Assignment 2 Solutions

Question 1

Since $P=V^2/R$, $R=V^2/P=120*120/600=24$ ohms
P1 = 150W = I^2R ➔ I = 2.5A = V/(Rcoil+R) = 120/(24+R) ➔ R=24 ohms
Range of R should be 0➔ 24Ohms

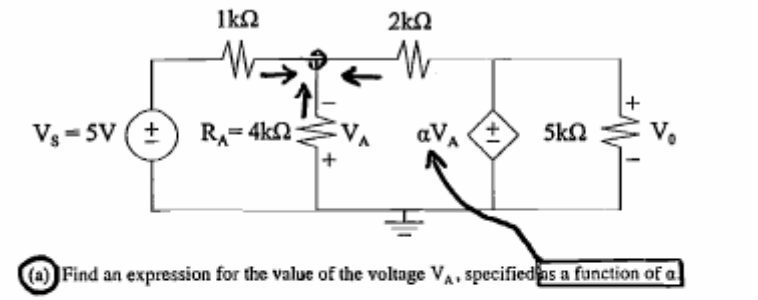
Question 2

Since the battery has negligible open circuit losses, then the model for the battery should be with only series internal resistance (no shunt resistance).

Then,
100 000=10 000 + V^2*5*3600/(Rs +2)
➔ Rs = 18 Ohms

Then, 90 000 = 100/18 * hour * 3600
➔ hour = 90 000 * 18/(100 * 3600) = 4.5

Question 3



(a) Find an expression for the value of the voltage V_A, specified as a function of α.

KCL: $\frac{5+V_A}{1000} + \frac{V_A}{4000} + \frac{(\alpha+1)V_A}{2000} = 0$

$\Rightarrow V_A = -\frac{20}{2\alpha+7}$ //

(b) Find the voltage gain of the circuit, defined by V_o / V_s in the limit as $\alpha \to \infty$.

$$\lim_{\alpha\to\infty}(V_A) = \lim_{\alpha\to\infty}\left(-\frac{20}{2\alpha+7}\right) = 0 \;;$$

$$V_A = 0 \Rightarrow I_2 = I_1 = \frac{5}{1000} = 5mA \;;$$

KVL: $V_o = 5 - 1000 I_1 - 2000 I_2 = -10 V \;;$

$$\Rightarrow \frac{V_o}{V_s} = \frac{-10}{5} = -2 \;//$$

(c) Find the power supplied by the controlled source in the limit as $\alpha \to \infty$.

$$P_{\diamond}^{sup} = (\alpha V_A) I = V_o I = \underbrace{(-2V_s)}_{?} I = -10 I \;;$$

KCL: $I = I_s - I_2 = \frac{V_o}{5000} - 0.005$

$$= \frac{-10}{5000} - 0.005 = -7mA \;;$$

$$\Rightarrow P_{\diamond}^{sup} = (-10)(-0.007) = +70mW \;//$$

Question 4

(a) $I_{IN} = [V_{IN} - \alpha V_R] / (R_{IN} + R) \;;\; V_R = RI_{IN}$

$\rightarrow I_{IN} = [V_{IN} - \alpha(RI_{IN})] / (R_{IN} + R)$

$= V_{IN} / [R_{IN} + (\alpha+1)R]$

(b) $V_{OUT} / V_{IN} = (\alpha V_R) / V_{IN} = \alpha(RI_{IN}) / V_{IN}$

$= \alpha R / [R_{IN} + (\alpha+1)R]$

(c) $\lim_{\substack{\alpha\to\infty \\ R\to\infty}} [V_{OUT} / V_{IN}] = 1$

Question 5

(a) $I_S = 0.01V_0$; $V_S = -300\,(0.01V_0) - V_0 = \underline{-4V_0}$;

$\Rightarrow V_S = \underline{-400}\, I_S \quad \Rightarrow V_S \propto I_S \quad \Rightarrow$ Ohmic device.

(b) $R_{EQ} = V_S / I_S = -400\,\Omega$

(c) $P_{Supplied} = I_S\,(-V_S) = (0.01V_0)(\underline{4V_0}) = 0.04\,V_0^2$;

KCL: $(V_0 - 5)/100 + V_0/200 - 0.01V_0 = 0$;

$\Rightarrow V_0 = 10V$; $\Rightarrow P_{Supplied} = 4W$

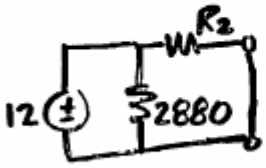
Question 6

O/C :

$P = \frac{V^2}{R_1} = \frac{144}{R_1} = 0.05$

$\Rightarrow R_1 = 2880\,\Omega$ //

S/C :



$P_{R_2} = \frac{V^2}{R_2} = \frac{144}{R_2} = 48 - 0.05$

$\Rightarrow R_2 \approx 3\,\Omega$ //

$(= 3.003\,\Omega)$