## 517.

## Problem 38.3 (RHK)

A solenoid is wound with a single layer of insulated copper wire (diameter, 2.52 mm). It is 4.10 cm in diameter and 2.0 m long. We have to find the inductance per meter for the solenoid near its centre. We may assume that adjacent wires touch and that insulation thickness is negligible.

## **Solution:**



The diameter of the insulated copper wire,

 $d = 2.52 \text{ mm} = 2.52 \times 10^{-3} \text{ m}.$ 

Length of the solenoid, l = 2.0 m.

The diameter of the solenoid,

 $2r = 4.10 \text{ cm} = 4.10 \times 10^{-2} \text{ m}.$ 

The cross-sectional area of the solenoid will be

$$A = \pi r^{2} = \pi \left( 2.05 \times 10^{-2} \right)^{2} \text{ m}^{2} = 13.20 \times 10^{-4} \text{ m}^{2}.$$

As the solenoid has been closely wound with adjacent loops touching each other, the number of turns per unit length of the winding will be

$$n = \frac{1}{2.52 \times 10^{-3}} = 397 \text{ m}^{-1}.$$

Therefore, inductance per meter for the solenoid near its centre will be given by

$$L = \mu_0 n^2 A = (4\pi \times 10^{-7}) \times (397)^2 \times 13.20 \times 10^{-4} \text{ H m}^{-1}$$
$$= 261 \ \mu\text{H m}^{-1}.$$

