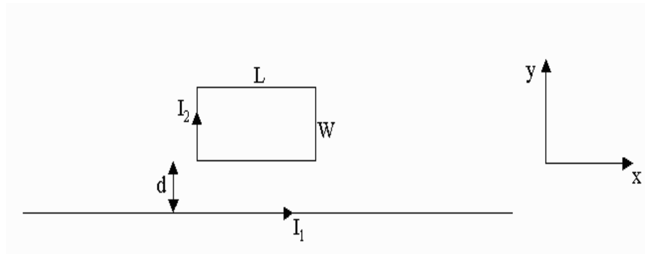
Q- An infinite wire carries current I_1 = 1.1 A in the +x direction as shown in the diagram bellow. A rectangular loop of length L = 8 cm and width w = 3 cm carries current I_2 = 0.5 A in the clockwise direction as shown. The loop is located in the x-y plane a distance d = 3 cm from the infinite wire.



(a) What is B_{top}, the magnitude of the magnetic field due to the infinite wire at any point along the top segment (length 8 cm) of the loop?

The magnetic field at a distance r from an infinite wire carrying current I is given by

$$B = \frac{\mu_0 I}{2\pi R}$$

Hence the field at the top wire will be

$$B_{top} = \frac{4\pi * 10^{-7} * 1.1}{2\pi * 0.06} = 3.67 * 10^{-6} \text{ T}$$

B_{top} = $3.67*10^{-6}$ T

(b) What is B_{bottom}, the magnitude of the magnetic field due to the infinite wire at any point along the bottom segment (length 8 cm) of the coil?

The field at the bottom wire will be

$$B_{bottom} = \frac{4\pi * 10^{-7} * 1.1}{2\pi * 0.03} = 7.33 * 10^{-6} \text{ T}$$

B_{bottom} = $7.33*10^{-6}$ T

(c) What is F_x, the net force acting on the loop?

The force on the wire will be given by F = BIL and this force is perpendicular to the current in the wire and the magnetic field both. The two sides perpendicular to the wire are symmetrical to the wire and the current in both are in opposite direction thus the force on them are equal and opposite and hence net force on the coil is only that due to on the sides parallel to the wire.

The force on the top side F_T = $3.67*10^{-6}*0.5*0.08$ = $1.468*10^{-7}$ N and its direction will be towards the wire. (Flaming's left hand rule)

The force on the bottom side F_B = $7.33*10^{-6}*0.5*0.08$ = $2.936*10^{-7}$ N and its direction is away from the wire

As both forces are in opposite directions as discussed above hence the net force on the wire will be $F_B - F_T$ = $1.468*10^{-7}$ N

F_x= $1.468*10^{-7}$ N