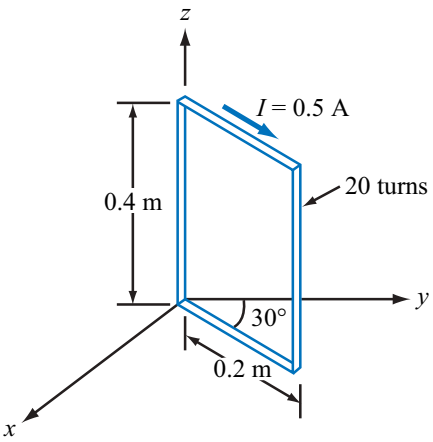
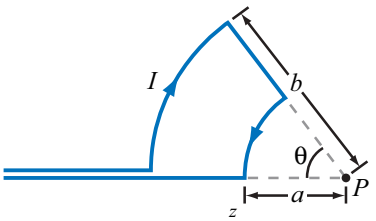
CMPE 330 Spring 2015 Problem Set #6

NOTE: You must show complete work for full credit. Report numerical solutions to two significant figures unless otherwise specified.

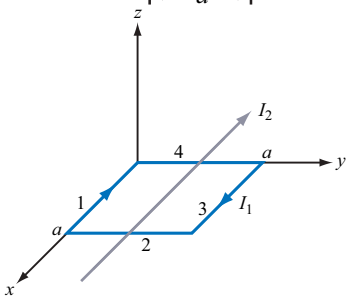
1. The rectangular loop shown in the figure to the right [Ulaby et al., Fig. P5.4] consists of 20 closely wrapped turns and is hinged along the z-axis. The plane of the loop makes an angle of 30° with the y-axis, and the current in the windings is 0.5 A. What is the magnitude of the torque exerted on the loop in the presence of a uniform magnetic field $\mathbf{B} = \hat{\mathbf{y}}1.2$ T? When viewed from above, is the expected direction of rotation clockwise or counterclockwise? [modified from Ulaby et al. 5.4, p. 274]



2. The loop shown to the right [Ulaby et al., Fig. P5.9] consists of radial lines and segments of circles whose centers are at point P. Determine the magnetic field $\mathbf{H}$ at P in terms of a, b, θ, and I. [Ulaby et al. 5.9, p. 275]



3. A square loop, placed as shown in the accompanying figure [Ulaby et al., Fig. P5.20] has 2 m sides and carries a current $I_1 = 5$ A. If a straight, long conductor carrying a current $I_2 = 10$ A is introduced and placed just above the midpoints of two of the loop's sides, determine the net force acting on the loop. [Ulaby et al. 5.20, p. 278]



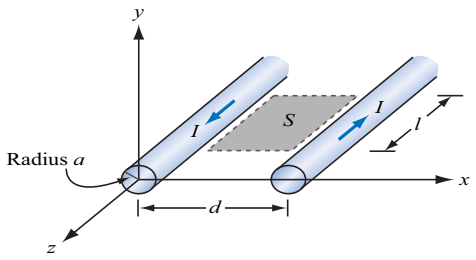
4. A thin current element extending between $z = -L/2$ and $z = L/2$ carries a current I along the $+\hat{\mathbf{z}}$ through a circular cross-section of of radius A. [Ulaby et al. 5.29, p. 279]

   a. Find $\mathbf{A}$ at a point P located very far from the origin. Assume that R is so much larger than L that point P may be considered at approximately the same distance from every point along the current element.

   b. Determine the corresponding $\mathbf{H}$.

5. Given that a current sheet with surface current density $\mathbf{J}_S = \hat{\mathbf{x}}4\,(\text{A/m})$ exists at $y = 0$, the interface between two magnetic media, and $\mathbf{H}_1 = \hat{\mathbf{z}}8\,(\text{A/m})$ in medium 1 ($y > 0$), determine $\mathbf{H}_2$ in medium 2 ($y < 0$). [modified from Ulaby et al. 5.33, p. 279.]

6. Obtain an expression for the self-inductance per unit length for the parallel wire transmission line of Ulaby's Fig. 5-27(a), shown at the right, in terms of a, d, and μ, where a is the radius of the wires, d is the axis-to-axis distance between the wires, and μ is the permeability of the medium in which they reside. [Ulaby et al. 5.37, p. 280]



7. A solenoid with a length of 20 cm and a radius of 5 cm consists of 400 turns and carries a current of 12 A. If $z = 0$ represents the midpoint of the solenoid, generate a plot for $|\mathbf{H}(z)|$ along the axis of the solenoid for a range $-20\,\text{cm} \leq z \leq 20\,\text{cm}$. Please use MATLAB to generate the solution numerically and indicate how you did it. Include a copy of the computer code that you create to solve the problem. [Modified from Ulaby et al. 5.38, p. 280]