

1) An air core Solenoid has 500 turns and a length of 0.25m. The Solenoid has a radius of 1.5cm. The permeability

of air is ($\mu_r = 1$). Calculate

the inductance of the Solenoid.

Soln.

$$N = 500 \text{ turns}$$

$$l = 0.25 \text{ m}$$

$$r = 1.5 \text{ cm}$$

$$\mu = \mu_r \cdot \mu_0$$

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

$$\mu_r = 1$$

$$\mu = 4\pi \times 10^{-7} \times 1$$

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

$$A = \pi r^2$$

$$r = 1.5 \text{ cm} = 0.015 \text{ m}$$

$$A = \pi \times (0.015)^2$$

$$A = 0.0007$$

$$L = \frac{4\pi \times 10^{-7} \times 0.0007 \times 500^2}{0.25}$$

$$L = 0.00088$$

$$L = 0.88 \text{ mH}$$

2) Calculate ^{the} magnetic force per unit length between two parallel wires carrying current of 5A and 7A in the same direction, placed 4 cm apart in free space.

Soln.

$$F = \frac{\mu \hat{I}_1 \hat{I}_2 l}{2\pi d}$$

$$\frac{F}{l} = \frac{\mu \hat{I}_1 \hat{I}_2}{2\pi d}$$



$$I_1 = 5A$$

$$I_2 = 7A$$

$$d = 4cm = 0.04m$$

$$\mu_r = 1$$

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

$$\frac{F}{l} = \frac{4\pi \times 10^{-7} \times 5 \times 7}{2\pi \times 0.04}$$

$$\frac{F}{l} = 1.75 \times 10^{-4} N/m$$

3) Determine the inductance per unit length of a co-axial cable with inner and outer conductor radii of 1mm and 3mm respectively. Assume μ_r as unity.

Soln:

Inner radius $a = 1mm = 1 \times 10^{-3} m$

Outer radius $b = 3mm = 3 \times 10^{-3} m$

$$\mu_r = 1$$

$$\frac{L}{d} = \frac{\mu}{2\pi} \ln\left(\frac{b}{a}\right)$$

$$\frac{L}{d} = \frac{\mu_0 \mu_r}{2\pi} \ln\left(\frac{b}{a}\right)$$

$$= \frac{4\pi \times 10^{-7} \times 1}{2\pi} \ln\left(\frac{3 \times 10^{-3}}{1 \times 10^{-3}}\right)$$

$$\frac{L}{d} = 0.22 \times 10^{-6} \text{ H/m}$$

$$\frac{L}{d} = 0.22 \text{ } \mu\text{H/m}$$

