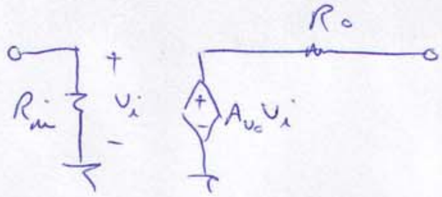
Quiz 1 Set B :

Question 1)

a)

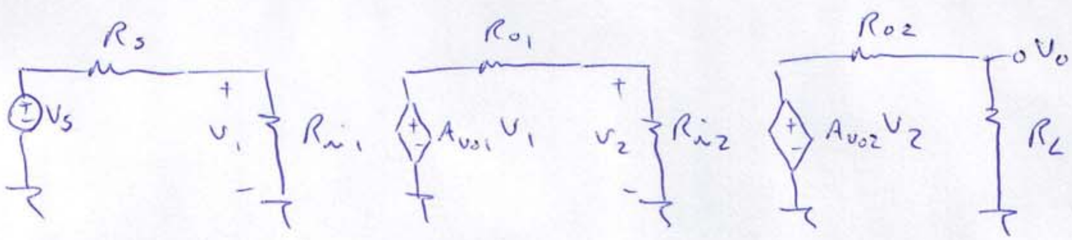


R_{in} : input resistance

R_o : output resistance

A_{vo} : open-circuit voltage gain

b)



$$\frac{v_1}{v_s} = \frac{R_{in1}}{R_{in1}+R_s}$$

$$\frac{v_2}{v_1} = A_{vo1}\frac{R_{in2}}{R_{in2}+R_{o1}}$$

$$\frac{v_o}{v_2} = A_{vo2}\frac{R_L}{R_L+R_{o2}}$$

$$\Rightarrow \frac{v_o}{v_s} = \underbrace{\frac{R_{in1}}{R_{in1}+R_s}}_{①} A_{vo1} \underbrace{\frac{R_{in2}}{R_{in2}+R_{o1}}}_{②} A_{vo2} \underbrace{\frac{R_L}{R_L+R_{o2}}}_{③}$$

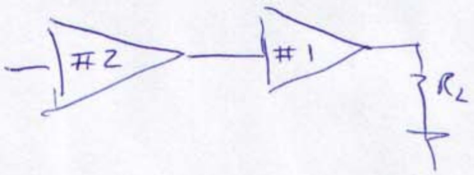
① it is better to have a first stage with a large input impedance

② the input impedance of the second should not be too much smaller than the output impedance of the first stage.

③ it is better to have a second stage with an output impedance much smaller than the load

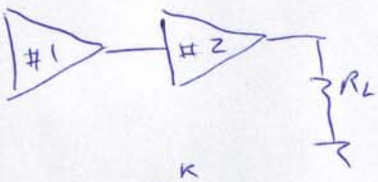
=> Apm. #2 seems to be a better choice for the first stage.

c)



$$A_v = \frac{1^{M\Omega}}{1^{M\Omega} + 100^{k\Omega}} \times 100 \times \frac{2^k}{2^k + 1^k} \times 80 \times \frac{100}{100 + 100}$$

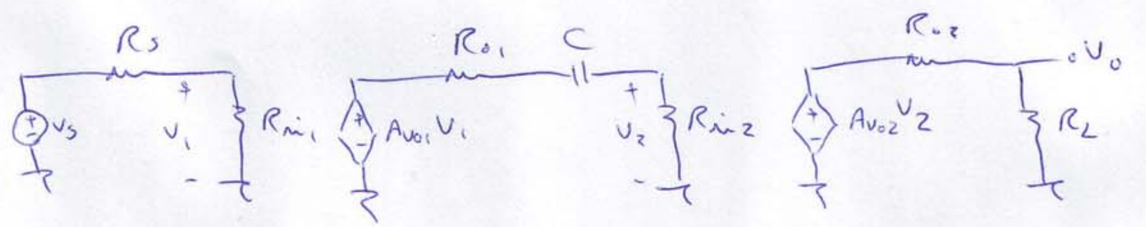
$$A_v = 2424 \ \text{V/V}$$



$$A_v = \frac{2^k}{2^k + 100^k} \times 80 \times \frac{1^M}{1^M + 100} \times 100 \times \frac{100}{100 + 1^k}$$

