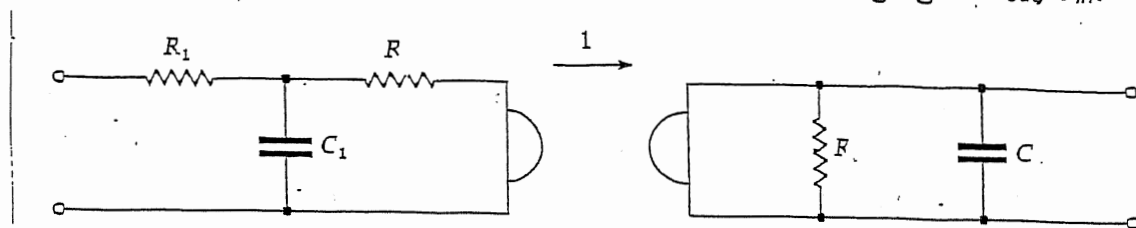


FINAL EXAMINATION

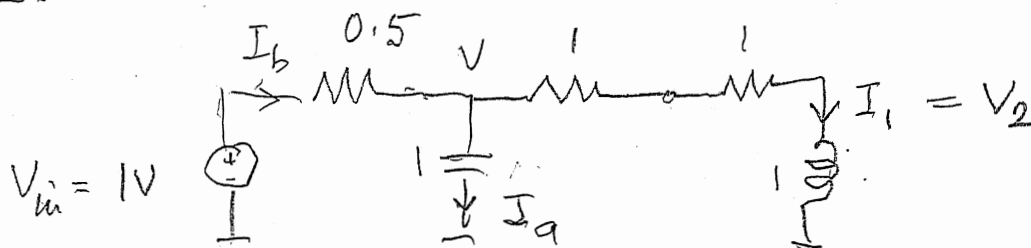
December 5, 2018

2:00 – 3:50 pm

1. In the circuit shown, $R_1 = 0.5$, $R = C = C_1 = 1$. Find the voltage gain V_{out}/V_{in} .



1.



Bashkow's method:

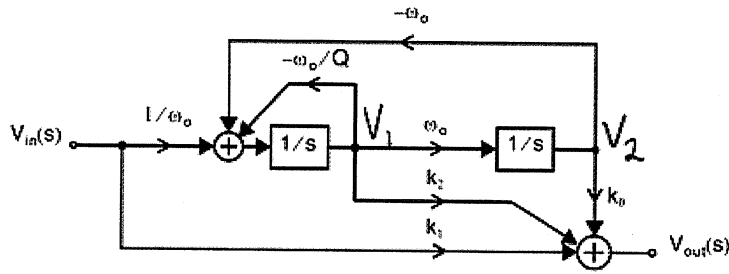
$$\hat{I}_1 = 1A, \quad \hat{V} = 2 + s, \quad \hat{I}_a = s^2 + 2s$$

$$\hat{I}_b = s^2 + 2s + 1, \quad \hat{V}_{in} = \hat{V} + 0.5\hat{I}_b = 0.5s^2 + 2s + 2.5$$

$$\hat{I}_1 = \frac{1}{\hat{V}_{in}} = \frac{2}{s^2 + 4s + 5} = V_2 = V_{out}/V_{in}$$

Q12.2)

3,



$$V_1 = \frac{1}{s} \left[\frac{1}{\omega_0} V_{in} - \omega_0 V_2 - \frac{\omega_0}{Q} V_1 \right] \quad (1)$$

$$V_2 = \frac{1}{s} \omega_0 V_1 \quad (2)$$

Sub. (2) into (1):

$$V_1 = \frac{1}{s} \left[\frac{1}{\omega_0} V_{in} - \omega_0 \left(\frac{\omega_0}{s} + \frac{1}{Q} \right) V_1 \right]$$

$$\Rightarrow s^2 V_1 = \frac{s}{\omega_0} V_{in} - \omega_0 \left(\omega_0 + \frac{s}{Q} \right) V_1$$

$$\Rightarrow V_1 = \frac{s/\omega_0}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2} \cdot V_{in} \quad (3)$$

$$V_{out} = k_1 V_{in} + k_2 V_1 + k_0 V_2 \quad (4)$$

Sub (2) & (3) into (4):

$$V_{out} = \frac{\left[k_1 \left(s^2 + \frac{\omega_0}{Q} s + \omega_0^2 \right) + k_2 \frac{1}{\omega_0} s + k_0 \right] \cdot V_{in}}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}$$

$$\Rightarrow \frac{V_{out}}{V_{in}} = \frac{k_1 s^2 + \left(k_1 \frac{\omega_0}{Q} + k_2 \frac{1}{\omega_0} \right) s + k_0 + k_1 \omega_0^2}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}$$

for axis zero for $k_1/k_2 = -\frac{Q}{\omega_0^2}$

Q 12.3)

