



# POSTAL BOOK PACKAGE 2024

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### ELECTRICAL ENGINEERING

#### Objective Practice Sets

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## Magnetic Circuit

**Q.1** The laws of electromagnetic induction are summarized in the following equation:

- (a)  $e = L \frac{di}{dt}$  (b)  $e = iR$   
 (c)  $e = -\frac{d\psi}{dt}$  (d) None of these

**Q.2** A coil of 1000 turns is wound on a core. A current of 1 A flowing through the coil creates a core flux of 1 mWb. What is the energy stored in the magnetic field?

- (a) 1 J (b)  $\frac{1}{4}$  J  
 (c) 2 J (d)  $\frac{1}{2}$  J

**Q.3 Assertion (A) :** In an electric circuit, the current is due to the presence of electromotive force.

**Reason (R) :** In a magnetic circuit, the magnetic flux is due to the presence of a magnetomotive force.

- (a) Both A and R are true and R is a correct explanation of A.  
 (b) Both A and R are true but R is not a correct explanation of A.  
 (c) A is true but R is false.  
 (d) A is false but R is true.

**Q.4** Consider the following statements regarding methods to increase the mutual inductance between two mutually coupled circuits.

1. Increase in the number of primary turns.
2. Increase in the number of secondary turns.
3. Decrease in the permeance offered to the mutual flux.
4. Decrease in the leakage flux.

Which of the above statements are correct?

- (a) 1, 2 and 3 (b) 1, 2 and 4  
 (c) 2, 3 and 4 (d) 1, 2, 3 and 4

**Q.5** Match **List-I** with **List-II** and select the correct answer using the code given below the lists:

**List-I**

- A. Magnetic flux  
 B. Magnetomotive force  
 C. Reluctance  
 D. Permeability

**List-II**

1. Resistance
2. Electric current
3. Conductivity
4. Electromotive force

**Codes:**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 4 | 3 |
| (b) | 3 | 1 | 4 | 2 |
| (c) | 2 | 4 | 1 | 3 |
| (d) | 3 | 4 | 1 | 2 |

**Q.6** Match **List-I** (Magnetic quantities) with **List-II** (Units) and select the correct answer using the codes given below the lists:

**List-I**

- A. Permeability  
 B. Magnetic field intensity  
 C. Magnetic flux  
 D. Magnetic flux density

**List-II**

1. Wb
2. Wb/m<sup>2</sup>
3. H/m
4. Amp.-turns/m

**Codes:**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 3 | 1 | 2 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 4 | 2 | 3 | 1 |
| (d) | 3 | 1 | 2 | 4 |

**Q.7** For a linear electromagnetic circuit, the following statement is true.

- (a) Field energy is equal to the co-energy.
- (b) Field energy is greater than the co-energy.
- (c) Field energy is lesser than the co-energy.
- (d) Co-energy is zero.

**Q.8** In which region of B-H curve a permanent magnet operating point lie:

- (a) Second quadrant of B-H curve
- (b) Second and third quadrant of B-H curve
- (c) Fourth quadrant of B-H curve
- (d) First quadrant of B-H curve

