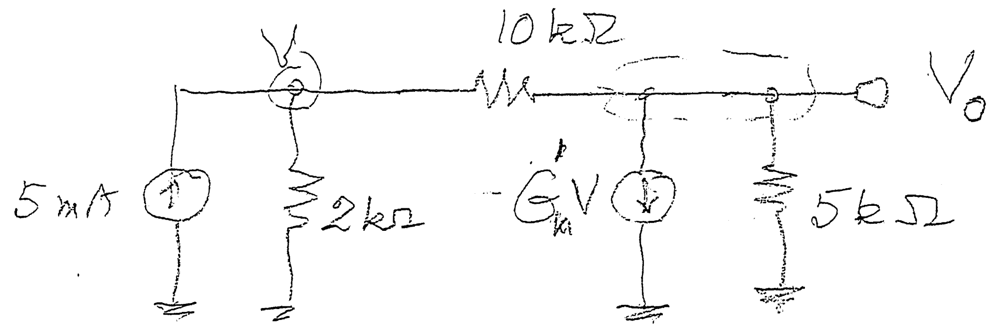
2.



$$G_m = 3\ mS\ ,\ G_m' = -G_m$$

$$\frac{\partial V_o}{\partial G_m} = ? \qquad (5.325 \times 10^4\ V/S)$$

$$5 + 0.1(V_o - V) = 0.5V$$

$$0.1(V - V_o) + G_m V = 0.2 V_o$$

$$V_o = 10[0.6V - 5] = 6V - 50$$

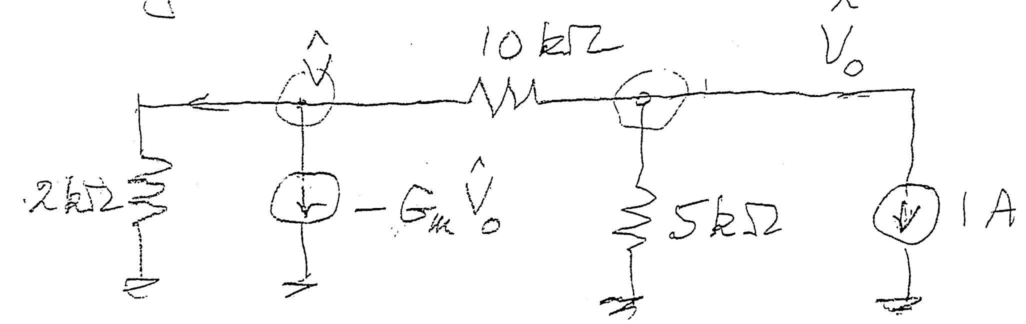
$$V_o = \frac{1}{0.3}[0.1V + G_m V] = (1 + 10G_m)V/3$$

$$6V - 50 = \frac{31}{3} V$$

$$V = \frac{50}{-13/3} = -\frac{150}{13} \cong -11.538\ V$$

$$V_o = -\frac{900}{13} - 50 \cong -119.23\ V$$

adjoint:



$$-\frac{\hat{V}}{2} + 3\hat{V}_o + 0.1(\hat{V}_o - \hat{V}) = 0$$

$$3.1\,\hat{V}_o = 0.6\,\hat{V}$$

$$0.1(\hat{V} - \hat{V}_o) = 10^3 + 0.2\,\hat{V}_o$$

$$0.1\,\hat{V} = 10^3 + 0.3\,\hat{V}_o$$

$$0.1\,\frac{3.1}{0.6}\,\hat{V}_o = 10^3 + 0.3\,\hat{V}_o$$

$$\left(\frac{3.1}{6} - 0.3\right)\hat{V}_o = 10^3$$

$$\frac{1.3}{6}\,\hat{V}_o = 10^3 \,, \quad \hat{V}_o = \frac{6000}{1.3} \simeq 4615.4\ \text{V}$$

$$\frac{\partial V_o}{\partial G_m'} = -V\hat{V}_o = -\frac{150}{1.3} \times \frac{6\times10^4}{13} = -\frac{9\times10^6}{169} \simeq -53.25\times10^3\ \frac{\text{V}}{\text{S}}$$

$$\frac{\partial V_o}{\partial G_m} = +53.25\ \text{V/mS}$$

Check:

$$V_o = 6V - 50 = \left(\frac{1}{3} + \frac{10}{3} G_m\right) V$$

$$\left[6 - \frac{1}{3} - \frac{10}{3} G_m\right] V = 50$$

$$V = \frac{150}{17 - 10G_m} \rightarrow -\frac{150}{13} \checkmark$$

$$\frac{\partial V}{\partial G_m} = 150 \frac{-(-10)}{13^2} = \frac{1500}{169}$$

$$\frac{\partial V_o}{\partial G_m} = 6 \frac{\partial V}{\partial G_m} = \frac{9000}{169} \cong 53.254 \ V/mS$$

$$H(s) = \frac{H(s)+H(-s)}{2} + \frac{H(s)-H(-s)}{2}$$

$$= He(s) + Ho(s), \quad \begin{cases} He(s) = He(-s) & \text{even} \\ Ho(-s) = -Ho(s) & \text{odd} \end{cases}$$

~~12-39~~ 3 (easy)

Since $H(s)$ is real rational, it can be written separately in even part and odd part

$$H(s) = He(s) + Ho(s) = Pe(s) + s\,Qe(s)$$

$$= R_1(s^2) + s\,R_2(s^2)$$

For $s = j\omega$

$$H(j\omega) = R_1(-\omega^2) + j\omega\,R_2(-\omega^2)$$

$$\beta(\omega) = \tan^{-1}\frac{\omega R_2(-\omega^2)}{R_1(-\omega^2)} = \tan^{-1} U(\omega)$$

$U(\omega) = \dfrac{\omega R_2(-\omega^2)}{R_1(-\omega^2)}$ is an odd function.

Also $\theta(x) = \tan^{-1} x$ is an odd function.

$\beta(\omega)$ is obviously an odd function;

i.e. $\beta(-\omega) = -\beta(\omega)$