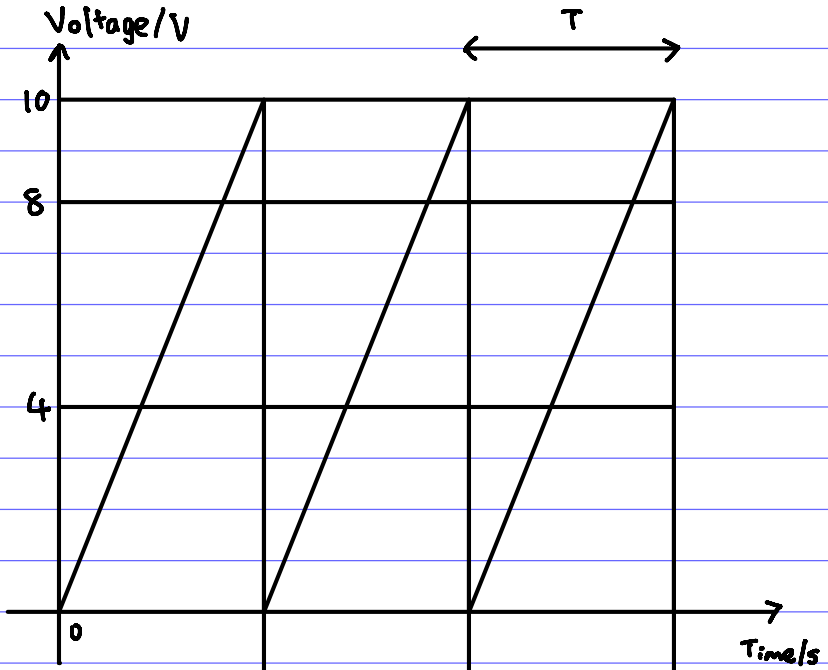
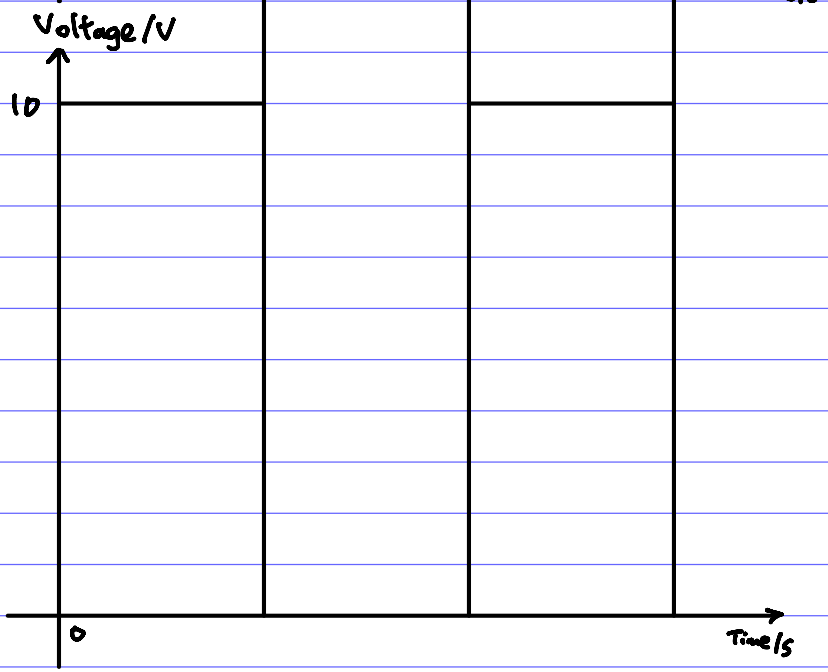
1)





i:) Yes, 100% duty cycle can be achieved.

ii) $P_{max} = \frac{V_{max}^2}{R_{LO}}$

$= \frac{100^2}{10}$

$= 1000W$

$= 1kW$

iii) $\frac{V_c}{V_{max}} = \frac{4}{10} = 0.4$

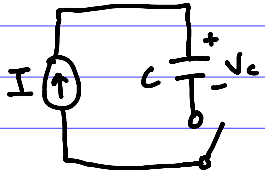
$P_{40\%} = 40\% P_{max}$

$= 0.4 (1 \times 10^3)$

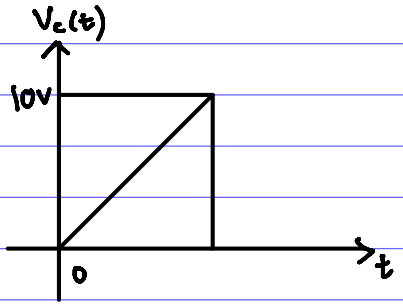
$= 400W$

iv) The control voltage should be doubled to double the power into the load.

