CHAPTER

6

Electromagnetic Induction

6.3 Magnetic Flux

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

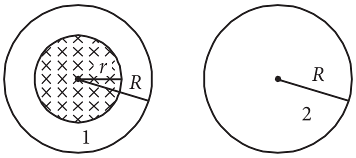
(a) 0.08 Wb (b) 0.01 Wb
(c) 0.02 Wb (d) 0.06 Wb *(2008)*

6.4 Faraday's Law of Induction

2. A 800 turn coil of effective area 0.05 m^2 is kept perpendicular to a magnetic field 5×10^{-5} T. When the plane of the coil is rotated by 90° around any of its coplanar axis in 0.1 s, the emf induced in the coil will be

(a) 0.02 V (b) 2 V
(c) 0.2 V (d) 2×10^{-3} V
(NEET 2019)

3. A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius $R > r$ encloses the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure. Then the e.m.f. generated is



(a) zero in loop 1 and zero in loop 2

(b) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2

(c) $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2

(d) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and zero in loop 2
(NEET-II 2016)

4. A coil of resistance 400 Ω is placed in a magnetic field. If the magnetic flux ϕ (Wb) linked with the coil varies with time t (sec) as $\phi = 50t^2 + 4$. The current in the coil at $t = 2$ sec is

(a) 0.5 A (b) 0.1 A
(c) 2 A (d) 1 A *(2012)*

5. A conducting circular loop is placed in a uniform magnetic field, B = 0.025 T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1}. The induced emf when the radius is 2 cm, is

(a) 2π μV (b) π μV
(c) $\frac{\pi}{2}$ μV (d) 2 μV *(2010)*

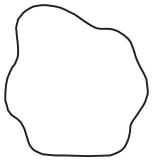
6. A rectangular, a square, a circular and an elliptical loop, all in the ($x - y$) plane, are moving out of a uniform magnetic field with a constant velocity, $\vec{V} = v\hat{i}$. The magnetic field is directed along the negative z axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for

(a) the circular and the elliptical loops
(b) only the elliptical loop
(c) any of the four loops
(d) the rectangular, circular and elliptical loops
(2009)

7. A conducting circular loop is placed in a uniform magnetic field 0.04 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at 2 mm/s. The induced emf in the loop when the radius is 2 cm is

(a) 4.8π μV (b) 0.8π μV
(c) 1.6π μV (d) 3.4π μV *(2009)*

8. As a result of change in the magnetic flux linked to the closed loop as shown in the figure, an e.m.f. V volt is induced in the loop. The work done (joule) in taking a charge Q coulomb once along the loop is



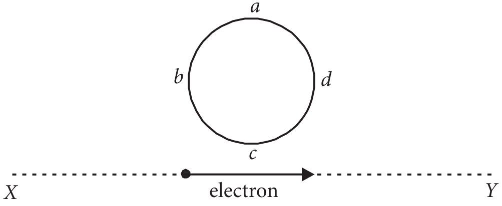
(a) QV (b) $2QV$
(c) $QV/2$ (d) zero. *(2005)*

9. A rectangular coil of 20 turns and area of cross-section 25 sq. cm has a resistance of 100 Ω. If a magnetic field which is perpendicular to the plane of coil changes at a rate of 1000 tesla per second, the current in the coil is
(a) 1 A (b) 50 A
(c) 0.5 A (d) 5 A *(1992)*

10. 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 e.m.f. induced in the coil is 0.1 V, when it is removed from the field in t sec. The value of t is
(a) 10 s (b) 0.1 s
(c) 0.01 s (d) 1 s *(1991)*

6.5 Lenz's Law and Conservation of Energy

11. An electron moves on a straight line path XY as shown. The $abcd$ is a coil adjacent to the path of electron. What will be the direction of current, if any, induced in the coil?



