DPP – 7 (EMI)

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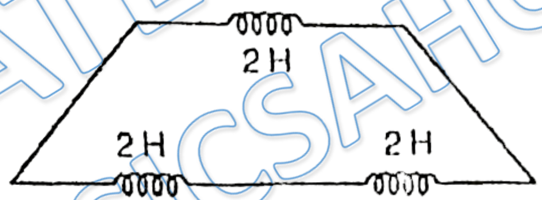
Q 1. Two inductors of 10mH respectively are connected together in a series combination so that their magnetic fields aid each other giving cumulative coupling. Their mutual inductance is given as 5mH. Calculate the total inductance of the series combination

(a) 15 mH (b) 20 mH
(c) 25 mH (d) 30 mH

Q 2. Three inductors of 10mH, 40mH and 50mH are connected together in a series combination with no mutual inductance between them. Calculate the total inductance of the series combination.

(a) 100 mH (b) 6.89 mH
(c) 50 mH (d) 10 mH

Q 3. Three pure inductors each of 2H are connected as shown in the figure. The equivalent inductance of the circuit between A & B is

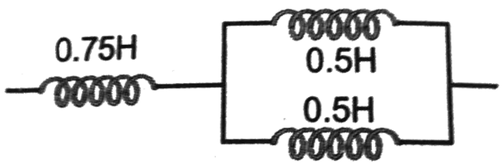


(a) $\frac{8}{6}$ H (b) $6H$
(c) $2H$ (d) none of these

Q 4. The equivalent inductance of two inductors is `2.4 H` when connected in parallel and `10 H` when connected inductors in series. Then find inductance of inductors ?

(a) 6H, 4H (b) 3H, 6H
(c) 6H, 3H (d) 12.4H, 7.6H

Q 5. Three inductances are connected as shown below. Assuming no coupling, the resultant inductance will be-



(a) 0.25 H (b) 0.5 H

(c) 0.75 H (d) 1 H

Q 6. A capacitor of capacity 2 μF is charged to a potential difference of 12V. It is then connected across an inductor of inductance 6 μH. What is the current (in A) in the circuit at a time when the potential difference across the capacitor is 6V

(a) 2 (b) 4

(c) 6 (d) 8

Q 7. In an LC circuit the capacitor has maximum charge q_0. The value of $\left(\frac{dI}{dt}\right)_{max}$ is:

(a) $\frac{q_0}{LC}$ (b) $\frac{q_0}{\sqrt{LC}}$

(c) $\frac{q_0}{LC} - 1$ (d) $\frac{q_0}{LC} + 1$

Q 8. A 16 μF capacitor is charged to a 20 Volt potential. Battery is then disconnected and inductor of inductance 40 mH is connected across the capacitor, So that LC oscillations are step-up. Maximum current in the coil is

(a) 0.4 A (b) 2 A

(c) 0.8 A (d) 0.2 A

Q 9. A charged 30 μF capacitor is connected to a 27 mH inductor. What is the angular frequency of free oscillations of the circuit ?

(a) 1.1×10^3 rad/s (b) 10^4 rad/s

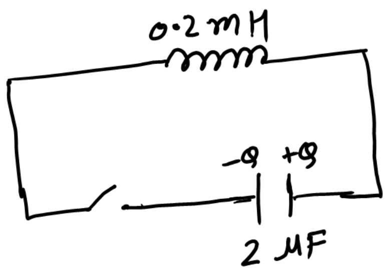
(c) 2.1×10^2 rad/s (d) 11×10^3 rad/s

Q 10. A 1.5 mH inductor in an LC circuit stores a maximum energy of 30 μJ. What is the maximum current in the circuit ?

(a) 2 A (b) 4.4 A

(c) 1.2 A (d) 0.2 A

Q 11. Fig. shows LC circuit with initial charge on capacitor 200 μC. If at t = 0, switch is closed, find the first instant when energy stored in inductor becomes one third that of capacitor:

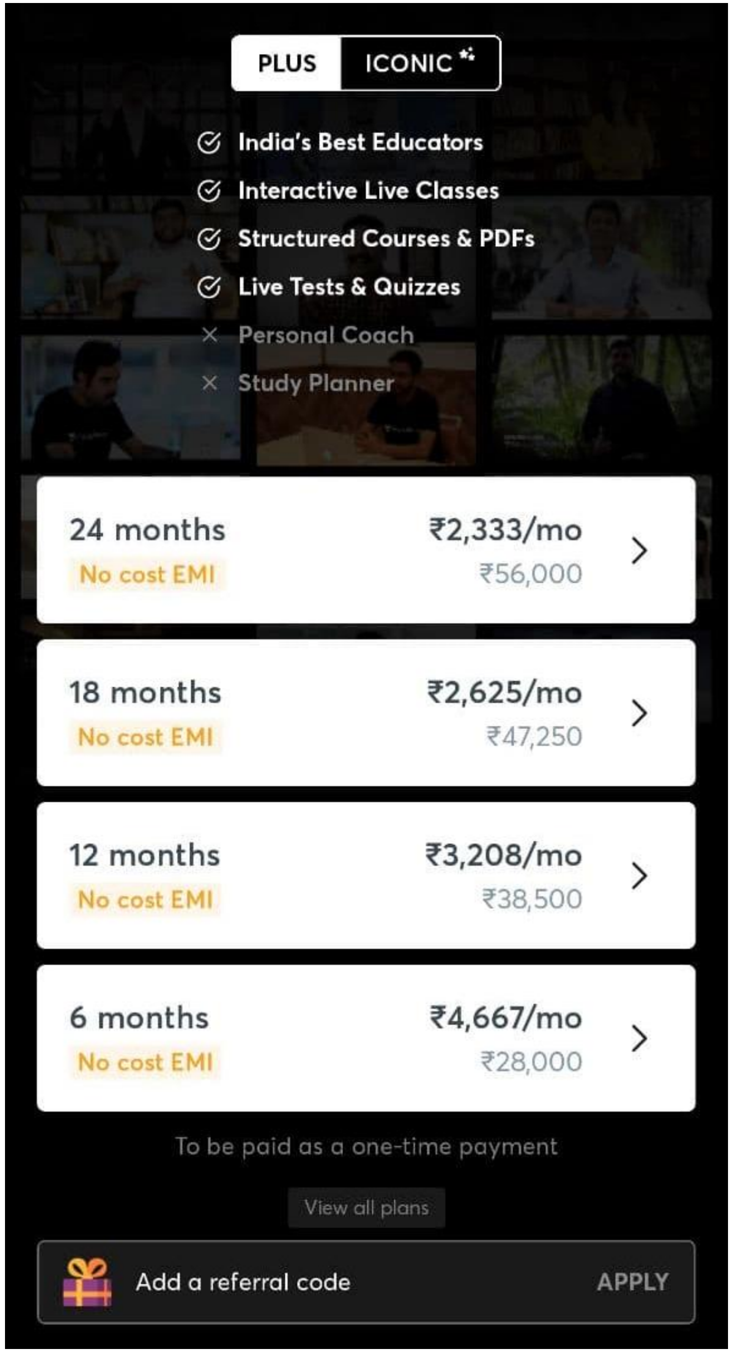


(a) 8 μ sec (b) 10.5 μ sec

(c) 2.5 μ sec (d) 1 μ sec

Answer Key

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



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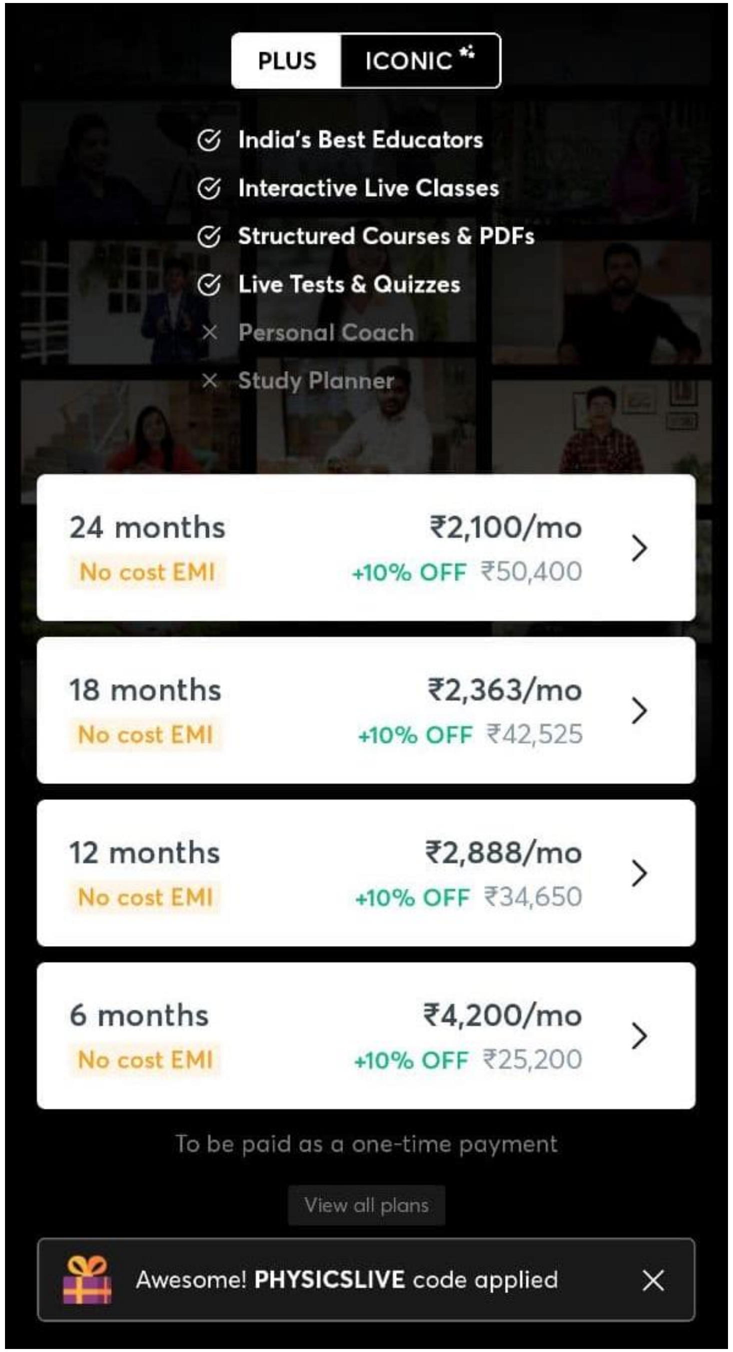

