16A.

6. $\phi_Y \propto I_X$

ϕ_Y = change in magnetic flux in coil Y,

I_X = change in current in coil X,

M = mutual inductance,

$\Rightarrow \phi_Y = MI_X$ ……….. (i)

Given , $I_X = 4A$

$\phi_Y = 0.4Wb$

Or $0.4 = M \times 4$

$\Rightarrow M = \dfrac{0.4}{4} = 0.1H$

8. $M_{12} = \frac{N_2 \phi_{B_2}}{i_1}$ and $M_{21} = \frac{N_1 \phi_{B_1}}{i_2}$

$L_1 = \frac{N_1 \phi_{B_1}}{i_1}$ and $L_2 = \frac{N_2 \phi_{B_2}}{i_2}$

$$\phi_{B_2} = \phi_{B_1}$$

Since $M_{12} = M_{21} = M$,

$$M_{12} M_{21} = M^2 = \frac{N_1 N_2 \phi_{B_1} \phi_{B_2}}{i_1 i_2} = L_1 L_2$$

$\therefore \quad M_{\max} = \sqrt{L_1 L_2}$

But, $L_1 = 2mH$, $L_2 = 8mH$

$\therefore M_{\max} = \sqrt{2 \times 8} = \sqrt{16} = 4mH$

9. $e = -\frac{Mdi}{dt} \Rightarrow \quad M = -\frac{e}{di/dt}$

$e = 5\pi V$ and $i = 10 \sin(100\pi t)$,

$$\therefore \left(\frac{di}{dt}\right)_{\max} = 10 \times 100\pi$$

$$\therefore \quad M = -\frac{5\pi}{10 \times 100\pi} = -5 \times 10^{-3} H = 5mH$$

11. M = 0.005 H and $I_o = 10A$

$\omega = 100\pi \, rad \, s^{-1}$

$I = I_o \sin \omega t$

or $\frac{dI}{dt} = \frac{d}{dt}(I_o \sin \omega t) = I_o \cos \omega t . \omega = 10 \times 1 \times 100\pi = 1000\pi$

$$\therefore e = M \times \frac{di}{dt} = 0.05 \times 1000 \times \pi = 5\pi V$$

12. $L_1 = L$ and $L_2 = L$

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} = \frac{1}{L} + \frac{1}{L} = \frac{2}{L}$$

$$\therefore L_{eq} = \frac{L}{2}$$

13. $M = \frac{\phi}{I_P} = \frac{\mu_o \mu_r N_1 N_2 A I_P}{l I_P} = \frac{\mu_o \mu_r N_1 N_2 A}{l}$

APPLICATIONS OF EMI (MOTOR, DYNAMO, TRANSFORMER)

2011

1. Two solenoids of equal number of turns have their lengths and the radii in the same ratio 1: 2. The ratio of their self – inductance will be

a) 1 : 2 b) 2 : 1 c) 1 : 1
d) 1 : 4 e) 1 : 3

2. Assertion (A): An electric motor will have maximum efficiency when back emf becomes equal to half of applied emf

Reason (R): Efficiency of electric motor depends only on magnitude of back emf

a) Both assertion and reason are true and reason is the correct explanation of assertion

b) Both assertion and reason are true but reason is not the correct explanation of assertion

c) Assertion is true but reason is false

d) Both assertion and reason are false

3. A transformer is used to light a 100W and 110V lamp from a 220V main. If the main current is 0.5A, the efficiency of the transformer is approximately

a) 30% b) 50% c) 90% d) 10%

4. An electric motor runs on DC source of emf 200V and draws a current of 10A. If the efficiency be 40%, then the resistance of armature is

a) 2Ω b) 8Ω c) 12Ω d) 16Ω

5. Which quantity is increased in step – down transformer?

a) Current b) Voltage c) Power d) Frequency

6. In a step – up transformer, the turn ratio is 1: 2. A Leclanche cell (emf = 1.5V) is connected across the primary. The voltage developed in the secondary would be