(a) The current will reverse its direction as the electron goes past the coil
(b) No current induced
(c) $abcd$ (d) $adcb$ *(2015)*

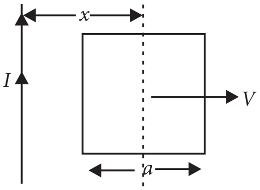
12. A metal ring is held horizontally and bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is
(a) more than g (b) equal to g
(c) less than g (d) either(a) or (c) *(1996)*

13. Faraday's laws are consequence of conservation of
(a) energy
(b) energy and magnetic field
(c) charge
(d) magnetic field *(1991)*

6.6 Motional Electromotive Force

14. A cycle wheel of radius 0.5 m is rotated with constant angular velocity of 10 rad/s in a region of magnetic field of 0.1 T which is perpendicular to the plane of the wheel. The EMF generated between its centre and the rim is
(a) 0.25 V (b) 0.125 V
(c) 0.5 V (d) zero
(Odisha NEET 2019)

15. A conducting square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to



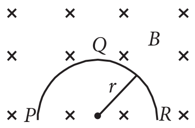
(a) $\dfrac{1}{(2x+a)^2}$

(b) $\dfrac{1}{(2x-a)(2x+a)}$

(c) $\dfrac{1}{x^2}$ (d) $\dfrac{1}{(2x-a)^2}$.

(2015 Cancelled)

16. A thin semicircular conducting ring (PQR) of radius r is falling with its plane vertical in a horizontal magnetic field B, as shown in the figure.
The potential difference developed across the ring when its speed is v, is



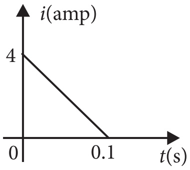
(a) zero
(b) $\dfrac{Bv\pi r^2}{2}$ and P is at higher potential
(c) πrBv and R is at higher potential
(d) $2rBv$ and R is at higher potential *(2014)*

17. A straight line conductor of length 0.4 m is moved with a speed of 7 m/s perpendicular to a magnetic field of intensity 0.9 Wb/m^2. The induced e.m.f. across the conductor is
(a) 5.04 V (b) 25.2 V
(c) 1.26 V (d) 2.52 V *(1995)*

6.7 Energy Consideration : A Quantitative Study

18. A long solenoid of diameter 0.1 m has 2×10^4 turns per meter. At the centre of the solenoid, a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0 A from 4 A in 0.05 s. If the resistance of the coil is $10\,\pi^2$ Ω, the total charge flowing through the coil during this time is
(a) 16 μC (b) 32 μC
(c) 16π μC (d) 32π μC *(NEET 2017)*

19. In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is



(a) 8 (b) 2 (c) 6 (d) 4 *(Mains 2012)*

20. 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) $Q = \frac{1}{R} \cdot \frac{\Delta\phi}{\Delta t}$ (b) $Q = \frac{\Delta\phi}{R}$

(c) $Q = \frac{\Delta\phi}{\Delta t}$ (d) $Q = R \cdot \frac{\Delta\phi}{\Delta t}$ *(2004)*

21. The total charge, induced in a conducting loop when it is moved in magnetic field depends on
(a) the rate of change of magnetic flux
(b) initial magnetic flux only
(c) the total change in magnetic flux
(d) final magnetic flux only. *(1992)*

6.8 Eddy Currents

22. In which of the following devices, the eddy current effect is not used?
(a) electric heater
(b) induction furnace
(c) magnetic braking in train
(d) electromagnet *(NEET 2019)*

23. Eddy currents are produced when
(a) a metal is kept in varying magnetic field
(b) a metal is kept in steady magnetic field
(c) a circular coil is placed in a magnetic field
(d) current is passed through a circular coil *(1988)*

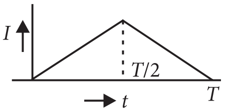
6.9 Inductance

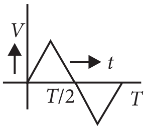
24. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance
(a) 0.138 H (b) 138.88 H
(c) 1.389 H (d) 13.89 H *(NEET 2018)*

25. A current of 2.5 A flows through a coil of inductance 5 H. The magnetic flux linked with the coil is
(a) 0.5 Wb (b) 12.5 Wb
(c) zero (d) 2 Wb
(Karnataka NEET 2013)

26. The current (I) in the inductance is varying with time according to the plot shown in figure.

Which one of the following is the correct variation of voltage with time in the coil ?