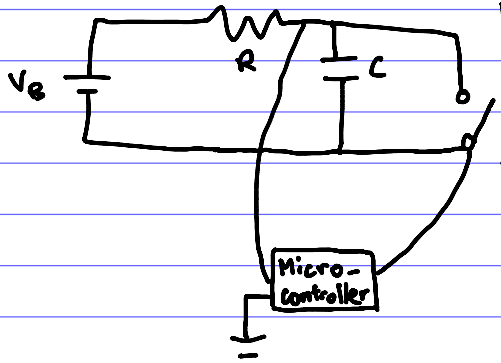
(v) Constant assent

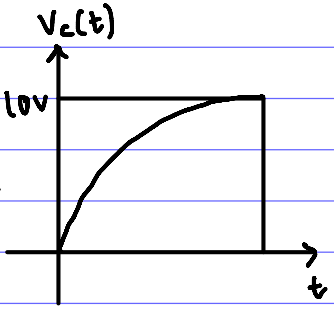


$$I_c = C\frac{dV_c}{dt}$$

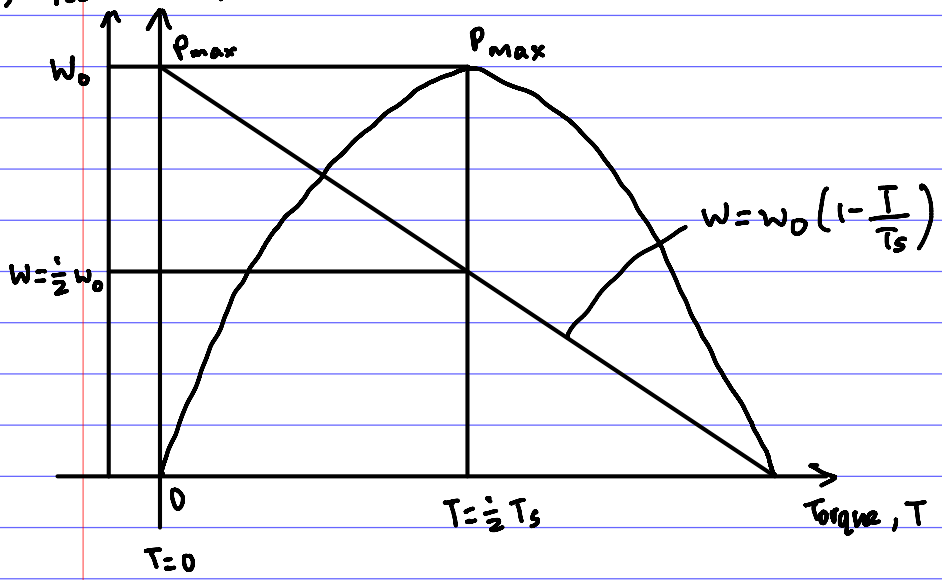


Non-constant assent





2) Speed, w Power, P



No load condition

$P_{out} = wT$

When $T = 0$, $w = w_0$

When $T = T_s$, $w = 0$

i) $P_{out} = w_0 \left(1 - \frac{T}{T_s}\right) T$

$P_{max} = \frac{1}{2} w_0 \left(1 - \frac{\frac{1}{2} T_s}{T_s}\right) T_s$

$= \frac{1}{2} w_0 \left(\frac{1}{2}\right) T_s$

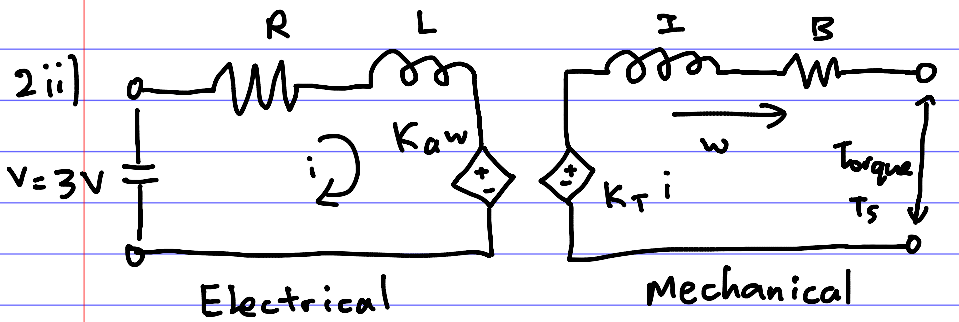
$= \frac{1}{4} w_0 T_s$

$= \frac{1}{4} \left(2\pi \left(\frac{18108}{60}\right)\right)(0.7)$

$= 331.846432 \text{ mW}$

$\approx 332 \text{ mW}$

2 ii)



