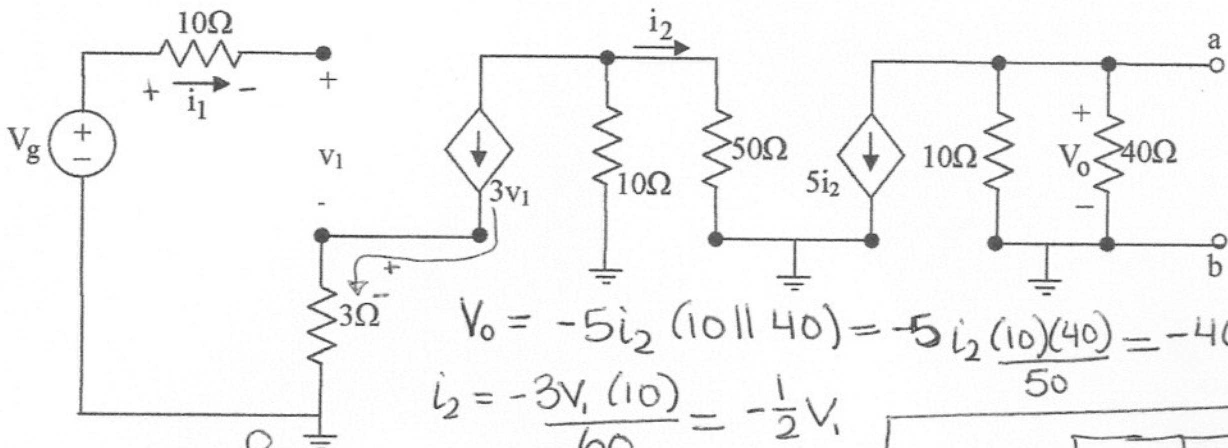
ECE2280 **Homework #1** **Spring 2007**

Homework #1:

1. Given V_g=10mV, find V_o. Find the Thevenin equivalent between terminals a-b. (Note: $v_1 \neq V_g$)



$V_o = -5i_2 (10 \| 40) = -5 i_2 \frac{(10)(40)}{50} = -40 i_2$

$i_2 = -\frac{3V_1 (10)}{60} = -\frac{1}{2} V_1$

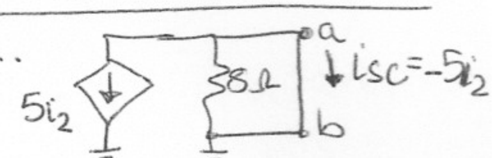
$+V_g - 10\cancel{i_1} - V_1 - 3V_1 (3) = 0$