(a)


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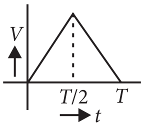

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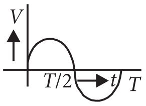
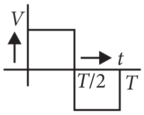
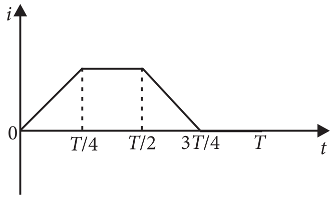
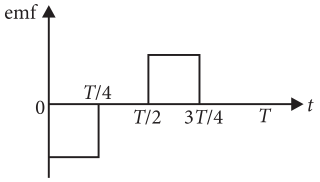


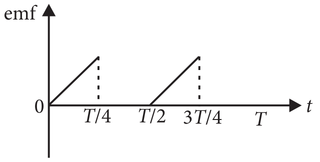
(d)


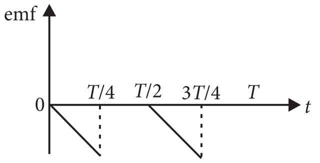
(2012)

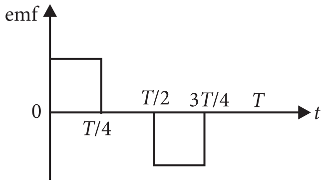
27. The current i in a coil varies with time as shown in the figure. The variation of induced emf with time would be



(a)


(b)


(c)


(d)


(2011)

28. A long solenoid has 500 turns. When a current of 2 ampere is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is
(a) 1.0 henry (b) 4.0 henry
(c) 2.5 henry (d) 2.0 henry *(2008)*

29. Two coils of self inductance 2 mH and 8 mH 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) 16 mH (b) 10 mH
(c) 6 mH (d) 4 mH *(2006)*

30. For a coil having $L = 2$ mH, current flow through it is $I = t^2 e^{-t}$ then, the time at which emf becomes zero
(a) 2 sec (b) 1 sec
(c) 4 sec (d) 3 sec. *(2001)*

31. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin\omega t$, where $I_0 = 10$ A and $\omega = 100\pi$ rad/sec. The maximum value of e.m.f. in the second coil is
(a) π (b) 5π
(c) 2π (d) 4π *(1998)*

32. If N is the number of turns in a coil, the value of self inductance varies as
(a) N^0 (b) N
(c) N^2 (d) N^{-2} *(1993)*

33. What is the self-inductance of a coil which produces 5 V when the current changes from 3 ampere to 2 ampere in one millisecond?
(a) 5000 henry (b) 5 milli-henry
(c) 50 henry (d) 5 henry *(1993)*

34. 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 *(1991)*

35. A 100 millihenry coil carries a current of 1A. Energy stored in its magnetic field is
(a) 0.5 J (b) 1 J
(c) 0.05 J (d) 0.1 J *(1991)*

36. The current in self inductance L = 40 mH is to be increased uniformly from 1 amp to 11 amp in 4 milliseconds. The e.m.f. induced in inductor during process is
(a) 100 volt (b) 0.4 volt
(c) 4.0 volt (d) 440 volt *(1990)*

37. An inductor may store energy in
(a) its electric field (b) its coils
(c) its magnetic field
(d) both in electric and magnetic fields *(1990)*

6.10 AC Generator

38. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced e.m.f. is
(a) four times per revolution
(b) six times per revolution
(c) once per revolution
(d) twice per revolution *(NEET 2013)*

