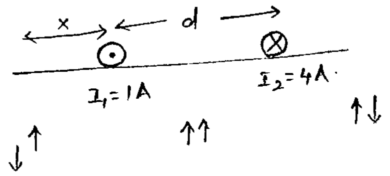
Solutions to Midterm Exam 03 (2015 Summer, 203B)

MT03, prob. 1

$$\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi r} = \frac{\cancel{4\pi}^{2} \times 10^{-7} \times 2.00 \times \cancel{4.00}}{\cancel{2\pi}\ \cancel{4.00} \times 10^{-2}} = 4.00 \times 10^{-5}\ \frac{N}{m}$$

MT03, prob. 2

Argue that it will be zero on the left side of I_1.



$$\frac{\cancel{\mu_0} I_1}{\cancel{2\pi} x} = \frac{\cancel{\mu_0} I_2}{\cancel{2\pi}(d+x)}$$

$$\frac{1}{x} = \frac{4}{d+x}$$

$$d + x = 4x \Rightarrow x = \frac{d}{3} = \frac{10.0\,cm}{3} = 3.33\,cm \text{ to left of } I_1$$

MT03, prob. 3

$$B_{tot} = +\frac{1}{2}\frac{\mu_0 I}{2\pi a} + \frac{1}{2}\frac{\mu_0 I}{2a} + \frac{1}{2}\frac{\mu_0 I}{2\pi a}$$

$$= \frac{\mu_0 I}{2a}\left(\frac{1}{2} + \frac{1}{\pi}\right) = \frac{\cancel{4\pi}^{2} \times 10^{-7} \times 1.00}{\cancel{2} \times 5.00 \times 10^{-2}} \frac{(\pi + 2)}{\cancel{2\pi}} = 1.03 \times 10^{-5}\ T$$

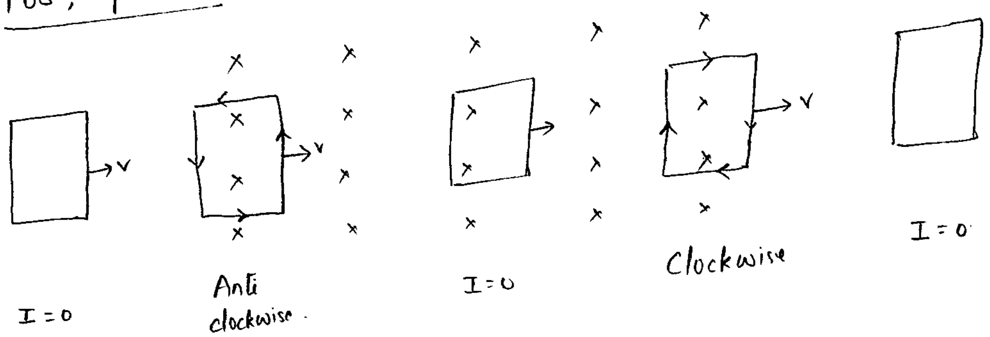
MT03, prob. 4

(a) Increasing

(b) Anticlockwise.

(c) $I = \frac{1}{R}\frac{\Delta \Phi_B}{\Delta t} = \frac{1}{R} B l v = \frac{1.2\,T \times (10 \times 10^{-2}\,m)\ 5.0\,\frac{m}{s}}{0.40\,\Omega} = 1.5\ A$

MT03, prob. 5



MT03, prob. 6

$$V_{eff} = -N\frac{\Delta(BA\cos\omega t)}{\Delta t} = +NBA\omega \sin\omega t$$

$$V_{eff}^{max} = NBA\omega = 560 \times 0.17\,T \times (12\times10^{-2}m)^2 \times 59\,\frac{rad}{s} = 80.9\,V$$

MT03, prob. 7

$$\frac{V_1}{N_1} = \frac{V_2}{N_2} \qquad \frac{V_2}{1} = \frac{V_1}{20} = \frac{120\,V}{20} \Rightarrow V_2 = 6\,V$$

MT03, prob. 8

$R = 47.1\,\Omega$

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi \times 2575 \times 2.5\times10^{-6}} = 24.74\,\Omega.$$

$$X_L = \omega L = 2\pi \times 2575 \times 4.25\times10^{-3} = 68.7\,\Omega.$$

$$Z = \sqrt{R^2 + (X_c - X_L)^2} = \sqrt{47.1^2 + (24.74 - 68.7)^2} = 64.4\,\Omega$$