1. Rotating rectangular loop in B field

A rectangular loop rotates as shown with angular frequency $\omega$. A uniform and constant magnetic field $\mathbf{B}$ points into the page.

(a) Find the emf around the loop. This should be a function of time.

(b) Now suppose that not only is the loop rotating, but the magnitude of the magnetic field is changing as $B(t) = B_0 \sin(\omega t)$. At $t = 0$, the direction of $\mathbf{B}$ is perpendicular to the plane of the loop and inward. Find the emf around the loop.

2. Sliding bar and resistor

Consider the sliding-bar and resistor apparatus in Griffiths figure 7.17. Suppose a constant force of magnitude $F$ pushes the bar through the region of perpendicular magnetic field of magnitude $B$.

(a) Starting from zero velocity, determine the velocity of the bar as a function of time? (ignore self-inductance.)

(b) Determine the current as a function of time.

3. Circular disk in a time-dependent magnetic field

A metal disk of radius $a$, thickness $d$, and conductivity $\sigma$ is located in the $xy$ plane, and centered at the origin. There is a time-dependent uniform magnetic field $\mathbf{B} = B(t) \hat{z}$. Determine the induced current density $\mathbf{J}(r,t)$.

4. Equal but opposite currents $I$ flow on the top and bottom of two long parallel plates, as shown in the figure. The plates have width $w$ separation $d$, where $d \ll w$.

(a) Neglecting edge effects, find the magnetic field between the two plates.

(b) Calculate the magnetic field energy per unit length.

(c) Compute the self inductance per unit length.