$10V_1 = V_g$

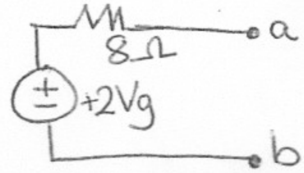
$V_1 = V_g/10$

$\therefore V_o = -40(-\frac{1}{2})(\frac{V_g}{10}) = +2V_g = \boxed{+20mV}$

$V_o = V_{Th}$

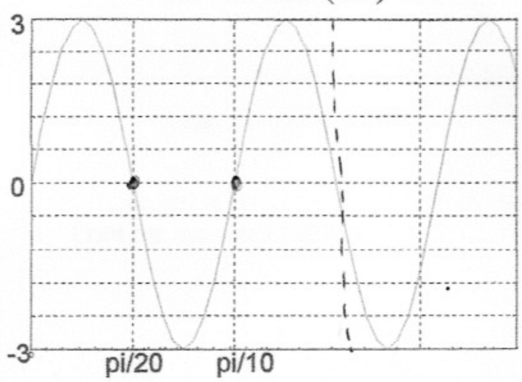


$R_{Th} = \frac{V_{Th}}{i_{sc}} = \frac{-40i_2}{-5i_2} = \boxed{8\Omega}$

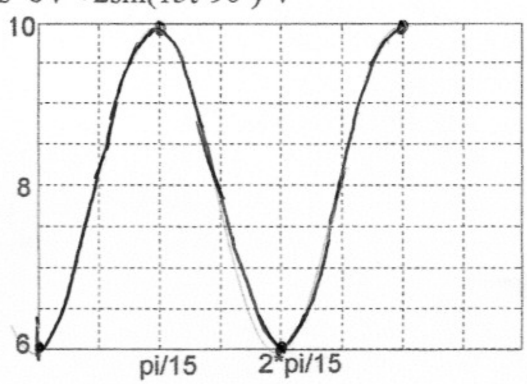


2. Sketch the following waveforms. Identify the dc component of the waveform and the ac component of the waveform.

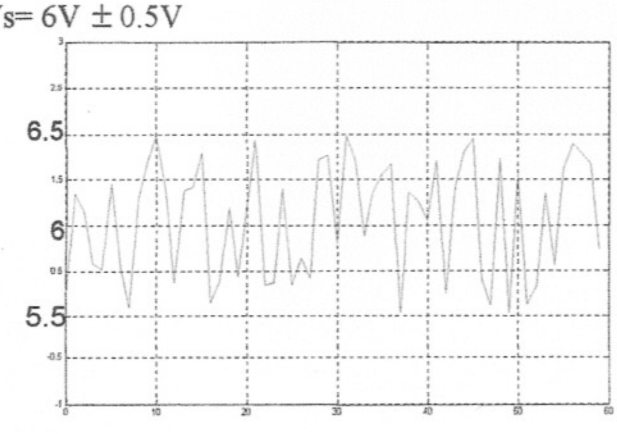
a. Vs=3sin(20t) V



b. Vs=8V +2sin(15t-90°) V

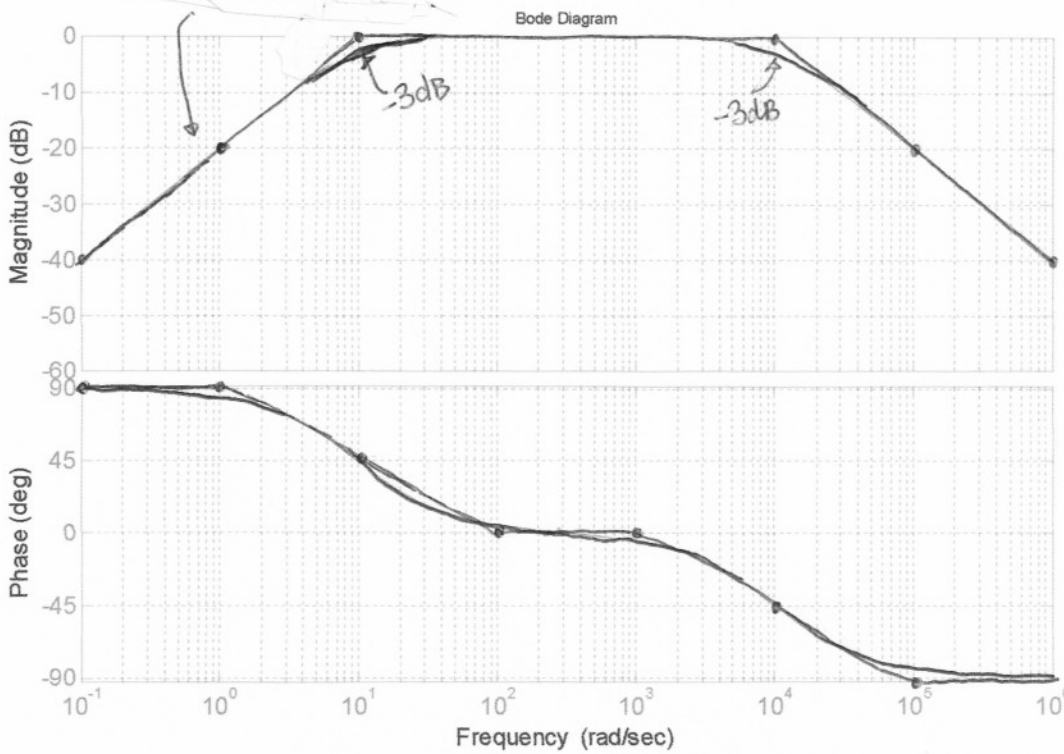


c. Vs= 6V ± 0.5V



4. a. $H(s) = \dfrac{10{,}000s}{(s+10000)(s+10)} = \dfrac{10{,}000\,s}{10{,}000 \cdot 10 \cdot \left(\frac{s}{10{,}000}+1\right)\left(\frac{s}{10}+1\right)} \Rightarrow$ @ $\omega = 1 \Rightarrow \dfrac{10K \cdot (1)}{10K \cdot 10 \left(\sqrt{\left(\frac{1}{10{,}000}\right)^2+1^2}\right)\left(\sqrt{\left(\frac{1}{10}\right)^2+1^2}\right)}$

$\approx .1\, V/V = -20dB$



critical freq:

10 → -20dB/dec. -45° slope between 1 to 100

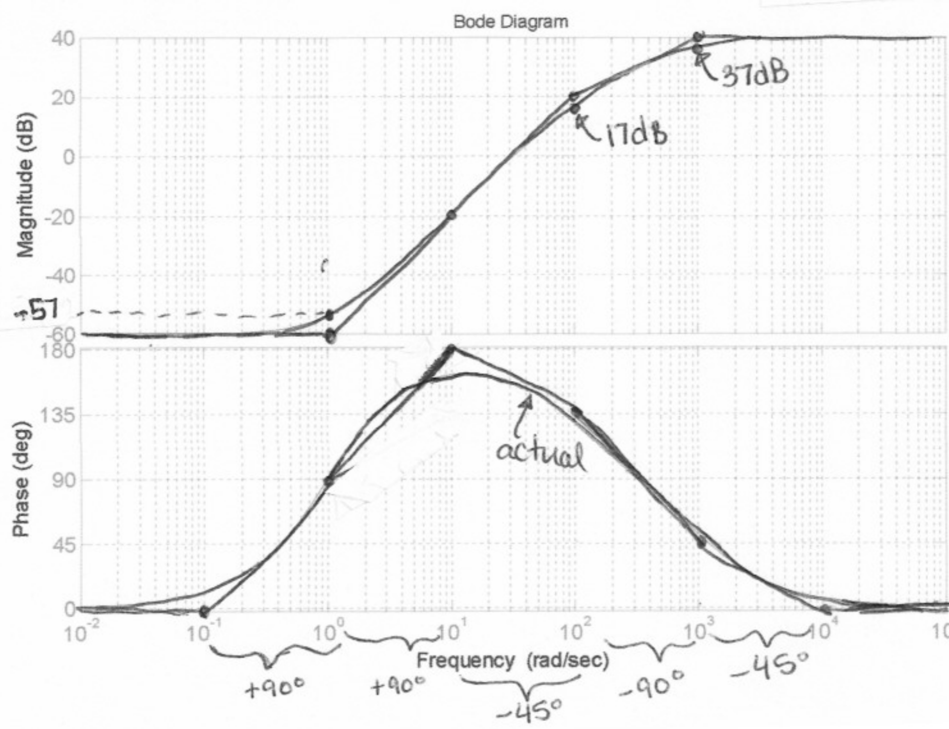
10,000 → -20dB/dec. -45° slope between 1K → 100K

starting ⇒ -20dB at ω=1

1(90°) = 90° to start

4. b. $H(s) = \dfrac{100(s+1)^2}{(s+100)(s+1000)} = \dfrac{100(s+1)^2}{100 \cdot 1{,}000\left(\frac{s}{100}+1\right)\left(\frac{s}{1K}+1\right)} \Rightarrow$ at $\omega = .1 \Rightarrow \dfrac{100\left(\sqrt{.1^2+1^2}\right)^2}{100 \cdot 1{,}000\left(\sqrt{\left(\frac{.1}{100}\right)^2+1^2}\right)\left(\sqrt{\left(\frac{.1}{1K}\right)^2+1^2}\right)}$

$= -60dB$



critical freq.:

2 at 1 ⇒ +40dB/dec.