39. In a region of magnetic induction $B = 10^{-2}$ tesla, a circular coil of radius 30 cm and resistance π^2 ohm is rotated about an axis which is perpendicular to the direction of B and which forms a diameter of the coil. If the coil rotates at 200 rpm the amplitude of the alternating current induced in the coil is
(a) $4\pi^2$ mA (b) 30 mA
(c) 6 mA (d) 200 mA *(1988)*

ANSWER KEY

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

Hints & Explanations

1. **(c) :** $B = \frac{1}{\pi}\left(\frac{\text{Wb}}{\text{m}^2}\right)$

Area of the disc normal to B is $\pi R^2 \cos 60°$.
Flux = B × Area normal

$\therefore$ Flux $= \frac{1}{2} \times 0.04 = 0.02$ Wb

2. **(a) :** Here $N = 800$, $A = 0.05$ m^2, $\Delta t = 0.1$ s
$B = 5 \times 10^{-5}$ T

Induced emf, $\varepsilon = -\frac{\Delta\phi}{\Delta t} = -\frac{(\phi_f - \phi_i)}{\Delta t}$

$$\phi_i = N(\vec{B}\cdot\vec{A}) = 800 \times 5 \times 10^{-5} \times 0.05 \times \cos 0° = 2 \times 10^{-3} \text{ T m}^2$$

$\phi_f = 0$

$$\therefore \quad \varepsilon = \frac{-(0 - 2\times 10^{-3})}{0.1} = 2 \times 10^{-2} \text{ V} = 0.02 \text{ V}$$

3. **(d) :** Emf generated in loop 1,

$$\varepsilon_1 = -\frac{d\phi}{dt} = -\frac{d}{dt}(\vec{B}\cdot\vec{A}) = -\frac{d}{dt}(BA) = -A \times \frac{dB}{dt}$$

$$\varepsilon_1 = -\left(\pi r^2 \frac{dB}{dt}\right)$$

($\because$ $A = \pi r^2$ because $\frac{dB}{dt}$ is restricted upto radius r.)

Emf generated in loop 2,

$$\varepsilon_2 = -\frac{d}{dt}(BA) = -\frac{d}{dt}(0 \times A) = 0$$

4. **(a) :** Here, $\phi = 50t^2 + 4$ Wb, $R = 400\ \Omega$

Induced emf, $\varepsilon = -\frac{d\phi}{dt} = -\frac{d}{dt}(50t^2 + 4) = -100t$ V

At $t = 2$ s, $\varepsilon = -200$ V; $|\varepsilon| = 200$ V

Induced current in the coil at $t = 2$ s is

$$I = \frac{|\varepsilon|}{R} = \frac{200\text{ V}}{400\ \Omega} = \frac{1}{2}\text{ A} = 0.5\text{ A}$$

5. (b) : Here, Magnetic field, $B = 0.025$ T

Radius of the loop, $r = 2$ cm $= 2 \times 10^{-2}$ m

Constant rate at which radius of the loop shrinks,

$$\frac{dr}{dt} = 1 \times 10^{-3}\text{ m s}^{-1}$$

Magnetic flux linked with the loop is

$$\phi = BA\cos\theta = B(\pi r^2)\cos 0° = B\pi r^2$$

The magnitude of the induced emf is

$$|\varepsilon| = \frac{d\phi}{dt} = \frac{d}{dt}(B\pi r^2) = B\pi 2r\frac{dr}{dt}$$

$$= 0.025 \times \pi \times 2 \times 2 \times 10^{-2} \times 1 \times 10^{-3}$$

$$= \pi \times 10^{-6}\text{ V} = \pi\ \mu\text{V}$$

6. (a) : Once a rectangular loop or a square loop is being drawn out of the field, the rate of cutting the lines of field will be a constant for a square and rectangle, but not for circular or elliptical areas.