- Q.9** A magnetic circuit with relative permeability of 50 having mean core length of 30 cm and cross sectional area of  $10 \text{ cm}^2$ , the value of permeance is  $\text{_____} \times 10^{-7} \text{ Wb/AT}$ .
- Q.10** The emf induced in a conductor of machine driven at 600 rpm, the peak value of flux density is  $1.0 \text{ Wb/m}^2$ , diameter of machine 2.0 meter and length of machine 0.30 m is  
(a) 41.83 V (b) 29.58 V  
(c) 9.42 V (d) 18.84 V
- Q.11** An iron-cored choke, with 2 mm air-gap length, takes 2 A when fed from a constant-voltage source of 230 V. If its air-gap length is increased to 10 mm, then the magnetic flux produced by the choke would  
(a) remains constant and the current would increase.  
(b) decrease and the current would increase.  
(c) decrease and the current would also decrease.  
(d) remain constant and the current would decrease.
- Q.12 Assertion (A) :** Leakage flux does not follow the intended path in a magnetic circuit.  
**Reason (R) :** In a magnetic circuit, all the flux produced by a coil is confined to desired magnetic path.  
(a) Both A and R are true and R is a correct explanation of A.  
(b) Both A and R are true but R is not a correct explanation of A.  
(c) A is true but R is false.  
(d) A is false but R is true.
- Q.13** The field winding of a dc electro-magnet is wound with 960 turns and has a resistance of  $50 \Omega$ . The excitation voltage is 230 V and the magnetic flux linking the coil is 5 mWb. The energy stored in the magnetic field is  
(a) 22 Joules (b) 11 Joules  
(c) 19 Joules (d) 29 Joules
- Q.14** A coil with 60 turns wound over a ferromagnetic core having relative permeability of 400 has an inductance of 50 mH. If coil turns are doubled and the core is replaced by a new ferromagnetic core having relative permeability 600, the new inductance would be  
(a) 0.15 H (b) 0.3 H  
(c) 1.5 H (d) 3 H
- Q.15** A magnetic circuit has 150 turns-coil, the cross-sectional area  $5 \times 10^{-4} \text{ m}^2$  and the length of the magnetic circuit  $25 \times 10^{-2} \text{ m}$ . What are the values of magnetic field intensity and relative permeability when the current is 2 A and total flux is  $0.3 \times 10^{-3} \text{ Wb}$ ?  
(a) 1200 AT/m and 397.9  
(b) 300 AT/m and  $500 \times 10^{-6}$   
(c) 300 AT/m and 397.9  
(d) 1200 AT/m and  $500 \times 10^{-6}$
- Q.16** The flux in a magnetic core is alternating sinusoidally at a frequency of 600 Hz. The maximum flux density is 2 Tesla and the eddy current loss is 15 Watts. What would be the eddy current loss in the core if the frequency is raised to 800 Hz and the maximum flux density is reduced to 1.5 Tesla?  
(a) 12 Watts (b) 25.25 Watts  
(c) 15 Watts (d) 18 Watts
- Q.17** In contrast to an electric circuit magnetic circuit is  
(a) non-dissipative in dc excitation but dissipative and non-inductive in ac excitation.  
(b) non-dissipative in both ac and dc excitation but non-inductive in ac excitation.  
(c) dissipative in both ac and dc excitation and inductive in ac excitation.  
(d) dissipative in both ac and dc excitation and non-inductive in ac excitation.
- Q.18** Iron is removed from the iron cored coil so that the coil becomes air-cored coil. Inductance of this air-cored coil will  
(a) increase  
(b) decrease  
(c) remain the same  
(d) increase or decrease depending upon the coil configuration
- Q.19** In a magnetic circuit, following values of fluxes are given:  
Flux through magnetic core = 0.5 mWb  
Leakage flux = 0.1 mWb  
The value of leakage factor will be  $\text{_____}$ .
- Q.20** A magnetic circuit with a relative permeability of 50 has a core cross section of  $5 \text{ cm}^2$  and mean core length of 25 cm. The coil on the core has 120 turns with an mmf of 500 AT. The magnetic core flux is

- (a) 0.06 mWb (b) 0.25 mWb  
(c) 0.75 mWb (d) 1 mWb

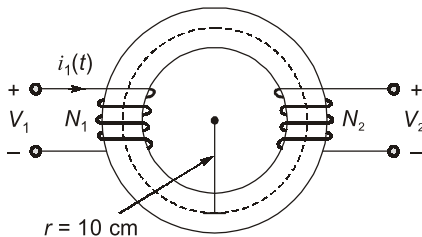
**Q.21** A steel core having cross sectional area of  $25 \text{ cm}^2$  and mean radius of 10 cm. For a relative permeability of 500 and a 400 turns coil producing a flux of 0.8 mWb in the ring, the value of current in exciting coil is \_\_\_\_\_ A.

