3. An infinitely long wire carries a current $i_0 \sin \omega t$ as shown, where i_0 and ω are known. Nearby is a rectangular loop of wire with resistivity ρ which has cross sectional area A and dimensions W and H as shown. Ignoring self inductance find the current that will flow in the loop.

$$\begin{aligned}\oint \vec{B} dl &= \mu_0 I \\ &= \mu_0 I_0 \sin \omega t \\ &= B(2\pi y)\end{aligned}$$

$$B(y) = \frac{\mu_0 i_0 \sin \omega t}{2\pi y}$$

$$\begin{aligned}-\frac{d}{dt}(\phi) &= -\frac{d}{dt}(\oint \vec{B} dl) \\ &= \frac{d}{dt}\frac{\mu_0 i_0 \omega \sin \omega t}{2\pi}\int_D^{D+H}\frac{1}{y}dy \\ &= \frac{\mu_0 i_0 \omega \cos \omega t}{2\pi}\ln\frac{D+H}{D}\end{aligned}$$

$$I = \frac{\mu_0 i_0 \omega W \cos \omega t}{2\pi R}\ln\frac{D+H}{D} \text{ where } R = \frac{2\rho(W+H)}{A}$$

$$I = \frac{\mu_0 i_0 \omega W \cos \omega t \ln \frac{D+H}{D}}{4\pi\rho\frac{(W+H)}{A}} \text{ where } A \text{ is the cross sectional area.}$$