7. (d) : Rate of decrease in the radius of the loop is 2 mm/s.

Final radius = 2 cm = 0.02 m

Initial radius = 2.2 cm = 0.022 m, $B = 0.04$ T

$$\varepsilon = -\frac{d\phi}{dt} = -B\frac{dA}{dt}$$

$\varepsilon = -\pi\ (0.022^2 - 0.02^2) \times 0.04 = -\pi \times 3.36 \times 10^{-6}$ V

$|\varepsilon| = \pi \times 3.36 \times 10^{-6}$ V $= 3.4\pi\ \mu$V

8. (a) : Work done due to a charge $W = QV$

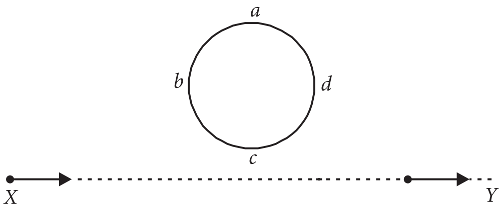
9. (c) : $i = \frac{\varepsilon}{R} = \frac{\frac{NAdB}{dt}}{R}$

$$= \frac{20 \times (25 \times 10^{-4}) \times 1000}{100} = 0.5\text{ A}$$

10. (b) : $\varepsilon = \frac{-(\phi_2 - \phi_1)}{t} = \frac{-(0 - NBA)}{t} = \frac{NBA}{t}$

$$t = \frac{NBA}{\varepsilon} = \frac{50 \times 2 \times 10^{-2} \times 10^{-2}}{0.1} = 0.1\text{ s}$$

11. (a) :



When the electron moves from X to Y, the flux linked with the coil *abcd* (which is into the page) will first increase and then decrease as the electron passes by. So the induced current in the coil will be first anticlockwise and will reverse its direction (*i.e.*, will become clockwise) as the electron goes past the coil.

12. (c) : When the magnet is dropped through the ring, an induced current is developed into the ring in the direction opposing the motion of magnet (Lenz's law). Therefore this induced current decreases the acceleration of bar magnet.

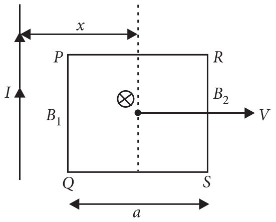
13. (a) : According to Faraday's law, it is the conservation of energy.

14. (b) : Here, $B = 0.1$ T, $r = 0.5$ m, $\omega = 10$ rad/s

So, the emf generated between its centre and rim is,

$$\varepsilon = \frac{1}{2}B\omega r^2 = \frac{1}{2} \times 0.1 \times 10 \times (0.5)^2 = 0.125\text{ V}$$

15. (b) : Here, $PQ = RS = PR = QS = a$



Emf induced in the frame, $\varepsilon = B_1(PQ)V - B_2(RS)V$

$$= \frac{\mu_0 I}{2\pi(x - a/2)}aV - \frac{\mu_0 I}{2\pi(x + a/2)}aV$$

$$= \frac{\mu_0 I}{2\pi}\left[\frac{2}{(2x - a)} - \frac{2}{(2x + a)}\right]aV$$

$$= \frac{\mu_0 I}{2\pi} \times 2\left[\frac{2a}{(2x - a)(2x + a)}\right]aV \quad \therefore \quad \varepsilon \propto \frac{1}{(2x - a)(2x + a)}$$

16. (d) : Motional emf induced in the semicircular ring *PQR* is equivalent to the motional emf induced in the imaginary conductor *PR*.

i.e., $\varepsilon_{PQR} = \varepsilon_{PR} = Bvl = Bv(2r)$ $(l = PR = 2r)$

Therefore, potential difference developed across the ring is $2rBv$ with R at higher potential.