a) 3.0 V b) 0.75 V c) 1.5 V d) zero

7. The emf induced in a secondary coil is 20000V, when the current breaks in the primary coil. The mutual inductance is 5H and the current reaches to zero in $10^{-4}s$ in the primary. The maximum current in the primary before it breaks is

a) 0.1 A b) 0.4 A c) 0.6 A d) 0.8 A

8. Two coils are wound on the same iron rod so that the flux generated by one passes through the other. The primary coil has N_P turns in it and when a current 2A flows through it the flux in it is $2.5\times10^{-4}Wb$. If the secondary coil has 12 turns the mutual inductance of the coils is (assume the secondary coil is in open circuit)

a) $10\times10^{-4}H$ b) $15\times10^{-4}H$ c) $20\times10^{-4}H$ d) $25\times10^{-4}H$

9. A current of 5A is flowing at 220V in the primary coil of a transformer. If the voltage produced in the secondary coil is 2200V and 50% of power is lost, then the current in secondary will be

a) 2.5 A b) 5 A c) 0.25 A d) 0.5 A

10. An electric generator is based on

a) Faraday's law of electromagnetic induction

b) Motion of charged particles in electromagnetic field

c) Newton's laws of motion

d) Fission of uranium by slow neutrons

11. The primary and secondary coils of a transformer have 50 and 1500 turns respectively. If the magnetic flux ϕ linked with the primary coil is given by $\phi = \phi_o + 4t$, where ϕ is in weber, t is time in second and ϕ_o is constant, the output voltage across the secondary coil is

a) 90 V b) 120 V c) 220 V d) 30 V

12. The core of a transformer is laminated because

a) energy losses due to eddy currents may be minimised

b) the weight of the transformer may be reduced

c) rusting of the core may be prevented

d) ratio of voltage in primary and secondary may be increased

13. In step – up transformer, relation between number of turns in primary (N_p) and number of turns in secondary (N_s) coils is

a) N_s is greater than N_p b) N_p is greater than N_s

c) N_s is equal to N_p d) $N_p = 2N_s$

2007

14. Use of eddy currents is done in the following except

    a) moving coil galvanometer b) electric brakes

    c) induction motor d) dynamo

15. A six pole generator with fixed field excitation develops an emf of 100V, when operating at 1500 rpm. At what speed must it rotate to develop 120 V?

    a) 1200 rpm b) 1800 rpm c) 1500 rpm d) 400 rpm

16. A step – down transformer reduces the voltage of a transmission line from 2200 V to 220 V. The power delivered by it is 880 W and its efficiency is 88%. The input current is

    a) 4.65 mA b) 0.045 A c) 0.45 A d) 4.65 A

17. Fleming's left and right hand rule are used in

    a) DC motor and AC generator b) DC generator and AC motor

    c) DC motor and DC generator d) both rules are same, any one can be used

18. Voltage in the secondary coil of a transformer does not depend upon

    a) frequency of the source b) voltage in the primary coil

    c) ratio of number of turns in the two coils d) Both (b) and (c)

19. When power is drawn from the secondary coil of the transformer, the dynamic resistance

    a) increases b) decreases

    c) remains unchanged d) changes erratically

2006

20. Core of transformer is made up

    a) Soft iron b) steel c) iron d) alnico

21. Transformer is based upon the principle of

    a) self induction b) mutual induction c) eddy current d) None of these

22. A transformer has an efficiency of 80%. It works at 4kW and 100V. If secondary voltage is 240V, the current in primary coil is

    a) 10 A b) 4 A c) 0.4 A d) 40 A

23. In a step – up transformer, the number of turns in

    a) primary are less b) primary are more

    c) primary and secondary are equal d) primary are infinite

24. A step up transformer operates on a 230V line and supplies to a load of 2A. The ratio of primary and secondary windings is 1: 35. Determine the primary current

