22.47

$\omega_G = 38\,\omega_T$

$R_T = 0.300\ m$

$N_C = 125$ Turns

$A_C = 3.86 \times 10^{-3}\ m^2$

$B = 0.0900\ T$

$v_0 = 0$

$a_B = 0.550\ m/s^2$

$\tau = 5.10\ s$

$\mathcal{E}_0 = ?$

$\mathcal{E}_0 = NAB\,\omega_G \qquad \omega_G = 38\,\omega_T$

$\omega_T = \dfrac{v_T}{R_T} \qquad v_T = \cancel{v_0}^{\,0} + a_B \tau$

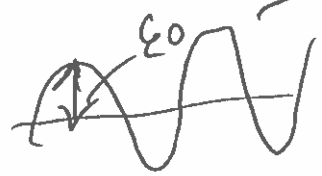
$\omega_T = \dfrac{a_B \tau}{R_T} = \dfrac{(.550\ m/s^2)(5.10\ s)}{(0.300\ m)}$

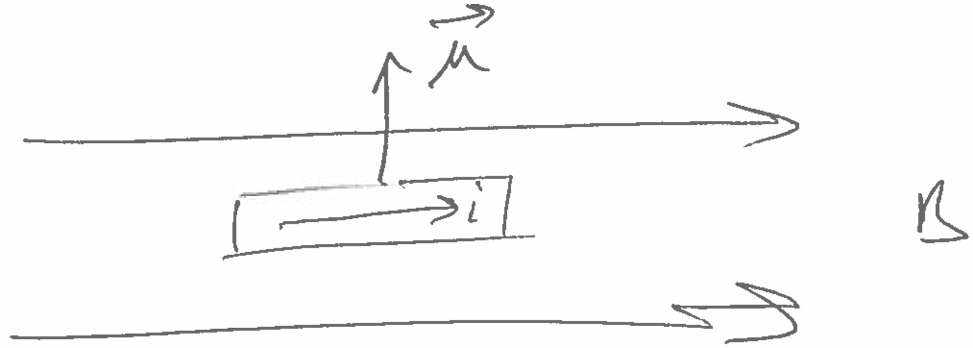
$\omega_T = 9.35\ rad/s$

$\mathcal{E}_0 = NAB\,\omega_G = NAB\,38\,\omega_T$

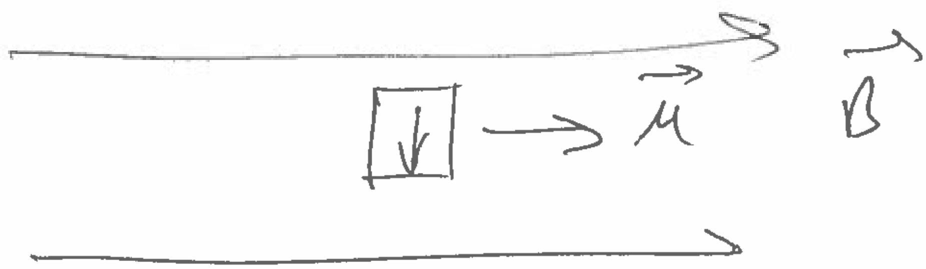
$\mathcal{E}_0 = (125\ \text{Turns})(3.86 \times 10^{-3}\ m^2)(0.0900\ T)\,38\,(9.35\ rad/s)$