17. (d) : Length of conductor $(l) = 0.4$ m,

Speed $(v) = 7$ m/s and magnetic field $(B) = 0.9$ Wb/m^2

Induced e.m.f. $(\varepsilon) = Blv = 0.9 \times 0.4 \times 7 = 2.52$ V.

18. (b) : Given $n = 2 \times 10^4$, $I = 4$ A

Initially $I = 0$ A

$\therefore$ $B_i = 0$ or $\phi_i = 0$

Finally, the magnetic field at the centre of the solenoid is given as

$$B_f = \mu_0 nI = 4\pi \times 10^{-7} \times 2 \times 10^4 \times 4 = 32\pi \times 10^{-3}\text{ T}$$

Final magnetic flux through the coil is given as

$$\phi_f = NBA = 100 \times 32\pi \times 10^{-3} \times \pi \times (0.01)^2$$

$$\phi_f = 32\pi^2 \times 10^{-5}\text{ T m}^2$$

Induced charge, $q = \frac{|\Delta\phi|}{R} = \frac{|\phi_f - \phi_i|}{R} = \frac{32\pi^2 \times 10^{-5}}{10\pi^2}$

$$= 32 \times 10^{-6}\text{ C} = 32\ \mu\text{C}$$

19. (b) : q = Area under i-t graph

$$= \frac{1}{2} \times 4 \times 0.1 = 0.2\text{ C}$$

As $q = \frac{\Delta\phi}{R}$

$\therefore \quad \Delta\phi = qR = (0.2\text{ C})\,(10\ \Omega) = 2$ weber

20. (b) : Induced emf is given by $V = \dfrac{\Delta\phi}{\Delta t}$

$$\text{current}(i) = \frac{Q}{\Delta t} \Rightarrow \frac{\Delta\phi}{\Delta t}\times\frac{1}{R} = \frac{Q}{\Delta t}$$

[where Q is total charge in time Δt]

$$\Rightarrow \quad Q = \frac{\Delta\phi}{R}$$

21. (c) : $q = \int i dt = \dfrac{1}{R}\int \varepsilon dt = \left(\dfrac{-d\phi}{dt}\right)\dfrac{1}{R}\int dt = \dfrac{1}{R}\int d\phi$

Hence total charge induced in the conducting loop depend upon the total change in magnetic flux.
As the emf or iR depends on rate of change of ϕ, charge induced depends on change of flux.

22. (a) : Electric heater works on the principle of Joule's heating effect.

23. (a) : Eddy currents are produced when a metal is kept in a varying magnetic field.

24. (d) : Magnetic potential energy stored in an inductor is given by

$$U = \frac{1}{2}LI^2 \Rightarrow 25\times10^{-3} = \frac{1}{2}\times L\times(60\times10^{-3})^2$$

$$L = \frac{25\times2\times10^6\times10^{-3}}{3600} = \frac{500}{36} = 13.89\text{ H}$$

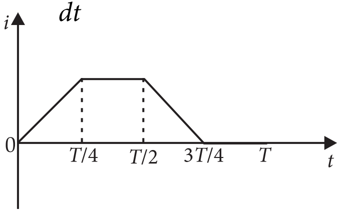
25. (b) : Here, $I = 2.5$ A, $L = 5$ H
Magnetic flux linked with the coil is
$\phi_B = LI = (5\text{ H})(2.5\text{ A}) = 12.5$ Wb

26. (d) : $|V| = \left|-L\dfrac{dI}{dt}\right|$

$|V| \propto$ slope of I-t graph

27. (a) : Induced emf, $e = -L\dfrac{di}{dt}$

For $0 \le t \le \dfrac{T}{4}$,
i-t graph is a straight line with positive constant slope.



