PHYS 3320 Electricity & Magnetism I
Fall 2018
Assignment 8

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1. A square loop of side L rotates about a vertical axis (z-direction). There is a uniform magnetic field $\mathbf{B} = B_o\,\mathbf{j}$ passing through the loop. If the coil rotates with an angular speed of ω calculate the induced emf in the coil.

2. Repeat the previous problem if the magnetic field is given by $\mathbf{B} = B_o\,(x/L)^2\,\mathbf{j}$

3. A uniform but time-dependent magnetic field exists in space, given by $\mathbf{B} = B(t)\,\mathbf{k}$.
   a. Find the emf about a fixed circular path of radius r lying in the z-y plane with its centre at the origin.
   b. If the electric field is always tangent to this circle show that

$$\boldsymbol{E} = -\frac{r}{2}\frac{dB}{dt}\hat{\boldsymbol{\phi}} = \frac{1}{2}\frac{dB}{dt}(y\,\boldsymbol{i} - x\,\boldsymbol{j})$$

4. A toroid made from a non-magnetic material has a square cross-section. (A toroid is a doughnut.) It has an inner radius a and outer radius b, with a thickness h = b-a. It is wound with N turns of wire, carrying a current I.
   a. Find the magnetic field inside the toroid.
   b. Show that the self inductance of the toroid is given by

$$L = \frac{\mu_o}{2\pi}N^2 h \ln\left(\frac{b}{a}\right)$$