NAME: Solution	Quiz #8: Phys142

A solenoid contains 1000 turns and is 5 cm in length with a radius of 1mm. Recall that the magnetic field produced by a solenoid is $B = \mu_0 n I$.

(a) [4 pts] What is the magnetic flux through a single turn of the solenoid given that the current is 0.5 A?

$$\Phi_1 = \vec{B} \cdot \vec{A} = B\pi r^2 \; ; \quad B = \mu_0 n I = \mu_0 \frac{N}{\ell} I$$

$$B = (4\pi \times 10^{-7}\ Tm/A)\left(\frac{1000}{0.05m}\right)(0.5A) = 0.0126\ T$$

$$\Phi_1 = \pi(0.001m)^2(0.0126\ T) = 3.95 \times 10^{-8}\ Wb$$

(b) [1 pts] What is the magnetic flux through the entire solenoid given the current is 0.5 A?

$$\Phi_{all} = NBA = N\Phi_1 = 1000(3.95 \times 10^{-8}\ Wb)$$

$$\Phi_{all} = 3.95 \times 10^{-5}\ Wb = 39.5\ \mu Wb$$

(c) [5 pts] What rate of change of current produces a 2V potential difference across the entire solenoid?

$$\mathcal{E} = -\frac{d\Phi}{dt} = -NA\frac{dB}{dt} = -\mu_0 n N A \frac{dI}{dt}$$

$$\Rightarrow \frac{dI}{dt} = \frac{-\mathcal{E}}{\mu_0 n N A} = \frac{-\mathcal{E}\ell}{\mu_0 N^2 A} = \frac{-2V(0.05m)}{(4\pi \times 10^{-7}\ Tm/A)(1000)^2(\pi)(0.001m)^2}$$

$$\frac{dI}{dt} = 2.53 \times 10^4\ A/s$$