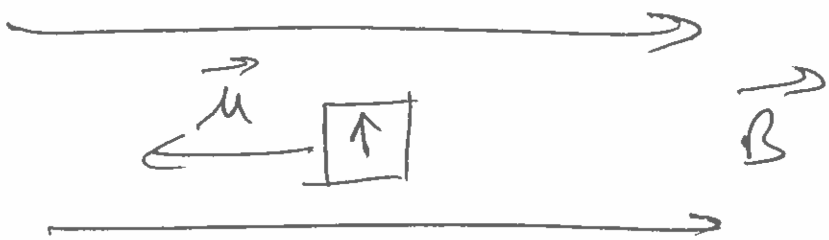
$\boxed{\mathcal{E}_0 = 15.4\ V}$





$\vec{\mu} = Ni\vec{A}$ $\qquad\qquad$ $\vec{\tau} = \vec{\mu} \times \vec{B}$





Spin coil in $\vec{B}$ $\Rightarrow$ Electrical Generator

Add current to coil in $\vec{B}$ $\Rightarrow$ Electric motor

Just as in a Generator a spinning coil in a magnetic field created A counter-torque opposing rotation of the coil.

Causing A coil to spin in a magnetic field of a motor creates A Back Emf ε_{Back} which opposes the emf creating the initial current in the coil.

$$i_0 = \frac{V_{app}}{R_{motor\ Armature}}$$

$$i_{Run} = \frac{V_{app} - \varepsilon_{Back}}{R_{motor}}$$

e9/ $R_{motor} = 23.0\,\Omega$

$V_{APP} = 120\,V$

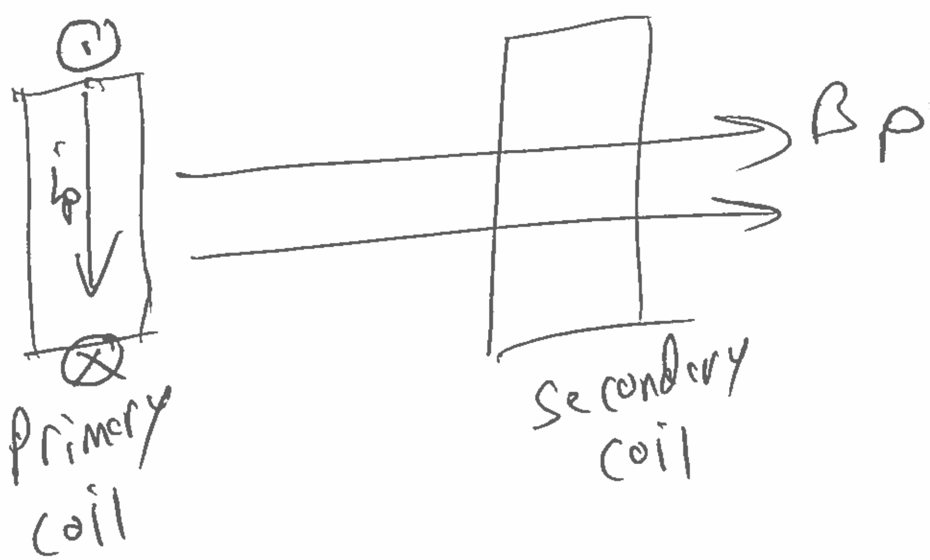
$\varepsilon_{Back} = 62.0\,V$

$$i_0 = \frac{V_{APP}}{R_{motor}} = \frac{120\,V}{23.0\,\Omega} = \underline{5.22\,A}$$

$$i_{Run} = \frac{V_{APP} - \varepsilon_{Back}}{R_{motor}} = \frac{120\,V - 62.0\,V}{23.0\,\Omega}$$

$$i_{Run} = \underline{2.52\,A}$$

Mutual Inductance



i_p is increasing B_p is increasing

$\Phi_{BS} = N(B_p A_S)$ Φ_{BS} is increasing

so i_{ind} in secondary opposes this increase so B_s is created pointing to the left so $i_{induced}$ goes up in secondary

if i_p decreased B_p decreases
Φ_{BS} decreases induced B_s would
No go RIGHT so i_s now goes
down

$$N_s \Phi_s = \underline{M} \, I_p$$

M is
The mutual
inductance

Mutual inductance is a constant that
depends on Geometry and number of
turns of wire that indicates how
The magnetic flux of the secondary
is effected by the current in the
primary.

