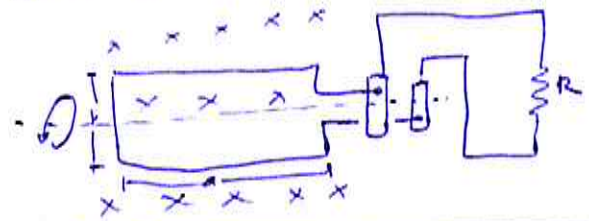
30.11. A rectangular coil of N turns and of length a and width b is Rotated at a frequency f in a uniform magnetic field $\vec{B}$. The coil is connected to co-rotating cylinders, against which metal brushes slide to make contact.

a) Show that the emf induced in the coil is given by

$$\mathcal{E} = 2\pi f N a b \sin(2\pi f t) = \mathcal{E}_0 \sin(2\pi f t)$$

b) What value of Nab gives an emf with $\mathcal{E}_0 = 150\,V$ when the Loop is rotated at 60.0 rev/s in a uniform mg. field of 0.5 T?



$$\cos\theta = \sin(\theta + \tfrac{\pi}{2})$$

a.) $\Phi_B = BA\cos\theta$ ($BA\sin\theta$, $BA\cos(\theta + \frac{\pi}{2})$)

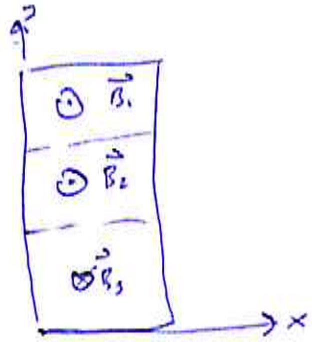
$\theta = \omega t = 2\pi f t$ $\quad A = ab$

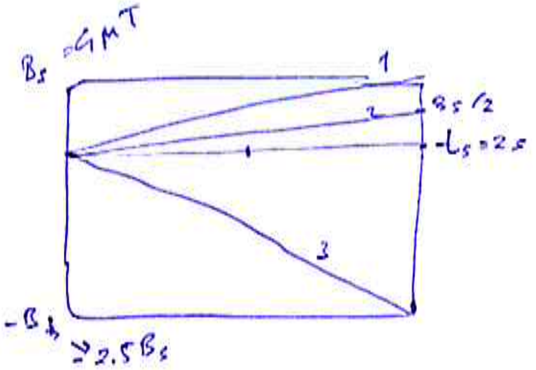
$$\mathcal{E} = -N\frac{d(BA\cos\theta)}{dt} = -NBA\frac{d\cos(2\pi f t)}{dt} = \underbrace{NBab\,2\pi f}_{\mathcal{E}_0}\sin(2\pi f t)$$

$$\mathcal{E}_0 = 2\pi f N a b B$$

b). $f = 60\ rev/s$, $B = 0.5\,T \Rightarrow Nab = \dfrac{150\,V}{2\pi\, 60.0\ rev/s \cdot 0.5\,T} = 0.796\,m^2$

30.18 Rectangular wire with resistance 5 mΩ.
(W = 20cm, H = 30cm)





Magnitude and direction of the current induced in frame?

$B_1 \parallel B_2$ opp. B_3

$$\mathcal{E} = -\sum \frac{d\Phi_B}{dt} = A\left(\frac{dB_1}{dt} + \frac{dB_2}{dt} - \frac{dB_3}{dt}\right)$$

$$= (0.1\,m)(0.2\,m)\,(2\times10^{-6}\,T/s + 1\times10^{-6}\,T/s - 5\times10^{-6}\,T/s)$$

$$= -4\times10^{-8}\,V \qquad |\mathcal{E}|/R = 8\,\mu A$$

dominated by $\vec{B}_3$ → counterclockwise ↺ i

Bravo