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Written Solution

DPP- 7 EMI: Combination of inductor (series and parallel), LC oscillations

By Physicsaholics Team

Solution: 1

current in both the solenoids is in same direction

$\therefore \quad L_{eq} = L_1 + L_2 + 2M$

$L_{eq} = 10 + 10 + 2(5)$

$= 30$

$\boxed{L_{eq} = 30 \text{ mH}}$ Ans.

Ans. d

Solution: 2

In Series Combination

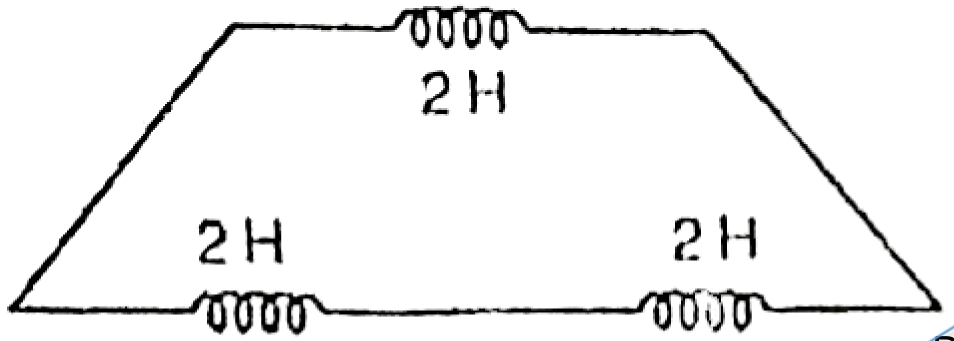
$$L_{eq} = L_1 + L_2 + L_3$$

$$= 10 + 40 + 50$$

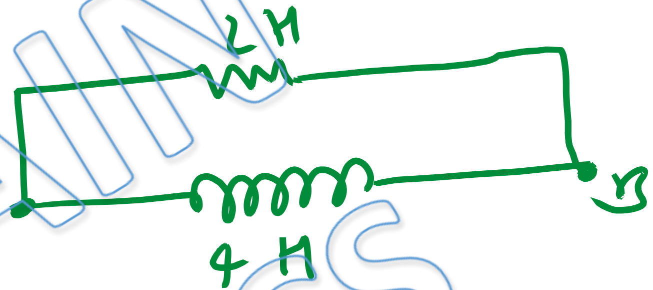
$$\boxed{L_{eq} = 100\ mH}\ \text{Ans.}$$

Ans. a

Solution: 3



$\Rightarrow$



$$\frac{1}{L_{eq}} = \frac{1}{2} + \frac{1}{4} \Rightarrow \frac{3}{4}$$

$$\boxed{L_{eq} = \frac{4}{3}\,H}$$ Ans

Ans. a

Solution: 4

In series

$L_{eq} = L_1 + L_2 = 10\,H$ — (1)

In parallel

$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} = \frac{1}{2.4}$

$L_{eq} = \frac{L_1 L_2}{L_1 + L_2} = 2.4\,H$ — (2)

from eqn (1) & (2)

$\frac{L_1 L_2}{10} = 2.4$

$\boxed{L_1 L_2 = 24}$ — (3)

from eqn (1)

$L_2 = 10 - L_1$

Put in eqn (3)

$L_1(10 - L_1) = 24$

$10L_1 - L_1^2 = 24$

$L_1^2 - 10L_1 + 24 = 0$

$L_1^2 - 6L_1 - 4L_1 + 24 = 0$

$L_1 = 4\,H$, or $6\,H$

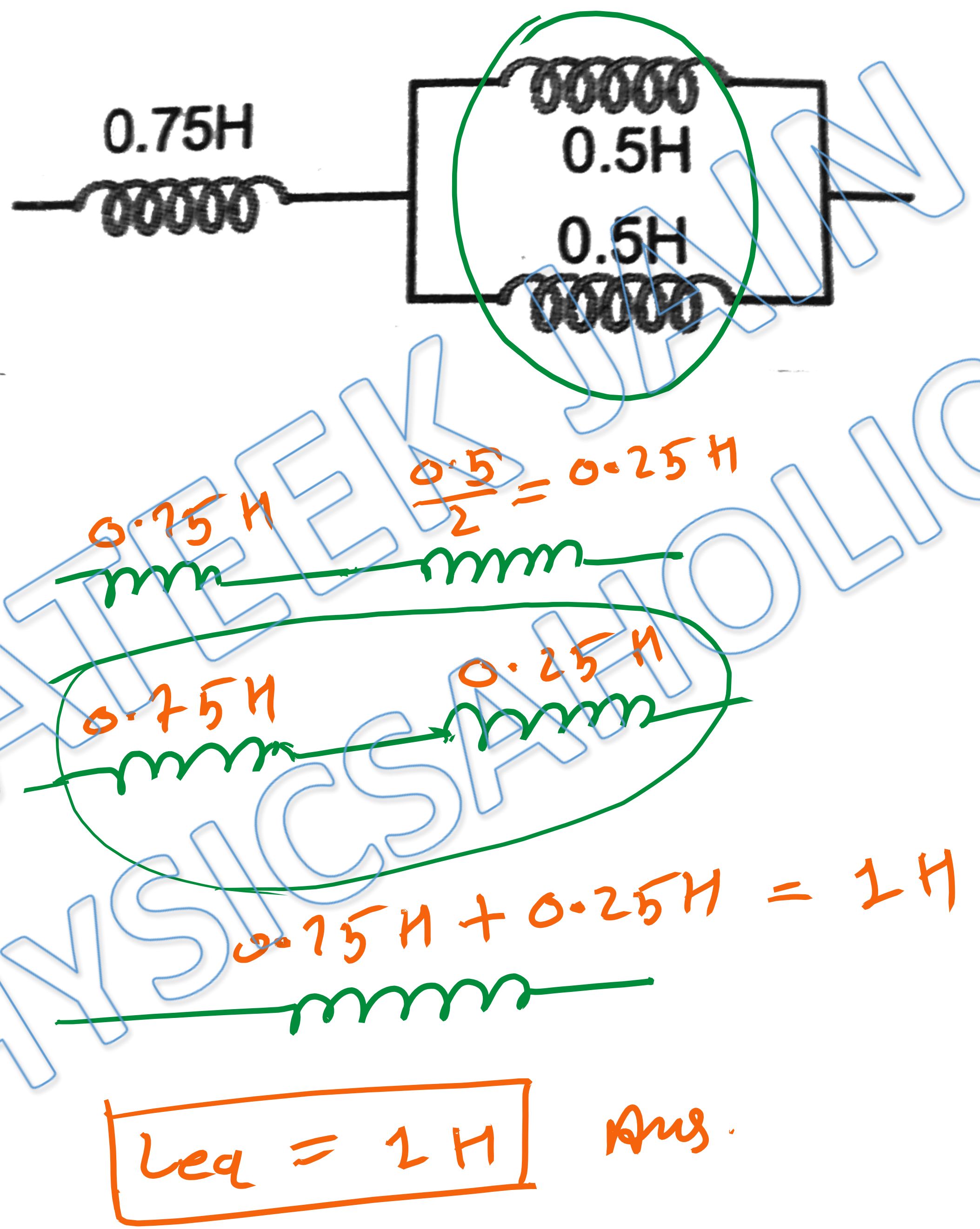
if $L_1 = 4\,H$; $L_2 = 6\,H$

and if $L_1 = 6\,H$; $L_2 = 4\,H$

$\therefore$ $\boxed{6\,H \text{ and } 4\,H}$ Ans.