**Q.22** The mutual inductance between two closely coupled coils is 1 H. Now the turns of one coil is decreased to half and those of the other is doubled. The new value of mutual inductance would be

- (a)  $\frac{1}{4}$  H (b) 2 H  
(c)  $\frac{1}{2}$  H (d) 1 H

**Q.23** The flux linkage ( $\lambda$ ) and current ( $i$ ) relation for an electromagnetic system is  $\lambda = (\sqrt{i})/g$ . When  $i = 2$  A and  $g$  (air-gap length) = 10 cm, the magnitude of mechanical force on the moving part, in N, is \_\_\_\_\_.

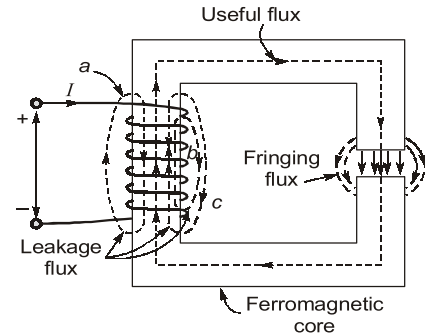
**Q.24** The magnetic circuit shown below has a uniform cross section of  $10^{-3} \text{ m}^2$ . If the circuit is energized by a current  $i_1(t) = 3 \sin 100 \pi t$  ampere in the coil of  $N_1 = 200$  turns, the emf induced in the coil (in V) of  $N_2 = 100$  turns is (Assume  $\mu = 500 \mu_0$ )



- (a)  $\frac{8\pi}{\sqrt{2}}$  (rms) and leading the current by  $90^\circ$ .  
(b)  $\frac{6\pi}{\sqrt{2}}$  (rms) and lagging the current by  $90^\circ$ .  
(c)  $\frac{4\pi}{\sqrt{2}}$  (rms) and leading the current by  $90^\circ$ .  
(d)  $\frac{5\pi}{\sqrt{2}}$  (rms) and lagging the current by  $90^\circ$ .

**Q.25** A coil of 100 turns is wound on a toroidal magnetic core having a reluctance of  $10^4 \text{ AT/Wb}$ . When the coil current is 5 A and is increasing at the rate of 200 A/s, the voltage across the coil would be (Assume coil resistance to be  $2 \Omega$ )

**Q.26** The magnetic circuit shown below have following data:



Area of cross section =  $5 \times 5 \text{ cm}^2$

Core length = 40 cm

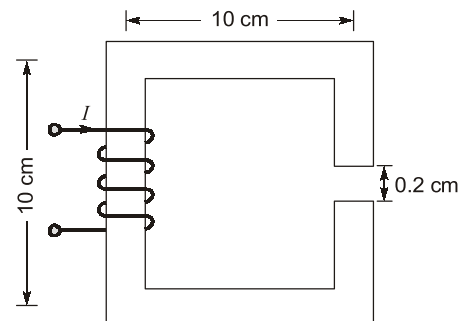
Gap length = 4 mm

$N = 560$  turns

For a flux density of 1.5 T, the exciting current is (Take  $\mu_r = 10000$  for iron and neglect fringing effects)

- (a) 7.26 A (b) 8.61 A  
(c) 6.52 A (d) None

**Q.27** The magnetic circuit shown below has uniform cross-sectional area and air gap of 0.2 cm. The mean path length of the core is 40 cm. Assume that leakage and fringing fluxes are negligible. When the core relative permeability is assumed to be infinite, the magnetic flux density computed in the air gap is 1 tesla. With same Ampere-turns, if the core relative permeability is assumed to be 1000 (linear), the flux density in Tesla (round off to three decimal places) calculated in the air gap is \_\_\_\_\_.