Assuming the stall condition, $\omega = 0$,

$$R = \frac{V_0}{i}$$

$$= \frac{3V}{422mA}$$

$$= 7.109004739\ \Omega$$

$$\approx 7.11\ \Omega$$

iii) Assuming the stall condition, $\omega = 0$,

$$K_T i = T_S$$

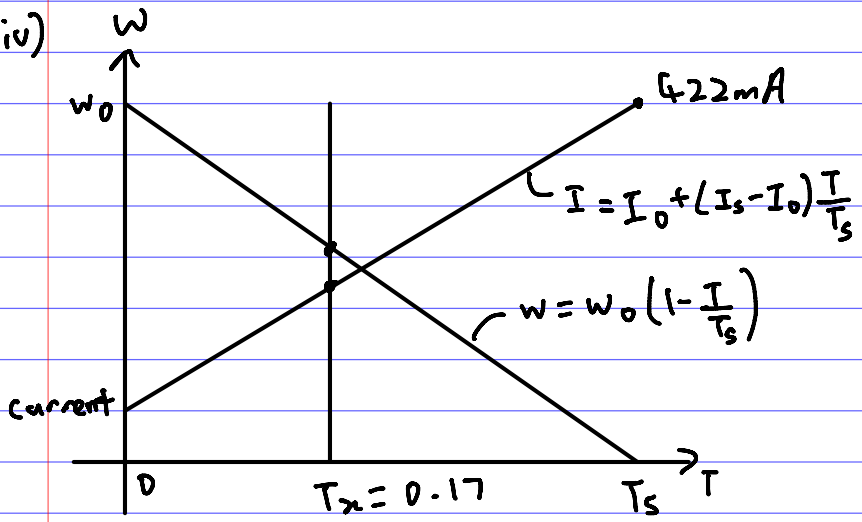
$$K_T = \frac{T_S}{I_S}$$

$$= \frac{0.7}{422}$$

$$= \frac{7}{4220}$$

$$\approx 1.66 mNm/A$$

2 iv)



$$\text{Efficiency} = \frac{P_{out}}{P_{in}}$$

$$= \frac{wT}{VI}$$

When $T_x = 0.17$

$$w = \frac{2\pi}{60}(18108)\left(1 - \frac{0.17}{0.7}\right)$$

$$= 1435.743747$$

$$\approx 1436$$

$$I = 46 + (422 - 46)\left(\frac{0.17}{0.7}\right)$$

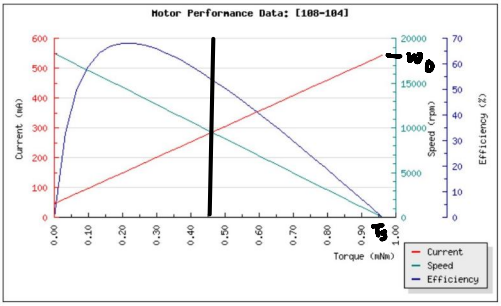
$$= \frac{4806}{35}$$

$$\therefore \text{Efficiency} = \frac{1436(0.17)}{3\left(\frac{4806}{35}\right)}$$

$$= 0.5925007139$$

$$\approx 59\%$$

3)



$T = \frac{1}{2} T_s$

$F = mg$

$= \frac{1}{2} mg$ per wheel

$T = rF$

$= r\left(\frac{1}{2} mg\right) \sin\theta$

$\frac{1}{2} T_s = \frac{1}{2} mgr \sin\theta$

$T_s = mgr \sin\theta$

$0.92 = 20(9.81) r \sin 30°$

$r = 9.378185525 \times 10^{-3} m$

$\approx 9.4 mm$

$v = \omega r$

$= \frac{1}{2} \omega_0 r$

$= \frac{1}{2}\left(\frac{2\pi}{60} \times 18000\right)(9.4)$

$= 8.859291283 ms^{-1}$

$\approx 8.86 ms^{-1}$