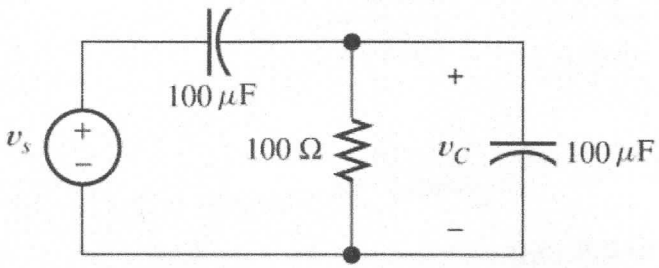
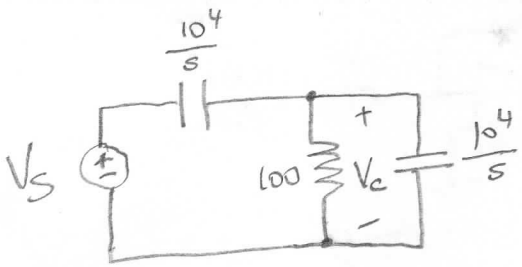
Student Name: _____

EE201 Final Exam Feb. 4, 2018

(35 pts) 1) Determine the output voltage $v_c(t)$ in the following circuit if the input voltage is unit step signal, $v_s(t) = u(t)$. (Hint: Use Laplace transform to find $V_c(s)$ first.)

Answer 1:





$$\frac{V_c}{V_s} = \frac{100 \,//\, \frac{10^4}{s}}{(100 \,//\, \frac{10^4}{s}) + \frac{10^4}{s}} = \frac{\frac{1}{10^{-2} + 10^{-4}s}}{\frac{1}{10^{-2}+10^{-4}s} + \frac{10^4}{s}} = \frac{1}{1 + \frac{s+100}{s}}$$

$$= \frac{s}{2s+100}$$

$$V_s = \frac{1}{s} \Rightarrow V_c = \frac{1}{2s+100} = \frac{0.5}{s+50}$$

$$\Rightarrow v_c(t) = 0.5\, e^{-50t}\, u(t)$$

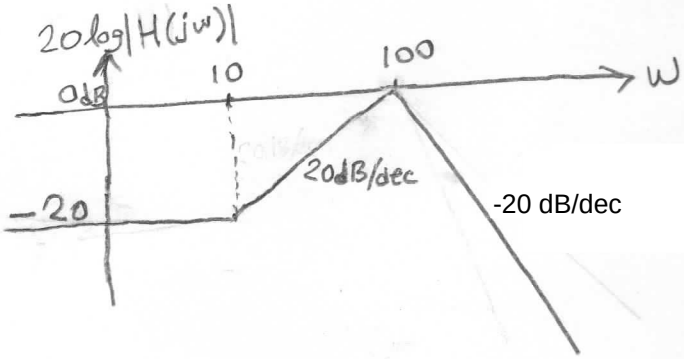
Note: Total time allowed is 90 min. Please show all your work and write legibly.

(30 pts) 2) Sketch the magnitude Bode plot for $H(s) = \frac{V_O(s)}{V_I(s)} = \frac{100(s+10)}{(s+100)^2}$.

Please show all important aspects and units. Calculate the actual dB gains (20log|H(jω)|) for ω=10 and ω=100.

Answer 2:

$$\Rightarrow \quad H(s) = \frac{0.1\,(s/10+1)}{(s/100+1)^2}$$



$$|H(j\omega)| = \frac{100\sqrt{\omega^2+100}}{(\omega^2+10000)}$$

$$\Rightarrow \quad 20\log|H(j10)| = 40 + 10\log(100\cdot 2) - 20\log(100+10000)$$

$$\cong -17\ dB \quad (3dB \text{ above } -20dB \text{ level})$$

$$\Rightarrow 20\log|H(j100)| = 40 + 10\log(10000+100) - 20\log(10000\cdot 2)$$

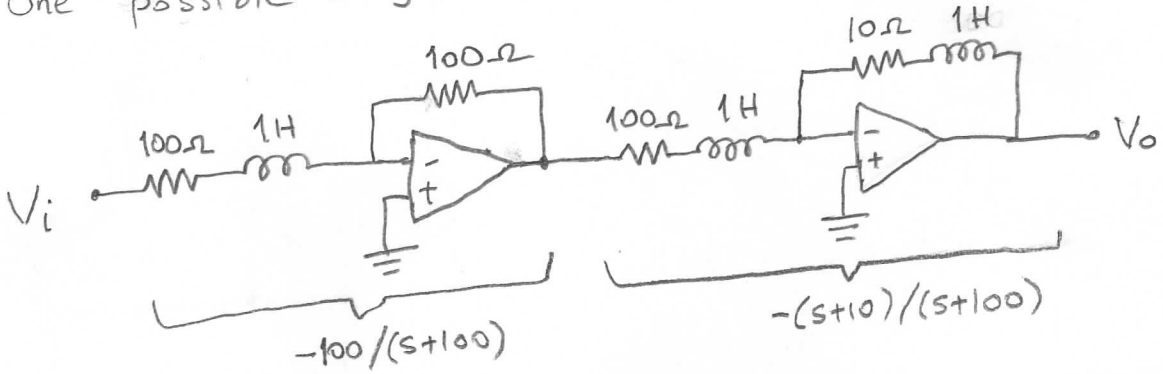
$$\cong -6dB \quad (6dB \text{ below } 0dB \text{ level})$$

(35 pts) 3) Design a circuit with a transfer function $H(s) = \frac{V_O(s)}{V_I(s)} = \frac{100(s+10)}{(s+100)^2}$.

Answer 3:

$$H(s) = \frac{100}{s+100} \cdot \frac{s+10}{s+100}$$

One possible design is to use inverting amplifiers:



Or:

$$H(s) = \frac{100/s}{1+100/s} \cdot \frac{1+10/s}{1+100/s}$$

$$\Rightarrow H(s) = \frac{\frac{1}{10^{-7}s}}{10^5 + \frac{1}{10^7 s}} \cdot \frac{10^5 + \frac{1}{10^{-6}s}}{10^5 + \frac{1}{10^{-7}s}}$$

Here we have a more practical implementation: