DPP – 6 (EMI)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/79

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Q 1. The coefficient of self inductance of a solenoid is 0.18 mH. If a crode of soft iron of relative permeability 900 is inserted, then the coefficient of self inductance will become nearly

(a) 5.4 mH (b) 162 mH
(c) 0.006 mH (d) 0.0002 mH

Q 2. If a rate of change of current of 4 A/s induces an emf of 20 mV in a solenoid, the self inductance of the solenoid is

(a) 5 mH (b) 80 mH
(c) 0.25 mH (d) zero

Q 3. A solenoid having 500 turns and length 2 m has radius of 2 cm, then self inductance of solenoid?

(a) 4×10^{-4} H (b) 2×10^{-4} H
(c) 8×10^{-4} H (d) 16×10^{-4} H

Q 4. A solenoid have the self inductance 2H. If length of the solenoid is doubled having turn density (turns per unit length) and area constant then new self inductance is going to be the:-

(a) 4H (b) 1H
(c) 8H (d) 0.5H

Q 5. A thin copper wire of length 100m is wound as a solenoid of length (l) and radius (r) its self inductance is found to be L. Now if same length of wire is would as a solenoid of length (l) of radius $\left(\frac{r}{2}\right)$. Then its self inductance will be

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

Q 6. What is the self - inductance of an air code solenoid 50 cm long and 2 cm radius if it has 500 turns ?

(a) 8 mH (b) 0.8 mH
(c) 4 mH (d) 12 mH

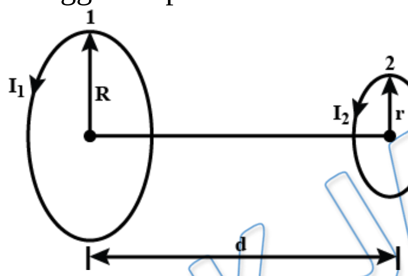
Q 7. A solenoid is of length 50 cm and has a radius of 2 cm. It has 500 turns. Around its central section a coil of 50 turns is wound. Calculate the mutual inductance of the system (nearly)

(a) 0.08 μH (b) 0.8 μH
(c) 8 μH (d) 80 μH

Q 8. A solenoid of length 50 cm with 20 turns per cm and area of cross section 40 cm^2 comletely surrounds another co-axial solenoid of the same length, area of cross section 25 cm^2 with 25 turns per cm. Calculate the mutual inductance of the system

(a) 2.21 mH (b) 3.81 mH
(c) 7.85 mH (d) 12.88 mH

Q 9. A circular loop of radius 0.3cm lies parallel to a much bigger circular loop of radius 20cm. The center of the small loop is on the axis of the bigger loop. The distance between their centers is 15cm. If a current of 2.0A flows through the smaller loop, then the flux linked with bigger loop is



(a) $6 \times 10^{-11}\ Wb$
(b) $3.3 \times 10^{-11}\ Wb$
(c) $6.6 \times 10^{-9}\ Wb$
(d) $9.1 \times 10^{-11}\ Wb$

Q 10. An L-R circuit has a cell of e.m.f. E, which is switched on at time t = 0. The current in the circuit after a long time will be

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

Q 11. The self-inductances of two identical coils are 0.1H. They are wound over each other. Mutual inductance will be-

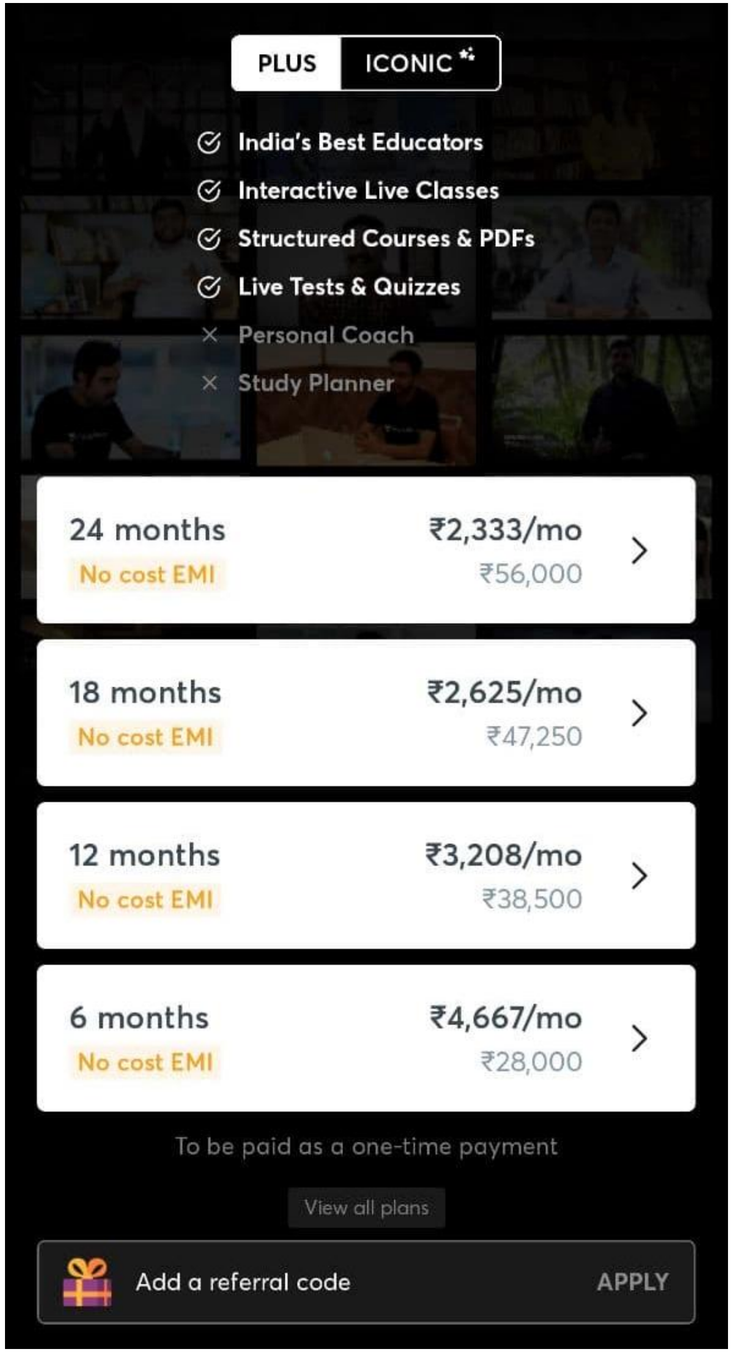
(a) 0.1 H (b) 0.2 H
(c) 0.01 H (d) 0.05 H

Q 12. 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 coil is:

(a) 1 mH (b) 6 mH
(c) 4 mH (d) 16 mH

Answer Key

Q.1 b	Q.2 a	Q.3 b	Q.4 a	Q.5 c
Q.6 b	Q.7 d	Q.8 c	Q.9 d	Q.10 b
Q.11 a	Q.12 c			



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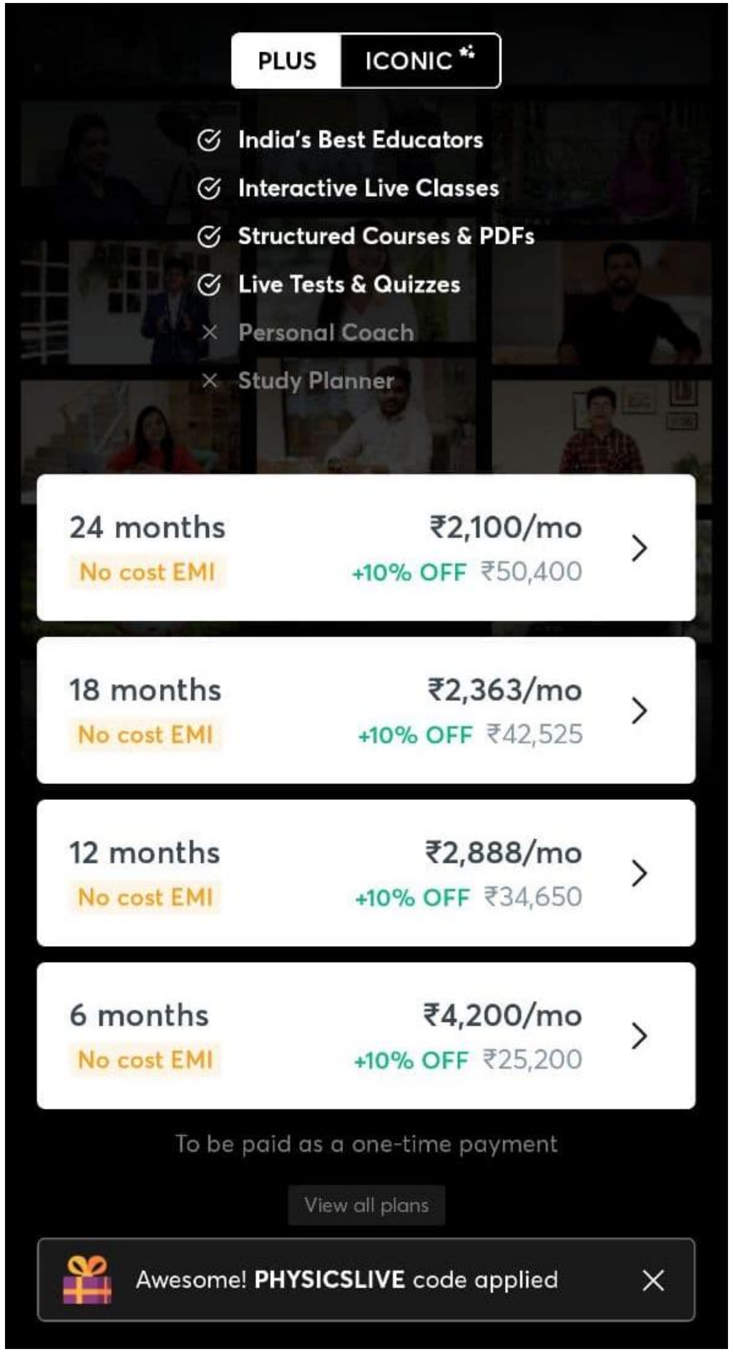

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Written Solution

DPP- 6 : EMI-Self Inductance of Solenoid, Mutual Inductance of Coaxial Coils Solenoids, relation between mutual induction and self induction

By Physicsaholics Team

Solution: 1

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

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

$$\frac{L}{L'} = \frac{\mu_0}{\mu_r \mu_0} = \frac{1}{\mu_r}$$

$$\frac{L}{L'} = \frac{1}{900}$$

$$L' = 900 L$$

$$L' = 900 \times 0.18 \text{ mH}$$

$$\boxed{L' = 162 \text{ mH}} \text{ Ans.}$$

Ans. b

Solution: 2

$$\phi = LI$$

$$\varepsilon = -\frac{d\phi}{dt} = -L\frac{dI}{dt}$$

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

$$20\,mV = L \cdot 4\ A/s$$

$$L = \frac{20}{4}\ mH$$

$$\boxed{L = 5\ mH}$$ Ans.

Ans. a

Solution: 3

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

$$L = \frac{{}^{2}\cancel{4}\pi \times 10^{-7} \times (500)^2 \times \pi (2\times 10^{-2})^2}{\cancel{2}}$$

$$L = 2\times\pi^2 \times 25 \times 4 \times 10^{-7}$$

$$L = 2\times 10 \times 100 \times 10^{-7}$$

$$\boxed{L = 2\times 10^{-4}\ H}$$ Ans.

Ans. b

Solution: 4

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

$N = nl$; N = total number of turns

$N^2 = n^2 l^2$; n = number of turns per unit length

so; $L = \frac{\mu_0 n^2 l^2 A}{l} = \mu_0 n^2 A l$

$\Rightarrow L \propto l$ $\quad \because$ [n & A are constant] given

if $l' = 2l$

then; $\frac{L}{L'} = \frac{l}{2l} \Rightarrow \boxed{L' = 2L}$

$L' = 2 \times 2 = 4 \Rightarrow \boxed{L' = 4H}$ Ans.

Ans. a

Solution: 5

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

$$N = \frac{l}{2\pi r} \quad \text{so;} \quad L' = \frac{\mu_0 (N')^2 A'}{l'}$$

$$N' = \frac{l}{2\pi\left(\frac{r}{2}\right)} \qquad = \frac{\mu_0 (2N)^2 \left(\pi\left(\frac{r}{2}\right)^2\right)}{l}$$

$$\boxed{N' = 2N} \qquad = \frac{\mu_0 (4N^2)\left(\pi \frac{r^2}{4}\right)}{l} = \frac{\mu_0 N^2 \pi r^2}{l}$$

$$\Rightarrow \boxed{L' = L} \quad \text{Ans.}$$

Ans. c

Solution: 6

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

$$= \frac{4\pi \times 10^{-7} \times (500)^2 \times \pi (2\times 10^{-2})^2}{50\times 10^{-2}}$$

$$= \frac{4\pi \times 10^{-7} \times 25\times 10^4 \times \pi \times 4\times 10^{-4}}{50\times 10^{-2}}$$

$$= \frac{4\pi^2 \times 100 \times 10^{-7}}{50\times 10^{-2}} = \frac{4\times 10\times 100\times 10^{-7}}{50\times 10^{-2}}$$

$$= 4\times 2\times 10^{-4} = 0.8\,mH$$

$$\boxed{L = 0.8\,mH}$$ Ans.

Ans. b

Solution: 7

$$M = \mu_0 n_1 n_2 l A_2$$

$$M = 4\pi \times 10^{-7} \times \left(\frac{500}{0.5}\right) \times \left(\frac{50}{0.5}\right) \times (0.5) \times \pi \left(2\times 10^{-2}\right)^2$$

$$M = 4\pi^2 \times 10^{-7} \times 1000 \times 100 \times \frac{1}{2} \times 4 \times 10^{-4}$$

$$M = 4 \times 10 \times 10^{-7} \times 10^{5} \times 2 \times 10^{-4}$$

$$M = 8 \times 10^{-5}\ H$$

$$\boxed{M = 80\ \mu H}$$ Ans.

Ans. d

Solution: 8

$A_2 = 25\ cm^2$;

$M = \mu_0 n_1 n_2 l A_2$

$M = 4\pi \times 10^{-7} \times \frac{20}{10^{-2}} \times \frac{25}{10^{-2}} \times 50 \times 10^{-2} \times 25 \times 10^{-4}$

$M = 4\pi \times 10^{-7} \times 20 \times 25 \times 50 \times 25 \times 10^{-2}$

$M = 7.85 \times 10^{6} \times 10^{-9} = 7.85 \times 10^{-3}\ H$

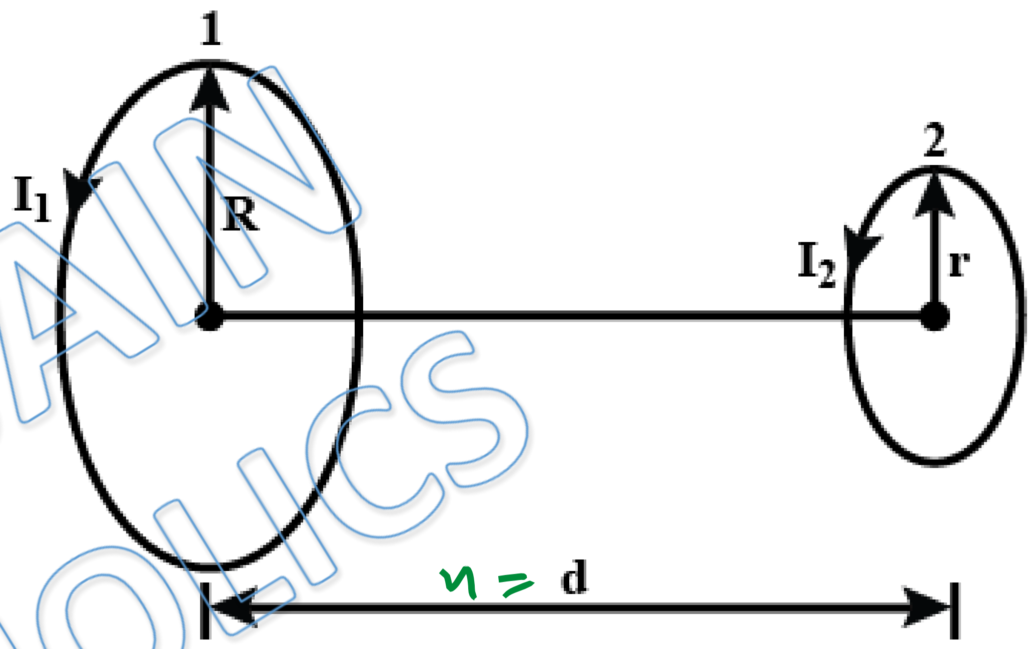
$M = 7.85\ mH$ Ans.

Ans. c

Solution: 9

if $d >> r$

∴ magnetic field inside small ring can be assumed as uniform due to Big Ring.



$$B_1 = \frac{\mu_0 I_1 R^2}{2(R^2+x^2)^{3/2}}$$

$$\phi_2 = B_1 A_2 = \frac{\mu_0 I_1 R^2}{2(R^2+x^2)^{3/2}} \pi r^2$$

$$M = \frac{\phi_2}{I_1} = \frac{\mu_0 R^2}{2(R^2+x^2)^{3/2}} \pi r^2 \quad ; x = d$$

$$\phi_1 = M I_2 = \frac{\mu_0 R^2}{2(R^2+x^2)^{3/2}} \pi r^2 . I_2 = \frac{4\pi \times 10^{-7} \times (20\times10^{-2})^2 \times \pi \times (0.3\times10^{-2})^2 \times 2}{2\left[(20\times10^{-2})^2 + (15\times10^{-2})^2\right]^{3/2}}$$

$$\boxed{\phi_1 = 9.1\times10^{-11} \text{ wb}}$$ Ans.

Ans. d

Solution: 10

$I = I_0 (1 - e^{-t/\tau})$

after long time

$I \simeq I_0$

$I = \frac{E}{R}$ Ans.

Ans. b

Solution: 11

$$M = \sqrt{L_1 L_2}$$

$$M = \sqrt{0.1 \times 0.1}$$

$$M = \sqrt{10^{-2}}$$

$$M = 10^{-1}$$

$$\boxed{M = 0.1 H}$$ Ans.

Ans. a

Solution: 12

$$M = \sqrt{L_1 L_2}$$

$$M = \sqrt{2mH \times 8mH}$$

$$M = \sqrt{16\ m^2H^2}$$

$$\boxed{M = 4\ mH}\ \text{Ans.}$$

Ans. c

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