2×(+45°) slope between ω=.1 to ω=10

90°

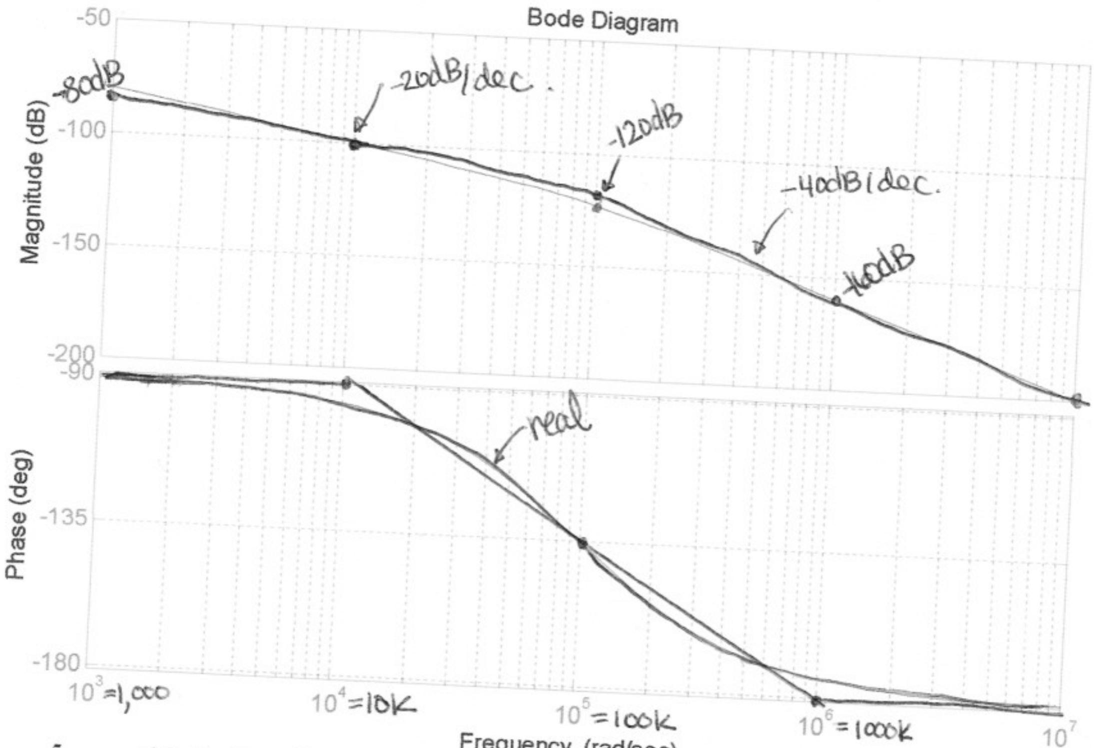
100 ⇒ -20dB/dec. -45° slope between ω=10 to ω=1K

1K ⇒ -20dB/dec. -45° slope between ω=100 to ω=10K

$$H(s) = \frac{10000}{s(s+100{,}000)}$$

4. c.