**Answers Magnetic Circuit**

1. (c) 2. (d) 3. (b) 4. (b) 5. (c) 6. (b) 7. (a) 8. (a) 9. (2.09)  
10. (d) 11. (a) 12. (d) 13. (b) 14. (b) 15. (a) 16. (c) 17. (d) 18. (b)  
19. (1.2) 20. (a) 21. (0.8) 22. (d) 23. (188.56) 24. (b) 25. (210) 26. (b)  
27. (0.833)

**Explanations Magnetic Circuit**

**1. (c)**

From Faraday's law of electromagnetic induction,

$$e = -\frac{d\psi}{dt}$$

(minus sign is due to Lenz's law).

**2. (d)**

$$L = \frac{N\phi}{I} = \frac{1000 \times 10^{-3}}{1} = 1 \text{ H}$$

$$\begin{aligned} \therefore \text{Energy stored} &= \frac{1}{2} LI^2 = \frac{1}{2} \times 1 \times 1^2 \\ &= \frac{1}{2} \text{ Joule} \end{aligned}$$

**3. (b)**

- For an electrical circuit,

$$I = \frac{\text{Emf}}{R}$$

- For a magnetic circuit

$$\phi = \frac{\text{Mmf}}{\text{Reluctance}}$$

- Current in electric circuit is analogous to flux in magnetic circuit.

**4. (b)**

Mutual inductance between two circuits can be increased by increasing the permeance or decreasing the reluctance offered to the mutual flux.

**5. (c)**

Magnetic flux in magnetic circuit is similar to the electric current in electric circuit similarly mmf is equivalent to emf, reluctance is resistance and permeability is conductivity in electric circuits.

**6. (b)**

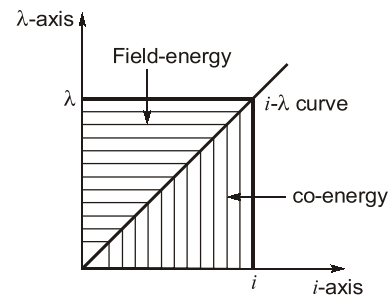
$$H = \frac{NI}{l} \left( \frac{\text{Ampere-turn}}{\text{metre}} \right)$$

$$\phi = B.A.$$

$$\text{or, } B = \frac{\phi}{A} \text{ (Wb/m}^2\text{)}$$

$\phi$  has a unit of Wb; permeability,  $\mu$  has unit of Henry/m.

**7. (a)**



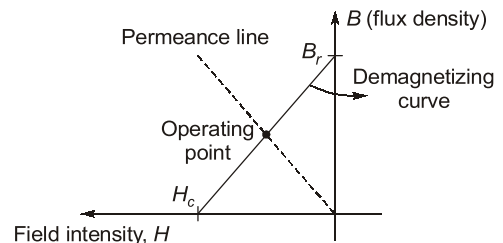
Where,  $\lambda = N\phi = \text{Flux linkage}$

Field energy is the energy absorbed by the magnetic system to establish flux  $\phi$ .

For a linear electromagnetic circuit

$$\text{Field energy} = \text{Co-energy} = \frac{1}{2} \lambda i$$

**8. (a)**



**9. Sol.**

Given,

$$l = 30 \text{ cm} = 0.3 \text{ m}$$

$$\mu_r = 50$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$$

$$A = 10 \text{ cm}^2 = 10 \times 10^{-4} \text{ m}^2$$

$$\therefore \text{Reluctance} = \frac{l}{\mu_0 \mu_r \cdot A}$$

$$\begin{aligned}\therefore \text{Permeance } (P) &= \frac{1}{\text{Reluctance}} = \frac{\mu_0 \mu_r \cdot A}{l} \\ &= \frac{4\pi \times 10^{-7} \times 50 \times 10 \times 10^{-4}}{0.3} \\ &= 2.09 \times 10^{-7} \text{ Wb/AT}\end{aligned}$$

**10. (d)**

$$\begin{aligned}\text{Area} = A &= 2\pi rl = 2\pi \times 1 \times 0.3 = 0.6\pi \\ \phi &= BA = 1 \times 0.6\pi = 0.6\pi \\ \text{Induced emf} &= \frac{\phi}{T} = \frac{\phi N}{60} = 0.6\pi \times \frac{600}{60} \\ &= 18.84 \text{ V}\end{aligned}$$

Hence, option (d) is correct.