Inductance has units
of Henries.

$$\mathcal{E}_s = -N_s \frac{\Delta \Phi_B}{\Delta t} = \frac{-\Delta (N_s \Phi_s)}{\Delta t}$$

$$N_s \Phi_s = M I_p$$

$$\boxed{\mathcal{E}_s = -M \frac{\Delta I_p}{\Delta t}}$$

$$\boxed{\mathcal{E}_s = -M \frac{\Delta i_p}{\Delta t}}$$

eg/ A pair of coils which have $M = 20\,H$. Current in primary changes by $3.0\,A/s$. What $\mathcal{E}_s$?

$$\mathcal{E}_s = -(20\,H)(3\,A/s) = \underline{-60\,V}$$

27.53

$$\mathcal{E}_s = 0.46\,V$$

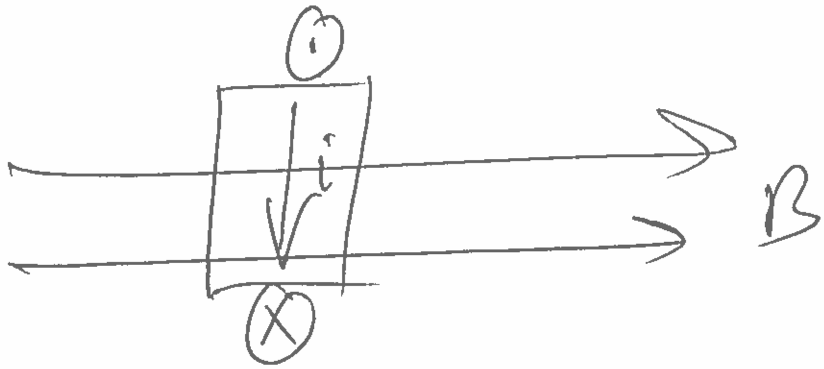
$$\mathcal{E}_s = M_0 \frac{\Delta i}{\Delta t} = 0.46\,V$$

$$\mathcal{E}_{s6} = M_6 \frac{\Delta i}{\Delta t} = 3 M_0 \frac{\Delta i}{\Delta t}$$

$$\mathcal{E}_{s6} = 3\left(\frac{M_0 \Delta i}{\Delta t}\right) = 3(.46\,V)$$

$$\boxed{\mathcal{E}_{s6} = 1.4\,V}$$

Self-inductance



$$\mathcal{E}_{ind} = -L\frac{\Delta i}{\Delta t}$$

L is self-inductance also measured in Henries.

If current increases in an inductor the emf created opposes the increase causing an induced current to go against increasing current

If current decreases in an inductor the emf created opposes the decrease causing an induced current to add to decreasing current.

22-55

Solenoid create a 1.4 mH inductance

$A = 1.2 \times 10^{-3}\ m^2$

$L = 1.4\ mH$

$\ell = 0.052\ m$

$N = ?$

$L_{sol} = \mu_0 n^2 A \ell$ $\qquad n = \frac{N}{\ell}$

$$L = \mu_0 \frac{N^2}{\ell^2} A \ell = \frac{\mu_0 N^2 A}{\ell}$$

$$N^2 = \frac{L \ell}{\mu_0 A}$$

$$N = \sqrt{\frac{L \ell}{\mu_0 A}}$$

$$N = \sqrt{\frac{(1.4 \times 10^{-3}\ H)(.052\ m)}{(4\pi \times 10^{-7}\ \frac{T m}{A})(1.2 \times 10^{-3}\ m^2)}} = 219.7$$

N = 220 turns

$$U_{\substack{stored \\ capacitor}} = \frac{1}{2} C V^2$$

$$U_{\substack{stored \\ inductor}} = \frac{1}{2} L i^2$$

$$U_{\substack{density \\ cap}} = \frac{U_{stored}}{Vol} = \frac{1}{2} k_r \varepsilon_0 E^2$$

$$U_{\substack{density \\ ind}} = \frac{1}{2\mu_0} B^2$$