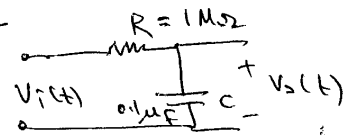
EE322 Fall 08 Homework Problem Set 35 (PS35)

Be sure to show your work.

1. Text, Problem 12-11. Sketch the asymptotic Bode magnitudes only.
2. Text, Problem 12-36.

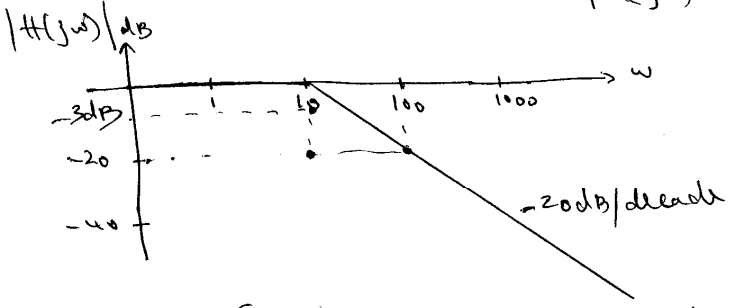
12.11

(a)



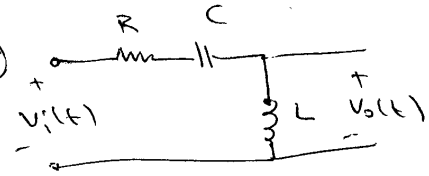
$$H(j\omega) = \frac{1/j\omega C}{R + \frac{1}{j\omega C}} = \frac{1}{1 + (j\omega)RC}$$

$$= \frac{1}{1 + (j\omega)\,10^6 \cdot 10^{-7}} = \frac{1}{1 + \frac{j\omega}{10}}$$



$$|H(j\omega)|_{dB} = 0 - 10\log\left[1 + \left(\frac{\omega}{10}\right)^2\right]$$

(b)



$$H(j\omega) = \frac{j\omega L}{R + \frac{1}{j\omega C} + j\omega L} = \frac{(j\omega)^2 LC}{(j\omega)^2 LC + (j\omega)RC + 1}$$

with $\omega_0^2 = \frac{1}{LC}$, rewrite the denominator in the form $\left(j\frac{\omega}{\omega_0}\right)^2 + 2k\left(\frac{j\omega}{\omega_0}\right) + 1$ where $k = \frac{R}{2}\sqrt{\frac{C}{L}}$

$$H(j\omega) = \left(j\frac{\omega}{\omega_0}\right)^2 \Big/ \left[\left(\frac{j\omega}{\omega_0}\right)^2 + R\sqrt{\frac{C}{L}}\cdot\left(\frac{j\omega}{\omega_0}\right) + 1\right]$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-3}\cdot 10^{-6}}} = 3.16\cdot 10^4 \text{ rad/s},$$

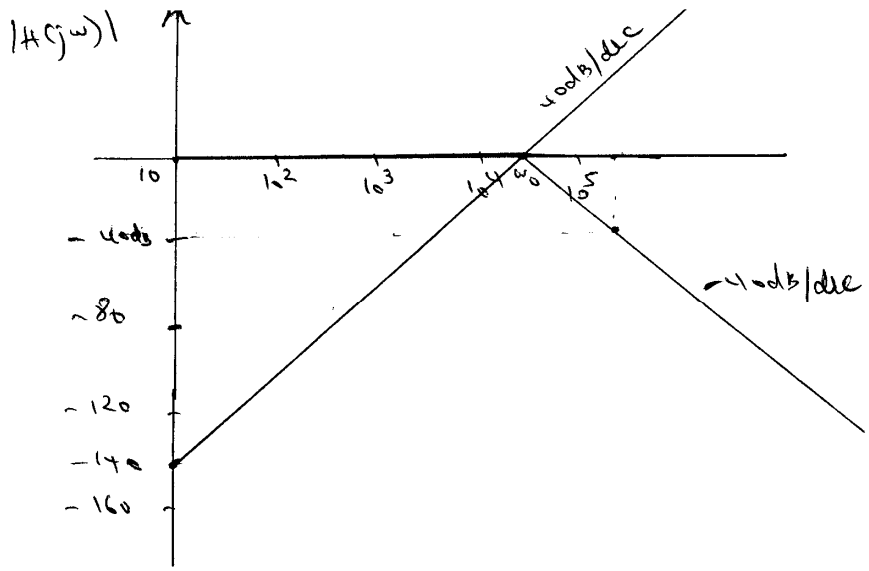
$$20\log|H(j\omega)| = \underbrace{40\log\left(\frac{\omega}{\omega_0}\right)}_{\text{straight line with slope } 40\text{ dB/decade}} - \underbrace{20\log\left|\left(\frac{j\omega}{\omega_0}\right)^2 + R\sqrt{\frac{L}{C}}\left(\frac{j\omega}{\omega_0}\right) + 1\right|}_{\text{for } \omega > \omega_0 \to \text{ straight line with slope of } -40\text{ dB/decade}}$$