**11. (a)**

Since length of air-gap is increased, therefore, reluctance offered to the magnetic circuit will increase.

$$\text{Also, Flux} = \frac{\text{MMF}}{\text{Reluctance}} = \frac{NI}{\text{Reluctance}}$$

Hence, to maintain the constant flux, the choke will draw more current so that the net mmf is increased.

**12. (d)**

- Reason (R) is not a correct statement as, this is only true for an ideal magnetic circuit, but not for all magnetic circuits in general.
- In practical magnetic circuits, a small amount of flux does follow a path through the surrounding air and is called leakage flux.

**13. (b)**

Current through the field winding,

$$\begin{aligned}I &= \frac{\text{Excitation voltage}}{\text{Field winding resistance}} \\ &= \frac{230}{50} = 4.6 \text{ A}\end{aligned}$$

Given,  $\phi = 5 \text{ mWb}$

$\therefore$  Inductance of coil,

$$\begin{aligned}L &= \frac{N\phi}{I} = \frac{960 \times 0.005}{4.6} \\ &= 1.043 \text{ H}\end{aligned}$$

So, energy stored in magnetic field

$$\begin{aligned}&= \frac{1}{2} LI^2 = \frac{1}{2} \times 1.043 \times (4.6)^2 \\ &= 11.04 \text{ J} \approx 11 \text{ Joules}\end{aligned}$$

**14. (b)**

$$L = \frac{N^2 \mu_0 \mu_r A}{l} \text{ or } L \propto N^2 \mu_r$$

$$\therefore \frac{L_2}{L_1} = \left( \frac{N_2}{N_1} \right)^2 \times \left( \frac{\mu_{r2}}{\mu_{r1}} \right)$$

$$\text{or, } \frac{L_2}{L_1} = (2)^2 \times \frac{600}{400} = 6$$

$$\begin{aligned}\text{or, } L_2 &= 6L_1 \\ \text{or, } L_2 &= 6 \times 50 \times 10^{-3} = 0.3 \text{ H}\end{aligned}$$

**15. (a)**

$$H = \frac{NI}{l} = \frac{150 \times 2}{25 \times 10^{-2}} = 1200 \text{ AT/m}$$

$$\text{and } B = \mu_0 \mu_r H = \frac{\phi}{A}$$

$$\Rightarrow \mu_r = \frac{0.3 \times 10^{-3}}{5 \times 10^{-4} \times 4\pi \times 10^{-7} \times 1200} = 397.9$$

**16. (c)**

We know that eddy current loss,

$$P_e \propto f^2 B_m^2$$

$$\therefore \frac{P_{e2}}{P_{e1}} = \left( \frac{f_2}{f_1} \right)^2 \times \left( \frac{B_{m2}}{B_{m1}} \right)^2$$

$$\begin{aligned}\text{or, } P_{e2} &= P_{e1} \times \left( \frac{f_2}{f_1} \right)^2 \times \left( \frac{B_{m2}}{B_{m1}} \right)^2 \\ &= 15 \times \left( \frac{1.5}{2} \right)^2 \times \left( \frac{800}{600} \right)^2 = 15 \text{ W}\end{aligned}$$

**17. (d)**

Magnetic circuit is dissipation in both ac and dc excitation and non-inductive in ac excitation unlike an, electric circuit.

**18. (b)**

We know that inductance,

$$L \propto \mu \text{ (Permeability)} \propto \mu_0 \mu_r \propto \mu_r$$

Since relative permeability of iron is more than that of air ( $\mu_r = 1$ ) therefore, with iron-cored coil  $L$  will be more while with air-cored coil  $L$  will be less.

