ECE 5020 HW1

1. $Z_{RL} = R_L \quad Z_{CL} = \frac{1}{sC_L} \quad Z_{RCL} = \frac{R_L \cdot \frac{1}{sC_L}}{R_L + \frac{1}{sC_L}} = \frac{R_L}{1+sR_LC_L}$

$Z_{RS} = R_S$

$Z_{network} = R_S + \frac{R_L}{1+sR_LC_L} \qquad T(s) = \frac{V_o(s)}{V_s(s)} = \frac{Z_{RCL}}{Z_{network}} = \frac{\frac{R_L}{1+sR_LC_L}}{R_S + \frac{R_L}{1+sR_LC_L}} = \frac{R_L}{R_L(sR_SC_L+1)+R_S}$

$$\boxed{T(s) = \frac{R_L}{sR_SR_LC_L + R_L + R_S}}$$

$$\tau = RC = R_S \| R_L \cdot C_L = \boxed{\frac{R_S \cdot R_L}{R_S + R_L} \cdot C_L = \tau}$$

$V_c(0) = 0V \qquad V_o(s) = T(s) \cdot \frac{1}{s} = \frac{R_L}{sR_SR_LC_L + R_L + R_S} \cdot \frac{1}{s} \qquad V_o(s) = \frac{A}{s(s+a)}$

$V_s(0) = 1V$

$$A = \frac{R_L}{R_L + R_S} \qquad a = \frac{1}{R_LR_SC_L/(R_L+R_S)} = \frac{1}{\tau}$$

$$V_o(s) = \frac{\frac{R_L}{R_L+R_S}}{s} - \frac{\frac{R_L}{R_L+R_S}}{s+a}$$

$$\hookrightarrow V_o(t) = \frac{R_L}{R_L+R_S} - \frac{R_L}{R_L+R_S} e^{-at} = \boxed{\frac{R_L}{R_L+R_S}\left(1 - e^{-\frac{t}{\tau}}\right) = V_o(t)}$$

2. $V_t = 0.35V \qquad V_{DD} = 1.0V \leftarrow$ PMOS?

a) $V_{in} = 0V$ $\boxed{V_{out} = 0V}$ b) $V_{in} = 0.6 \quad V_{gs} = 1 - 0.6 = 0.4V$ $\boxed{V_{out} = 0.6V}$

c) $V_{in} = 0.8 \quad V_{DD} - V_t = 0.65V$

$\boxed{V_{out} = 0.65V}$

d) $V_{in} = 1.0V$ $\boxed{V_{out} = 0.65V}$