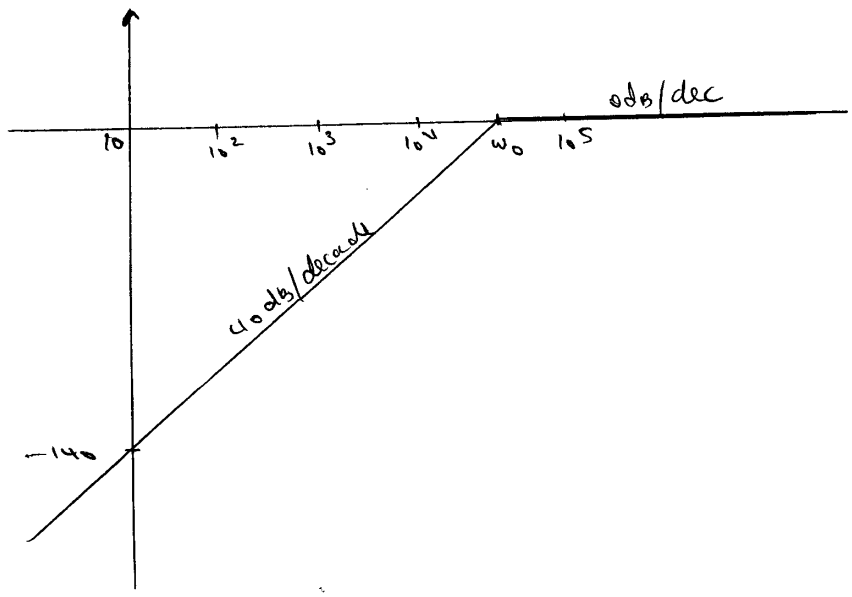
for $\omega < \omega_0 \to 0$ dB

at $\omega = 10 \Rightarrow$

$40\log\left(\frac{\omega}{\omega_0}\right) \approx -140$ dB

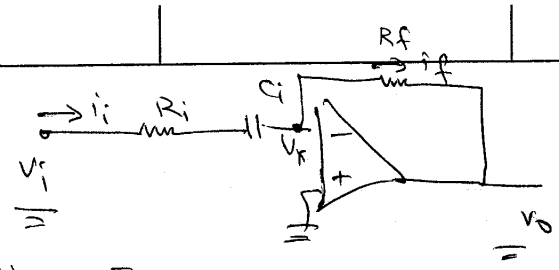
at $\omega = \omega_0 \Rightarrow 40\log\left(\frac{\omega}{\omega_0}\right) = 0$ dB


|H(jω)|
40db/dec
10
10^2
10^3
10^4
ω0
10^5
-40db
-80
-120
-140
-160
-40db/dec


0db/dec
10
10^2
10^3
10^4
ω0
10^5
40db/decade
-140

12.36

(a)



Node Equation $I_i = I_f$

$$\frac{V_i - V_x}{R_i + \frac{1}{j\omega C_i}} = \frac{V_x - V_o}{R_f}$$

$$V_x = V_- \simeq V_+ = 0 \quad \Rightarrow \quad \frac{V_o}{V_i} = \frac{-R_f}{R_i + \frac{1}{j\omega C_i}} = \frac{-R_f C_i (j\omega)}{1 + (j\omega) R_i C_i}$$

$$\omega_c = \frac{1}{R_i C_i} \quad \Rightarrow \quad H(j\omega) = \frac{-R_f C_i (j\omega)}{1 + \frac{j\omega}{\omega_c}}$$

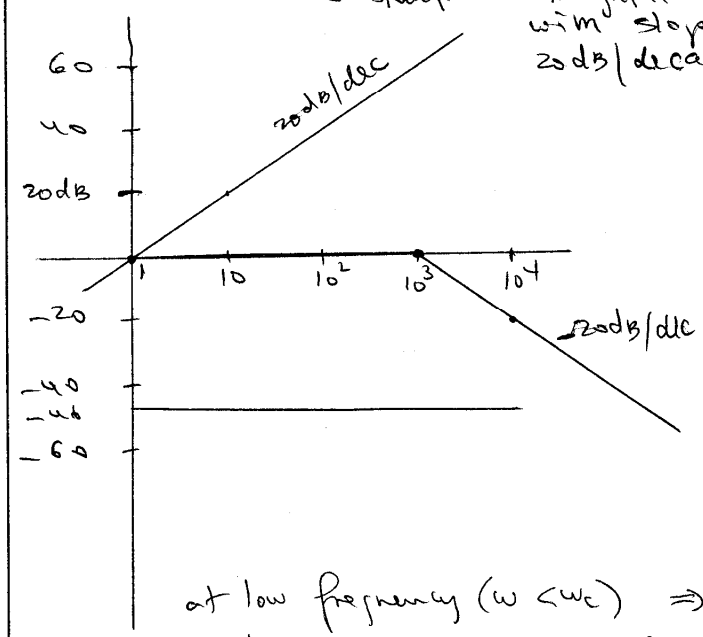
$$\omega_c = \frac{1}{10^3 \cdot 10^{-6}} = 10^3 \text{ rad/s}.$$

$$R_f C_i = 5 \cdot 10^3 \cdot 10^{-6} = 5 \cdot 10^{-3}$$

(b)

$$20 \log |H(j\omega)| = 20 \log R_f C_i + 20 \log \omega - 10 \log \left(1 + \left(\frac{\omega}{\omega_c}\right)^2\right)$$

$$= \underbrace{-46 \text{ dB}}_{\text{constant}} + \underbrace{20 \log \omega}_{\substack{\text{straight line} \\ \text{with slope} \\ 20 \text{dB/decade}}} - \underbrace{10 \log \left(1 + \left(\frac{\omega}{\omega_c}\right)^2\right)}_{\substack{\omega < \omega_c \Rightarrow 0 \text{dB} \\ \omega > \omega_c \Rightarrow \text{straight} \\ \text{line with slope} \\ -40 \text{dB/dec}}}$$



at low frequency ($\omega < \omega_c$) $\Rightarrow$ slope = 20dB/decade

at high frequency ($\omega > \omega_c$) $\Rightarrow$ slope = 0dB/decade

TOPS. 35502