**19. Sol.**

$\therefore$  Useful flux = Flux through magnetic core

$\therefore$  Total flux through exciting winding  
= useful flux + leakage flux

$\lambda$  = Leakage factor

i.e.  $\lambda = \frac{\text{Total flux through exciting winding}}{\text{Useful flux}}$

Hence,

$$\lambda = \frac{0.5 + 0.1}{0.5} = 1.2$$

**20. (a)**

Given,  $\mu_r = 50$ ,  $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

We know that,  $\mu = \mu_0 \mu_r$

Cross-section area,

$$A = 5 \text{ cm}^2 = 5 \times 10^{-4} \text{ m}^2$$

Core length,  $l = 25 \text{ cm} = 25 \times 10^{-2} \text{ m}$

Now, Reluctance =  $\frac{l}{\mu_0 \mu_r A}$

$$= \frac{25 \times 10^{-2}}{4\pi \times 10^{-7} \times 50 \times 5 \times 10^{-4}}$$

Also, Flux =  $\frac{\text{mmf}}{\text{Reluctance}}$

$$= \frac{500 \times 4\pi \times 10^{-7} \times 50 \times 5 \times 10^{-4}}{25 \times 10^{-2}}$$

$$= 0.628 \times 10^{-4} \text{ Wb}$$

$$= 0.0628 \text{ mWb} \approx 0.06 \text{ mWb}$$

**21. Sol.**

Given,  $A = 25 \text{ cm}^2$   
 $l = \pi D = 2\pi r$   
 $= 2\pi \times 10 \text{ cm}$   
 $\mu_r = 500$ ,  $N = 400 \text{ turns}$

Reluctance =  $\frac{l}{\mu_0 \mu_r A}$

$$= \frac{2\pi \times 10 \times 10^{-2}}{4\pi \times 10^{-7} \times 500 \times 25 \times 10^{-4}}$$

$$= 40 \times 10^4 \text{ AT/Wb}$$

$\therefore \phi (\text{Flux}) = \frac{\text{mmf}}{\text{Reluctance}}$

$$0.8 \times 10^{-3} = \frac{400 \times I}{40 \times 10^4}$$

$\Rightarrow I = 0.8 \text{ A}$

**22. (d)**

Since,  $L = \frac{N^2 \mu A}{l}$  or  $L \propto N^2$

Since, turns of one coil is decreased to half, therefore its new inductance,

$$L'_1 = \frac{L_1}{4}$$

Since, turns of other coil is doubled, therefore its new value of inductance,

$$L'_2 = 4L_2$$

Now, mutual inductance,

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

So, new value of mutual inductance is,

$$M' = K\sqrt{L'_1 L'_2}$$

$$\therefore M' = M \sqrt{\frac{L'_1 \cdot L'_2}{L_1 L_2}} = 1 \cdot \sqrt{\frac{\frac{1}{4} L_1 \times 4 L_2}{L_1 L_2}} = 1 \text{ H}$$

**23. Sol.**

Energy in magnetic system,

$$W_f = \int_0^\lambda i(\lambda) d\lambda$$

$\therefore i = \lambda^2 \cdot g^2$  (given)

$$W_f = \int_0^\lambda \lambda^2 \cdot g^2 \cdot d\lambda = g^2 \cdot \frac{\lambda^3}{2}$$

Now, mechanical force,

$$F_F = -\frac{\partial W_f(\lambda, g)}{\partial g}$$

$$= -\frac{\partial}{\partial g} \left( \frac{g^2 \cdot \lambda^3}{2} \right) = -\frac{2}{3} \lambda^3 \cdot g$$

