[Faraday's law] .quiz

1) Using the same apparatus in the Faraday's law lab, we choose the function generator to give us either one of the magnetic flux waveforms, sine or triangular, given in the fig. 1. Choose the one which you prefer.
The amplitude of the magnetic field waveform where the inner coil is placed, is $B_0 = 4$ mT. The area of the inner coil is $A = 2$ cm^2 and number of turns in this coil is $N = 11$.

a) Find the amplitude of the total magnetic flux passing through the inner coil, Φ_0.
b) Use your choice of the flux waveform, and draw the induced emf waveform, $\mathcal{E}(t)$, on the same graph.
c) Find the amplitude of the induced emf, $\mathcal{E}_0$.

a) $\varphi_0 = B_0 A \cancel{\cos\theta^{1}} = 4\,mT \cdot 2\times10^{-4}\,m^2 = 8\times10^{-7}$ Wb.
$\Phi_0 = N\varphi_0 = 11\varphi_0 = 8.8\times10^{-6}$ Wb.

b) See fig. 1.

c) Sine: $\mathcal{E}(t) = -\frac{d}{dt}\Phi = -2\pi f\,\Phi_0 \cos(2\pi f t)$
$= -28\,mV\cos(1000\pi t)$.

Triangular: $\mathcal{E}(t)$ will be a square wave
$\mathcal{E}_0 = |\text{Slope of } \Phi(t) \text{ in any line}| = \frac{\Phi_0 - 0}{.5ms - 0} = 18$ mV.

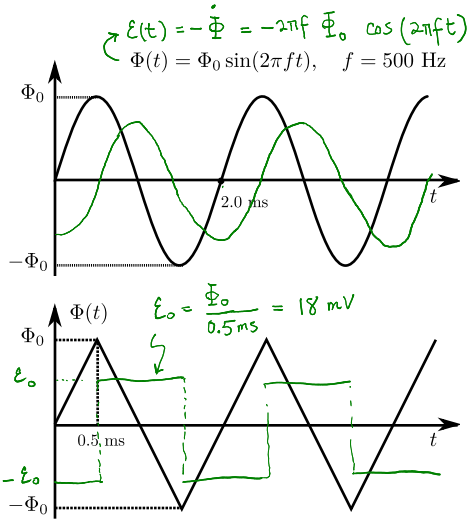


Figure 1: Flux waveforms.

2) As shown in the fig. 2, we are passing a magnet with a constant velocity through a ring which is sitting at the origin, i.e. $x = 0$. x-axis is the axis of the ring, and x_M is the position of the center of the magnet.

a) What is the magnetic flux passing through the ring, Φ_B, when the magnet is really far at $x_M = \pm\infty$?
b) Draw a graph of Φ_B in terms of x_M. Where does the flux has the maximum value?
c) We know that $x_M \propto t$, so $df/dt \propto df/dx_M$ where f is any function of time. On the same graph you drew in part 'b', draw the induced emf, $\mathcal{E}$.

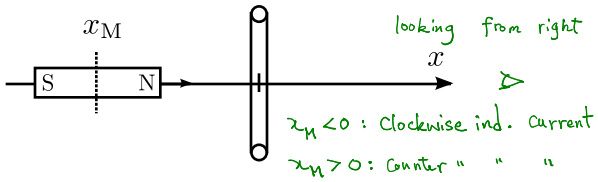
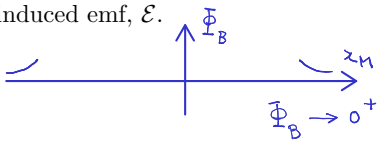


Figure 2: A bar magnet passing through a ring.

a) Zero.



$\Phi_B \to 0^+$: magnetic field lines are passing through the ring from left to right
$x_M \to \pm\infty$ no matter where x_M is, so $\forall x_M,\ \Phi_B(x_M) > 0$.

b) We know that $\Phi_B(x_M) = \Phi_B(-x_M)$ or Φ_B is an even func'n.
Also max. flux occurs at $x_M = 0$ & this is the only local maximum.

c) See fig. 3.

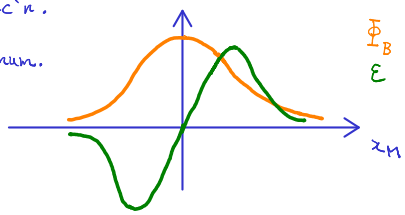


Figure 3: $\Phi_B(x_M)$ & $\mathcal{E}(x_M)$.