$\therefore \quad \dfrac{di}{dt} = \text{constant}$

$\Rightarrow \quad e = -$ve and constant

For $\dfrac{T}{4} \le t \le \dfrac{T}{2}$

i is constant $\therefore \ \dfrac{di}{dt} = 0 \Rightarrow e = 0$

For $\dfrac{T}{2} \le t \le \dfrac{3T}{4}$

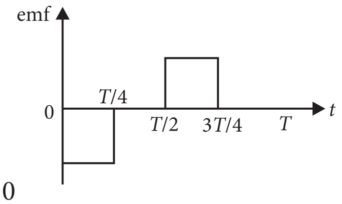
i-t graph is a straight line with negative constant slope.

$\therefore \ \dfrac{di}{dt} = \text{constant}$

$\Rightarrow \quad e = +$ve and constant

For $\dfrac{3T}{4} \le t \le T$

i is zero $\therefore \ \dfrac{di}{dt} = 0 \Rightarrow e = 0$



From this analysis, the variation of induced emf with time is as shown in the figure.

28. (a) : Net flux $N\phi = Li$
Flux per turn $= 4\times10^{-3}$ Wb, $i = 2$ A

$$L = \frac{N\phi}{i} = \frac{4\times10^{-3}\times500}{2} = 1\text{ henry}$$

29. (d) : Mutual inductance between coils is

$$M = K\sqrt{L_1L_2} = 1\sqrt{2\times10^{-3}\times8\times10^{-3}} \quad (\because K = 1)$$

$= 4\times10^{-3} = 4$ mH

30. (a) : $I = t^2e^{-t}$

$|\varepsilon| = L\dfrac{dI}{dt}$ here emf is zero when $\dfrac{dI}{dt} = 0$

$$\frac{dI}{dt} = 2te^{-t} - t^2e^{-t} = 0;\ 2te^{-t} = t^2e^{-t}$$

i.e., $te^{-t}(t-2) = 0 \Rightarrow t \ne \infty$ and $t \ne 0 \quad \therefore\ t = 2$ sec

31. (b) : As, $|\varepsilon| = M\dfrac{dI}{dt}$

$$= M\frac{d}{dt}(I_0\sin\omega t) = MI_0\omega\cos\omega t$$

$\therefore \quad \varepsilon_{\max} = 0.005\times10\times100\pi\times1 = 5\pi$

32. (c) : $L = \dfrac{N\phi}{i};\ \phi = BA;\ B = \mu_0ni = \dfrac{\mu_0Ni}{l}$

$$L = \frac{\mu_0N^2}{l}A = \mu_0n^2\,A\,l$$

where n is the number of turns per unit length $L \propto N^2$

33. (b) : $\varepsilon = -L\dfrac{di}{dt}$

$$L = \frac{-\varepsilon}{\dfrac{di}{dt}} = \frac{-5\times10^{-3}}{(2-3)}\text{ H} = 5\text{ mH}$$

34. (d) : Self inductance of a solenoid $= \mu_0n^2Al$
where n is the number of turns per length.
So self induction $\propto n^2$
So inductance becomes 4 times when n is doubled.

35. (c) : $E = \dfrac{1}{2}Li^2 = \dfrac{1}{2}(100\times10^{-3})\times1^2 = 0.05\text{ J}$

36. (a) : $|\varepsilon| = L\dfrac{di}{dt}$

Given that, $L = 40\times10^{-3}$ H, $di = 11\text{ A} - 1\text{ A} = 10$ A and $dt = 4\times10^{-3}$ s

$$\therefore \quad |\varepsilon| = 40\times10^{-3}\times\left(\frac{10}{4\times10^{-3}}\right) = 100\text{ V}$$

37. (c)

38. (d)

39. (c) : $I_0 = \dfrac{E_0}{R} = N\dfrac{BA\omega}{R}$

Given, $N = 1$, $B = 10^{-2}$ T, $A = \pi(0.3)^2$ m², $R = \pi^2\ \Omega$
$f = (200/60)$ and $\omega = 2\pi(200/60)$
Substituting these values and solving, we get
$I_0 = 6\times10^{-3}$ A $= 6$ mA

⁂