$\therefore i = 2 \text{ A}$ ,  $g = 10 \text{ cm}$ ,  $\lambda = 10\sqrt{2}$

Hence,  $|F_F| = \frac{2}{3} \times (10\sqrt{2})^3 \times 0.1$

$$= 188.56 \text{ N}$$

**24. (b)**

The flux in the circuit,

$$\psi = \frac{M \text{mmf}}{R} = \frac{N_1 i_1}{l / \mu A} = \frac{N_1 i_1 \mu A}{2\pi r} \quad [\because l = 2\pi r]$$

According to Faraday's law, the emf induced in the second coil is

$$V_2 = -N_2 \frac{d\phi}{dt}$$

$$= \frac{-100 \times 200 \times 500 \times 4\pi \times 10^{-7} \times 10^{-3}}{2\pi \times 10 \times 10^{-2}} \frac{di(t)}{dt}$$

$$= -\frac{1}{50} \frac{d}{dt} (3 \sin 100\pi t)$$

$$V_2 = -6\pi \cos 100\pi t \text{ V}$$

Rms value =  $\frac{V_m}{\sqrt{2}} = \frac{6\pi}{\sqrt{2}} \text{ V}$

**25. Sol.**

$$\text{Voltage across the coil} = L \frac{di}{dt} + IR$$

Given, number of turns of coil =  $N = 100$

$$\frac{di}{dt} = 200 \text{ A/s}$$

Reluctance,  $\mathfrak{R}_l = 10^4 \text{ AT/Wb}$

$\therefore$  Inductance of coil,

$$L = \frac{N^2 \mu_0 \mu_r A}{l} = \frac{N^2}{\mathfrak{R}_l}$$

$$= \frac{100^2}{10^4} = 1 \text{ H}$$

So, voltage across the coil

$$= 1 \times (200) + 5 \times 2$$

$$= 210 \text{ V}$$

**26. (b)**

$$\text{Mmf, } NI = \underbrace{H_1 l_i}_{(\text{iron core})} + \underbrace{H_2 l_g}_{(\text{air gap})}$$

$$= \frac{B}{\mu_0 \mu_r} \cdot l_i + \frac{B}{\mu_0} \cdot l_g = \frac{B}{\mu_0} \left[ \frac{l_i}{\mu_r} + l_g \right]$$

$$\therefore 560 \times I = \frac{1.5}{4\pi \times 10^{-7}} \left[ \frac{40 \times 10^{-2}}{10000} + 4 \times 10^{-3} \right]$$

$$\Rightarrow I = 8.61 \text{ A}$$

**27. Sol.**

Given,  $l_{ag} = 0.2 \text{ cm}$ ,  $l_m = 40 \text{ cm}$   
 $B_0 = 1 \text{ Tesla}$

$$\phi = \frac{\text{mmf}}{\mathfrak{R}}$$

For same mmf,

$$\phi \propto \frac{1}{\mathfrak{R}}$$

$$\text{In case-1: } \mathfrak{R}_1 = \frac{l_m}{\mu_0 A} = \frac{l_{ag}}{\mu_0 A} + \frac{l_m}{\mu_0 \mu_r A}$$

As  $\mu_r = \infty$

$$\therefore \mathfrak{R}_1 = \frac{0.2 \times 10^{-2}}{\mu_0 A}$$

In case-2:

$$\mathfrak{R}_2 = \frac{l_{ag}}{\mu_0 A} + \frac{l_m}{\mu_0 \mu_r A}$$

$$= \frac{0.2 \times 10^{-2}}{\mu_0 A} + \frac{40 \times 10^{-2}}{1000 \mu_0 A}$$

$$= \frac{0.24 \times 10^{-2}}{\mu_0 A}$$

As, flux,  $\phi \propto B$  for uniform cross section area.

$$\therefore B_2 = \frac{B_1 \times \mathfrak{R}_1}{\mathfrak{R}_2}$$

$$B_2 = \frac{1 \times 0.2 \times 10^{-2} / \mu_0 A}{0.24 \times 10^{-2} / \mu_0 A} = 0.833 \text{ T}$$

■■■■