Ans. a

Solution: 5



Ans. d

Solution: 6

$U_i = \frac{1}{2}CV^2 = \frac{1}{2}\times 2\,\mu F \times (12)^2 = 144\ \mu J$

$Q = CV = 2\,\mu F \times 12 = 24\ \mu C$

$V = 12$ Volt

when, $V_c = 6V$

$q = 2\times 6 = 12\ \mu J$

$U_c = \frac{1}{2}CV^2 = \frac{q^2}{2C} = \frac{(12\times 10^{-6})^2}{2(2\times 10^{-6})} = \frac{12^2}{2\times 2}\ \mu J = 36\ \mu J$

$\therefore U_L = U_i - U_c = 144 - 36 = 108$

$108\ \mu J = \frac{1}{2}LI^2$

$\overset{18}{\cancel{108}}\ \mu J = \frac{1}{2}\times (6\ \mu H)\times I^2$

$I^2 = 36$

$I = 6$ amp Ans.

Ans. c

Solution: 7

$$i = q_0 \omega \sin \omega t$$

$$\frac{di}{dt} = q_0 \omega^2 \cos \omega t$$

$$\left(\frac{di}{dt}\right)_{max} = q_0 \omega^2$$

$$= \frac{q_0}{LC}$$

Ans(a)

Solution: 8

$$q_0 = CV$$
$$= 16\,\mu F \times 20V$$
$$q_0 = 320\,\mu C$$

$$I_{max} = q_0 \omega$$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{16\times10^{-6}\times 40\times10^{-3}}} = \frac{1}{4\times2\times10^{-4}}$$

$$\omega = \frac{10^4}{8} = \frac{10}{8}\times10^3 \text{ rad/s}$$

$$\therefore I_{max} = 320 \times \frac{10}{8}\times10^3 \times 10^{-6}$$

$$\boxed{I_{max} = 0.4 \text{ amp}} \quad \text{Ans.}$$

Ans. a

Solution: 9

$$\omega = \frac{1}{\sqrt{LC}}$$

$$\omega = \frac{1}{\sqrt{27\times10^{-3}\times30\times10^{-6}}} = \frac{1}{9\times10^{-4}}$$

$$\omega = \frac{10}{9}\times10^{3}$$

$$\boxed{\omega = 1.1\times10^{3}\ rad/s}$$ Ans.

Ans. a

Solution: 10

$$U_L = \frac{1}{2} L I^2$$

$$(U_L)_{max} = \frac{1}{2} L (I_{max})^2$$

$$(30\times10^{-6}) = \frac{1}{2} 1.5\times10^{-3} I_m^2$$

$$4\ 60\times10^{-6} = 15\times10^{-4} I_m^2$$

$$I_m^2 = 4\times10^{-2}$$

$$I_m = 2\times10^{-1}$$

$$\boxed{I_{max} = 0.2 \text{ amp}}$$ Ans.

Ans. d

Solution: 11

given; $U_L = \frac{1}{3} U_C$

at initial condition

$U = \frac{q^2}{2C} = \frac{(200 \times 10^{-6})^2}{2 \times 2 \times 10^{-6}} = \frac{4 \times 10^4 \times 10^{-6}}{4}$

$U = 10^{-2}\,J$ — (1)

$q = 2 \times 10^{-4}\,C$

so; when $U_L = \frac{1}{3} U_C$

$U_C = U - U_L = U - \frac{1}{3} U_C$

$U_C + \frac{1}{3} U_C = U$

$\frac{4}{3} U_C = U$

$U_C = \frac{3}{4} U$

$U_C = \frac{3}{4} \times 10^{-2}\,J$

$\Rightarrow U_C = \frac{3}{4} \times 10^{-2}\,J$

$\frac{q^2}{2C} = \frac{3}{4} \times 10^{-2}$

$q^2 = (2 \times 2 \times 10^{-6}) \times \frac{3}{4} \times 10^{-2}$

$q^2 = 3 \times 10^{-8}$

$q = \sqrt{3} \times 10^{-4}\,C$

$q = q_0 \sin(\omega t + \frac{\pi}{2})$

$\sqrt{3} \times 10^{-4} = 2 \times 10^{-4} \sin(\omega t + \frac{\pi}{2})$

$\frac{\sqrt{3}}{2} = \sin(\omega t + \frac{\pi}{2}) = \cos \omega t$

$\cos \omega t = \frac{\sqrt{3}}{2} \Rightarrow \omega t = \frac{\pi}{6}$

$t = \frac{\pi}{6\omega} = \frac{\pi \sqrt{LC}}{6} = \frac{\pi}{6} \sqrt{0.2 \times 10^{-3} \times 2 \times 10^{-6}}$

$t = 10.5\,\mu s$ Ans.

Ans. b

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Chalo Niklo