$$@\ \omega = 10^3 \Rightarrow \frac{10{,}000}{100k \cdot 10^3\left(\sqrt{\left(\frac{10^3}{100k}\right)^2 + 1^2}\right)} = -80\text{dB}$$



frequencies ⇒
at origin ⇒
-20dB/dec.
-90°

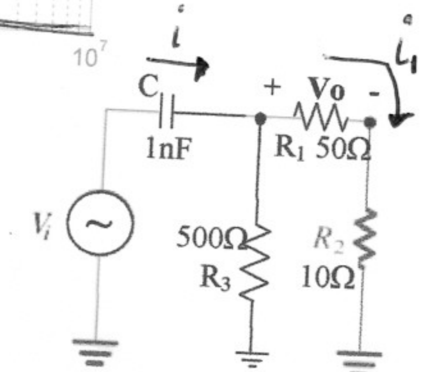
100k ⇒ -20dB/dec.
-45° slope between
ω = 10K to ω = 1000K

5. (a) Analyze the following circuit to find the transfer function Vo/Vi.

(i) Solve the circuit symbolically first (with R_1, R_2, R_3, C).

(ii) Find Vo/Vi with values.

(b) Sketch the transfer function using a straight-line approximation procedure.



$$V_o = i_1 R_1$$

$$i_1 = \frac{i \cdot R_3}{R_1 + R_2 + R_3}$$

$$i = \frac{V_i}{\frac{1}{CS} + R_3 \| (R_1 + R_2)} \cdot \frac{(CS)}{(C \cdot S)} = \frac{V_i \cdot C \cdot S}{1 + [R_3 \| (R_1 + R_2)]CS}$$

$$\therefore \boxed{\frac{V_o}{V_i} = \frac{\left[\frac{C \cdot S \cdot R_1 R_3}{R_1 + R_2 + R_3}\right]}{1 + [R_3 \| (R_1 + R_2)]CS} \cong \frac{8.9\times10^{-10} S}{(1 + 5.4\times10^{-8} S)}}$$

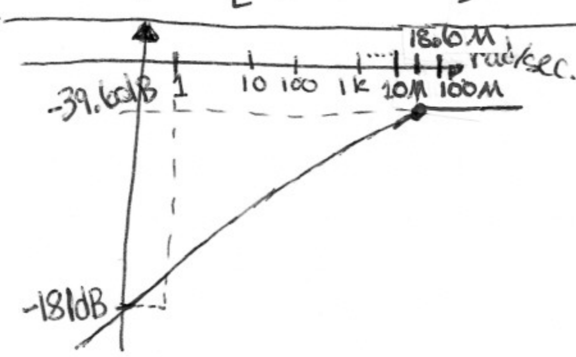
$@\ \omega = 1 \Rightarrow$

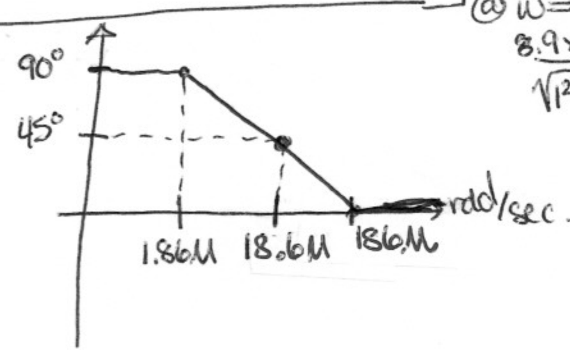
$$\frac{8.9\times10^{-10}(\sqrt{1^2})}{|(1 + 5.4\times10^{-8}\cdot 1)| \approx 1}$$

