EEC 130A: Homework 8

Due: 3:30 pm, Mar. 6th, 2012

Updated: Feb. 29th, 2012

1. (4 points) (FAE P5.6) A 20-turn rectangular coil with sides $l = 30$ cm and $w = 10$ cm is placed in the $y - z$ plane as shown in Fig. 1.

(a) If the coil, which carries a current $I = 10$ A, is in the presence of a magnetic flux density

$$\mathbf{B} = 2 \times 10^{-2} \left(\hat{\mathbf{x}} + \hat{\mathbf{y}}2\right) \qquad ,$$

determine the torque acting on the coil.

(b) At what angle ϕ is the torque zero?

(c) At what angle ϕ is the torque maximum? Determine its value.

2. (4 points) (FAE P5.10) An infinitely long, thin conducting sheet defined over the space $0 \leq x \leq w$ and $-\infty \leq y \leq \infty$ is carrying a current with a uniform surface current density $\mathbf{J}_s = \hat{\mathbf{y}}5$ (A/m). Obtain an expression for the magnetic field at point $P = (0, 0, z)$ in Cartesian coordinates.

3. (4 points) (FAE P5.14) Two parallel, circular loops carrying a current of 40 A each are arranged as shown in Fig. 2. The first loop is situated in the x-y plane with its center at the origin, and the second loop's center is at $z = 2$ m. If the two loops have the same radius $a = 3$ m, determine the magnetic field at:

(a) $z = 0$

(b) $z = 1$ m

(c) $z = 2$ m

4. (4 points) (FAE P5.17) In the arrangement shown in Fig. 3, each of the two long, parallel conductors carries a current I, is supported by 8-cm-long strings, and has a mass per unit length of 1.2 g/cm. Due to the repulsive force acting on the conductors, the angle θ between the supporting strings is 10°. Determine the magnitude of I and the relative directions of the currents in the two conductors.

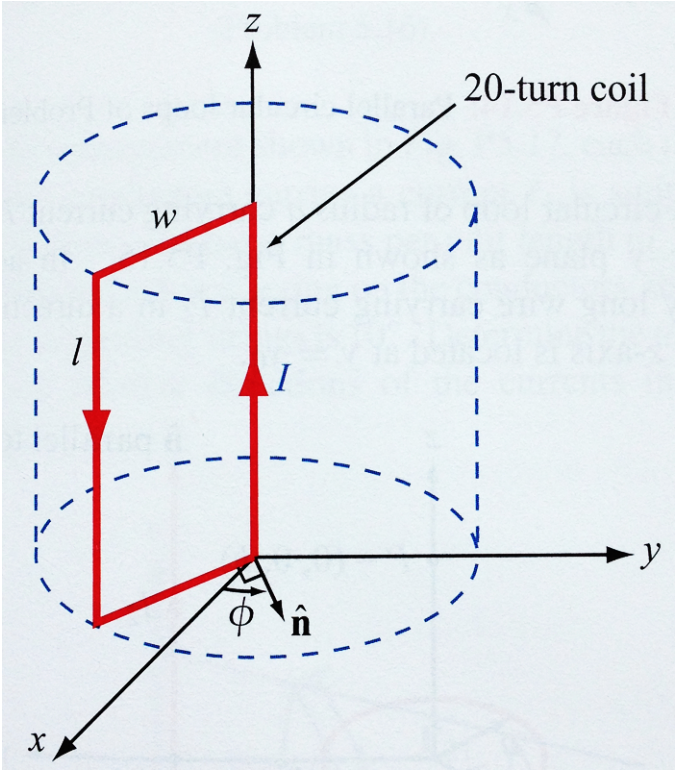

Figure 1: (FAE Fig. P5.6) Rectangular coil of Problem 1.

5. (4 points) (FAE P5.22) A long cylindrical conductor whose axis is coincident with the z-axis has a radius a and carries a current characterized by a current density $\mathbf{J} = \hat{\mathbf{z}} J_0/r$, where J_0 is a constant and r is the radial distance from the cylinder's axis. Obtain an expression for the magnetic field $\mathbf{H}$ for

(a) $0 \leq r \leq a$

(b) $r > a$

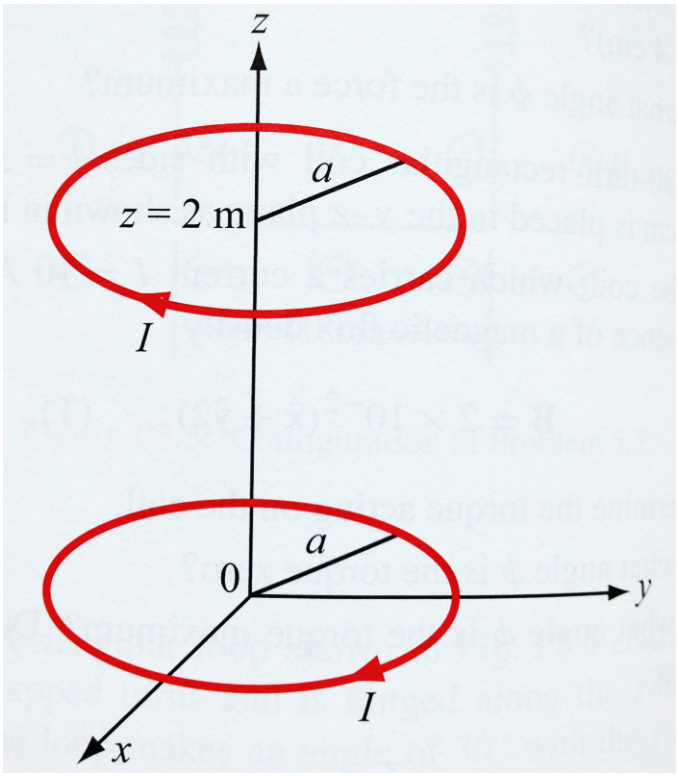

Figure 2: (FAE Fig. P5.14) Parallel circular loops of Problem 3.

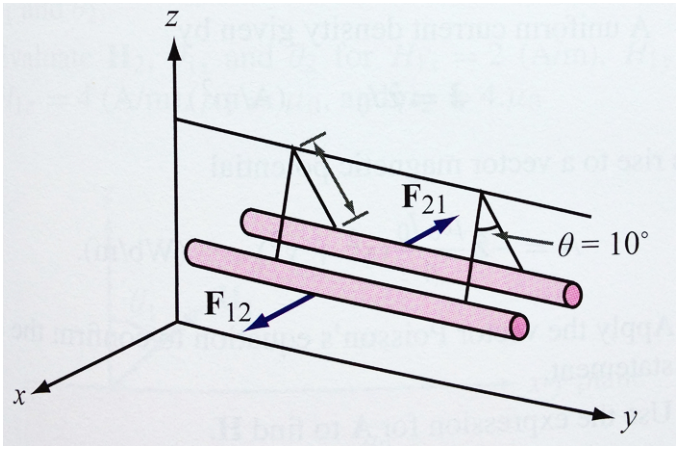

Figure 3: (FAE Fig. P5.17) Parallel conductors supported by strings (Problem 4).