Physics UN2802 Professor Christ
due 02/11/2021

Assignment #15

Reading:

Feb 9 Purcell Chapter 7.1-7.4
Feb 11 Purcell Chapter 7.5-7.10

Problems:

123. Purcell 6.4

124. Purcell 6.6 (Assume that the distance between the points B or E and the lower wire is also 30 cm so that lower part of the hanging frame, the wire between C and D, touches the lower wire if no current flows.)

125. Purcell 6.11

126. Purcell 6.12

127. Purcell 6.16

128. Purcell 6.18

129. Purcell 6.23

130. Consider a planar loop of area A carrying a current I. Let $\hat{n}$ be a unit normal to the plane of the loop directed relative to the direction of current flow by the right hand rule. If this loop is placed in a uniform magnetic field $\vec{B}$, show that it experiences a torque $\vec{\tau} = \vec{\mu} \times \vec{B}$, where $\mu = \frac{AI}{c}\hat{n}$. (Hint: this problem can be solved by expressing each component of $\vec{\tau}$ as a line integral around the current loop and then using Stoke's theorem.)

131. Purcell 6.25

132. Two lines of charge carrying $q_1 = 2$ esu/cm and $q_2 = -2$ esu/cm are located are parallel to the z-axis and have (x, y) coordinates $(x_1, y_1) = (2, 3)$ and $(x_2, y_2) = (6, 3)$ expressed in units of cm. They lie within a long square conducting tube whose cross section is 10 cm $\times$ 10 cm, also parallel to the z-direction. The four edges of the tube have the (x, y) coordinates (0,0), (10,0), (10,10) and (0,10), measured in cm. Draw a plot showing equipotential lines in the two-dimensional rectangle $0 \leq x \leq 10$ cm, $0 \leq y \leq 10$ cm, $z = 0$ cm. Show lines corresponding to 201 values for ϕ lying between $\phi = -5$ esu/cm and $\phi = +5$ esu/cm separated by 0.05 esu/cm. Show the contours for positive values of ϕ as solid lines and those for negative values of ϕ as dashed lines. Work with a precision corresponding to at least 15,000 ordinary relaxation steps. (You might start with the Python example on the course website: (http://www.columbia.edu/~nhc1/UN2802/Python/Python_index.htm labeled "`Potential-in-box.ipynb`" and then gradually modify it to become the solution to the problem posed here.)