$= 8.9\times10^{-10}$ V/V $\cong -181$dB

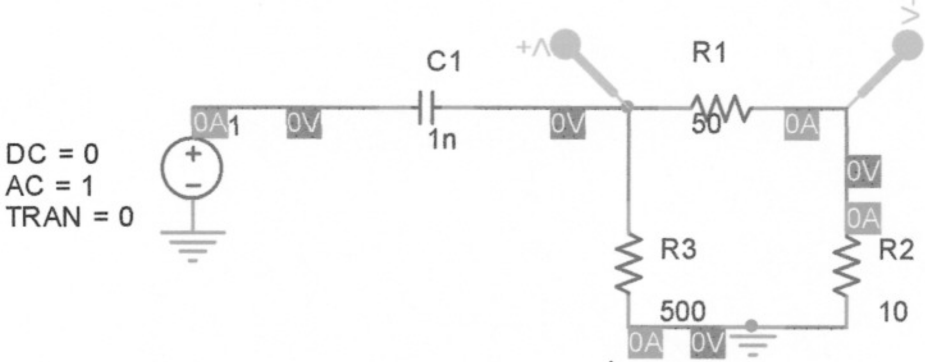
$@\ \omega = 18.6M \Rightarrow$

$$\frac{8.9\times10^{-10}(18.6M)}{\sqrt{1^2 + 5.4\times10^{-8}(18.6M)}} = 0.012$$

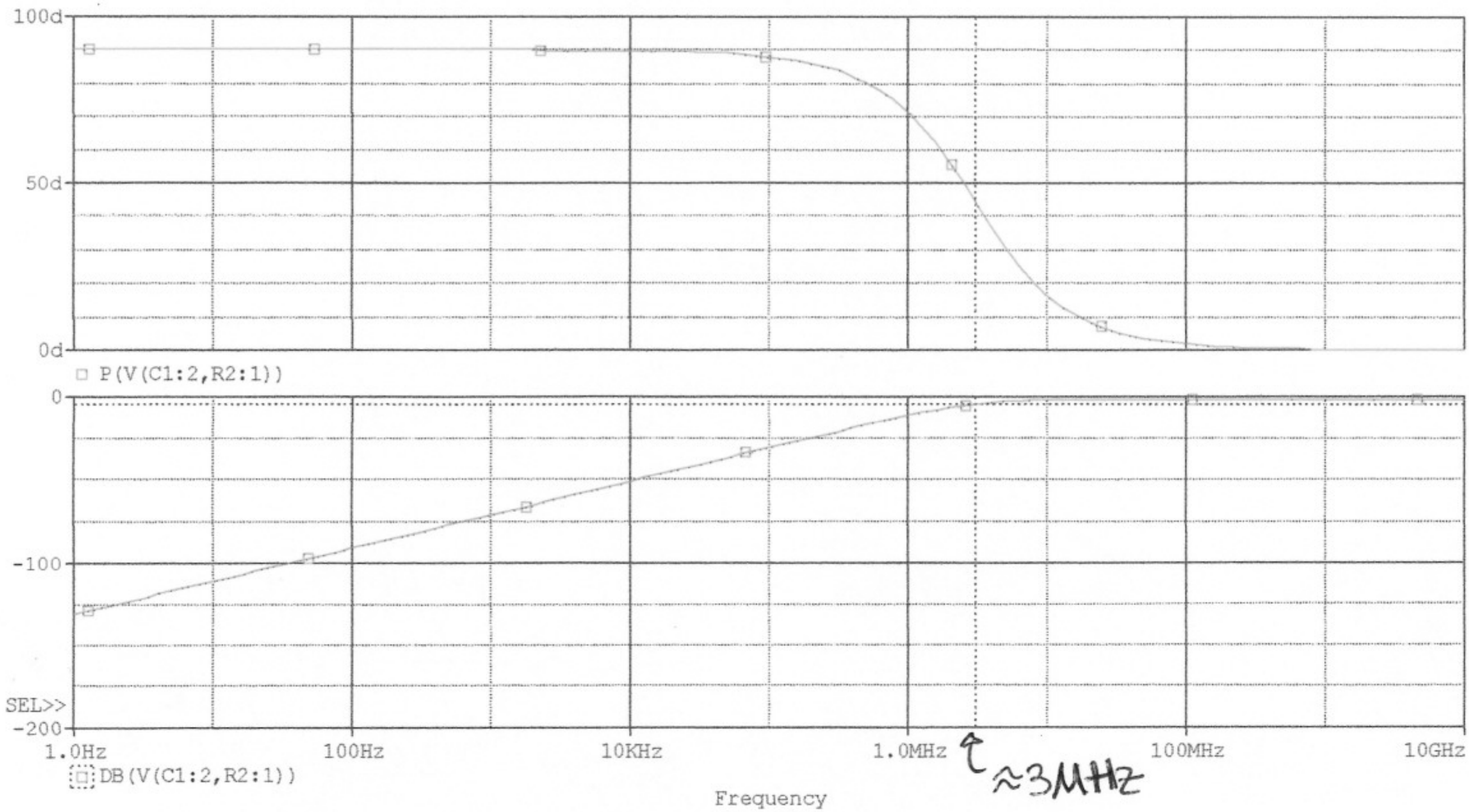




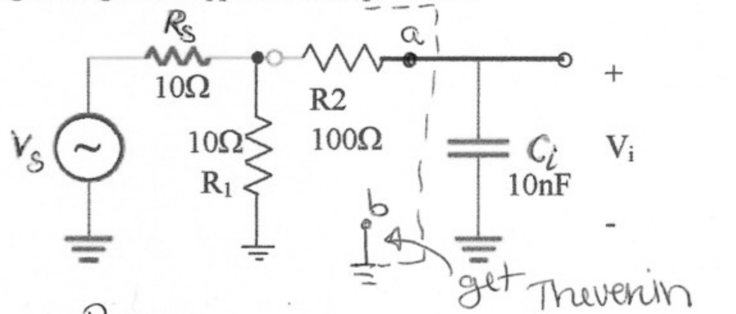
6. Use PSPICE to simulate the circuit of #5 and determine the Bode Plots.
Print out the schematic, along with the plots. Compare to (b)

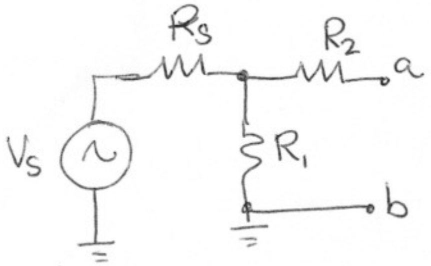


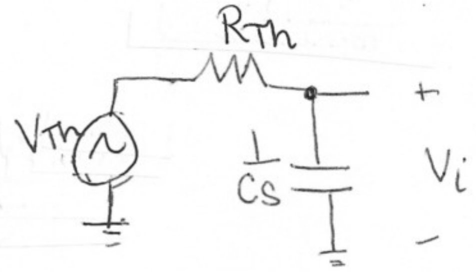
3dB point is approximately 3Meg Hz. ≅ 18.7M rad/sec.



7. Analyze the following circuit to find the transfer function Vi/Vs. Solve the circuit symbolically first (with R_S, R_i, R_1 & R_2, C_i) and then plug in their values. Sketch the transfer function using a straight-line approximation procedure.







$$V_{Th} = \frac{V_S(R_1)}{R_1 + R_S}$$

$$R_{Th} = R_2 + \frac{R_1 R_S}{R_1 + R_S} \quad \text{OR}$$

$$= R_2 + (R_1 \| R_S)$$

$$V_i = \left[\frac{V_{Th} \cdot \frac{1}{Cs}}{R_{Th} + \frac{1}{Cs}}\right]\left(\frac{Cs}{Cs}\right) = \frac{V_{Th}}{(R_{Th} C s + 1)}$$

$$\frac{V_i}{V_S} = \frac{\frac{V_S R_1}{R_1 + R_S}}{\left[(R_2 + R_1 \| R_S) C \cdot s + 1\right]} = \boxed{\frac{R_1}{(R_1 + R_S)\left[(R_2 + R_1 \| R_S) \cdot C \cdot s + 1\right]}}$$

$$\frac{V_i}{V_S} = \frac{10}{20\left[(100 + 5) \cdot 10\text{nF} \cdot s + 1\right]} = \boxed{\frac{0.5}{(1.05 \times 10^{-6} s + 1)}}$$