$$A = 14.26 \ll 2424$$

d)



$$\frac{V_1}{V_s} = \frac{R_{in1}}{R_s + R_{in1}}$$

$$\frac{V_2}{V_1} = A_{vo1} \frac{R_{in2}}{R_{in2} + \frac{1}{sC} + R_{o1}}$$

$$\frac{V_o}{V_2} = A_{vo2} \frac{R_L}{R_L + R_{o2}}$$

$$\Rightarrow A_v = \frac{V_o}{V_s} = \frac{R_{in1}}{R_s + R_{in1}} A_{vo1} \frac{R_{in2}\, sC}{(R_{o1} + R_{in2})sC + 1} A_{vo2} \frac{R_L}{R_L + R_{o2}}$$

$$A_v = \frac{R_{in1}}{R_{in1} + R_s} A_{vo1} \frac{R_{in2}}{R_{in2} + R_{o1}} A_{vo2} \frac{R_L}{R_L + R_{o2}} \times \frac{s}{s + \frac{1}{C(R_{o1} + R_{in2})}}$$

e)
which is the standard form for a <u>hig-pass</u> STC transfer function:

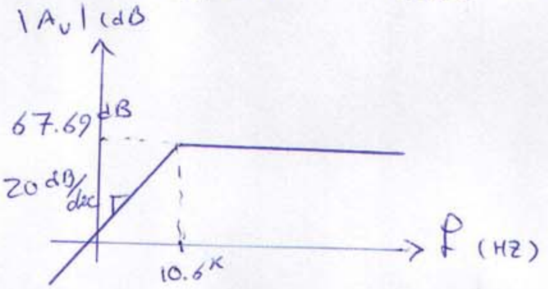
$$TF = K \frac{s}{s + \omega_o}$$

II) $\omega_o = \frac{1}{C(R_{o1}+R_{in2})}$

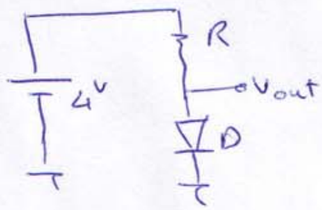
$\Rightarrow f_o = \frac{1}{2\pi C(R_{o1}+R_{in2})} = \frac{1}{2\pi \times 5\times 10^{-9}\times (1000+2000)} = 10.6 \text{ KHZ}$

III) high frequency gain (capacitor is S.C.) :

$A_v = \frac{R_{in1}}{R_{in1}+R_S} A_{vo1} \frac{R_{in2}}{R_{in2}+R_{o1}} A_{vo2} \frac{R_L}{R_L+R_{o2}} = 2424 \text{ V/V} = 67.69 \text{ dB}$



Question 2)



$$i_D = 2^{mA} \text{ @ } V_D = 0.75^V$$

$$\Rightarrow \quad 2^{mA} = I_S e^{\frac{0.75}{nV_T}}$$

$$V_{out} = 0.7^V \quad \Rightarrow \quad i_D = I_S e^{\frac{0.7}{nV_T}} \quad \Rightarrow$$

$$\frac{i_D}{2^{mA}} = e^{\frac{0.7-0.75}{nV_T}} \quad \Rightarrow \quad i_D = 2^{mA} e^{\frac{-0.05}{2\times 0.025}}$$

$$= 736^{\mu A}$$

$$R = \frac{(4 - V_{out})}{i} = \frac{4-0.7}{0.736^{mA}} = 4.48^{k\Omega}$$