    a) 8.8 A b) 12.5 A c) 25 A d) 50 A

2005

25. The turn ratio of a transformer is given as 2 : 3. If the current through the primary coil is 3A, thus calculate the current through load resistance

a) 1 A b) 4.5 A c) 2 A d) 1.5 A

26. A transformer with efficiency 80% works at a 4kW and 100V. If the secondary voltage is 200V. Then the primary and secondary currents are respectively

a) 40 A, 16 A b) 16 A, 40 A c) 20 A, 40 A d) 40 A, 20 A

5) 40 A, 10 A

27. In the induction coil, across secondary coil the output voltage is practically

a) unidirectional, high, intermittent b) unidirectional, low, intermittent

c) unidirectional, high, constant d) unidirectional, low, constant

28. The number of turns in primary and secondary of a transformer are 5 and 10 and mutual inductance of a transformer is 25H. Now, the number of turns in primary and secondary are 10 and 5, the new mutual inductance will be

a) 6.25 H b) 12.5 H c) 25 H d) 50 H

29. If a transformer of an audio amplifier has output impedance 8000Ω and the speaker has input impedance of 8Ω, the primary and secondary turns of this transformer connected between the output of amplifier and to loud speaker should have the ratio

a) 1000 : 1 b) 100 : 1 c) 1 : 32 d) 32 : 1

30. The coefficient of mutual inductance between the primary and secondary of the coil is 5H. A current of 10A is cut – off in 0.5s. The induced emf is

a) 1 V b) 10 V c) 5 V c) 100 V

31. Quantity that remains unchanged in a transformer is

a) Voltage b) current c) frequency d) None of these

2004

32. Eddy currents are produced in

a) induction furnace b) electromagnetic brakes

c) speedometers d) all of these

33. Which of the following is not transducer?

a) Loudspeaker b) Amplifier c) Microphone d) All of these

34. A step – up transformer has transformation ratio 3 : 2. The voltage in the secondary coil, if the voltage in the primary is 30V, will be

a) 300 V b) 90 V c) 45 V d) 23 V

35. A transformer is having 2100 turns in primary and 4200 turns in secondary. An AC source of 120V, 10A is connected to its primary. The secondary voltage and current are

a) 240A, 5A b) 120V, 10A c) 240V, 10A d) 120V, 20A

APPLICATIONS OF EMI (MOTOR, DYNAMO, TRANSFORMER)

KEY

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

SOLUTIONS

1. $L = \frac{\mu_o N_2 \pi r^2}{\lambda}$

$\therefore \frac{L_1}{L_2} = \left(\frac{r_1}{r_2}\right)^2 \left(\frac{\lambda_2}{\lambda_1}\right) = \left(\frac{1}{2}\right)^2 \times \left(\frac{2}{1}\right)$

$\frac{L_1}{L_2} = \frac{1}{2}$

3. $\eta = \frac{\text{Output power}}{\text{Input power}}$

or $\eta = \frac{V_s I_s}{V_p I_p}$

But, $V_s I_s = 100W, V_p = 220V, I_p = 0.5A$

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

4. Input power = $VI = 200 \times 10 = 2000W$

Output power = $\frac{40}{100} \times 2000$

= 800 W

Power loss in heating the armature= 2000 – 800 = 1200 W

$\therefore \; I^2 R = 1200$

or $\quad R = \frac{1200}{I^2} = \frac{1200}{10 \times 10}$

or $\quad R = 12\Omega$

7. $e = \frac{M i_{\max}}{t}$

or $\; 20000 = 5 \times \frac{i_{\max}}{10^{-4}}$

or $\quad i_{\max} = \frac{20000 \times 10^{-4}}{5} = 0.4A$

8. $M = \frac{N_s \phi}{i} = \frac{12 \times 2.5 \times 10^{-4}}{2} = 15 \times 10^{-4} H$

9. $V_p = 220V, \; V_s = 2200V, \; I_p = 5A$ and

Power loss = 50%

$$\eta\% = \frac{P_{\text{out}}}{P_{\text{in}}} \times 100 = \frac{V_s I_s}{V_p I_p} \times 100$$

$$50 = \frac{2200 \times I_s}{220 \times 5} \times 100$$

$I_s = 0.25A$

11. The magnetic flux linked with the primary coil is given by

$\phi = \phi_o + 4t$

So, voltage across primary

$$V_p = \frac{d\phi}{dt} = \frac{d}{dt}\left(\phi_o + 4t\right) = 4\text{V} \quad (\text{as } \phi_o = \text{constant})$$

Also, we have

$N_p = 50$ and $N_s = 1500$

From relation,

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

or $$V_s = V_p \frac{N_s}{N_p} = 4\left(\frac{1500}{50}\right) = 120 \text{ V}$$

15. Speed = $\frac{120}{100} \times 1500\, rpm$ = 1800 rpm

16. $$\eta = \frac{\text{Output power}}{\text{Input power}}$$

$$\Rightarrow \quad \frac{88}{100} = \frac{880}{P_i}$$

$$\Rightarrow \; P_i = 1000W$$

$$I_p = \frac{P_i}{V_i} = \frac{1000}{2200} = 0.45A$$

22. $P_i = V_p I_p$

or $I_p = \frac{P_i}{V_p} = \frac{4000}{100} = 40A$

24. $$\frac{I_P}{I_S} = \frac{N_S}{N_P}$$

or $I_P = I_S \times \frac{N_S}{N_P} = 2 \times 25 = 50A$

25. $V_s \times i_s = V_p \times i_p$

$$\Rightarrow \quad \frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p} = \text{transformer ratio}$$

But, $\frac{N_p}{N_s} = \frac{2}{3},\ i_p = 3A$

$$\Rightarrow \quad i_s = \frac{N_s}{N_s} i_p = \frac{2}{3} \times 3 = 2A$$

26. $\eta = \dfrac{\text{Output power}}{\text{Input power}}$

or $\eta = \dfrac{V_s I_s}{V_p I_p}$

$\therefore \dfrac{80}{100} = \dfrac{200 \times I_s}{4000}$

or $I_s = 16A$

Also $V_p I_p = 4000$ or $I_p = \dfrac{4000}{100} = 40A$

28. $M \propto N_1 N_2$

$\therefore \dfrac{M_1}{M_2} = \dfrac{N_1 N_2}{N'_1 N'_2}$

$\dfrac{25}{M_2} = \dfrac{5 \times 10}{10 \times 5}$

Or $M_2 = 25H$

29. $e_p = -N_o \dfrac{\Delta \phi}{\Delta t}$

$e_s = -N_s \dfrac{\Delta \phi}{\Delta t}$

Also e = iR

$\therefore \dfrac{R_p}{R_s} = \dfrac{N_p}{N_s}$

$R_s = 8000\Omega,\ R_p = 8\Omega$

$\therefore \dfrac{N_s}{N_p} = \dfrac{R_s}{R_p} = \dfrac{8000}{8} = \dfrac{1000}{l}$

30. $e = -M \dfrac{di}{dt}$

M = 5H, di = 10A, dt = 0.5s

$$\therefore \quad e = -5 \times \frac{10}{0.5} = -100\text{V}$$

34. $$\frac{E_s}{E_p} = \frac{N_s}{N_p}$$

or $E_s = E_p \frac{N_s}{N_p} = 30 \times \frac{3}{2} = 45V$

35. $V_s \times i_s = V_p \times i_p$

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

$$\therefore \quad V_s = \frac{N_s}{N_p} \times V_p$$

$V_p = 120V$, $N_s = 4200$, $N_p = 2100$

$$\therefore \quad V_s = \frac{4200}{2100} \times 120$$

$$V_s = 240V$$

and $\frac{I_s}{I_p} = \frac{N_p}{N_s}$

$$\Rightarrow I_s = \frac{N_p}{N_s} \times I_p = \frac{2100}{4200} \times 10 = 5A$$