Homework 1

1. $A = \frac{V_o}{V^+ - V^-}$

$V^- = 0$

$V^+ = \frac{1}{1+1000} V_i = \frac{1}{1001} V$

$\therefore A = \frac{4}{\frac{1}{1001} V} = 4004\ V/V$ #

2. (a) $\frac{0 - V_{\dot{x}}}{20k} = \frac{V_o - 0}{100k} \Rightarrow \frac{V_o}{V_{\dot{x}}} = -5\ V/V$ #

$R_m = 20k\Omega$ #

(b) $\dot{x} = \frac{0 - V_{\dot{x}}}{20k} = \frac{V_o - 0}{100k} \Rightarrow \frac{V_o}{V_{\dot{x}}} = -5\ V/V$ #

$R_m = 20k\Omega$ #

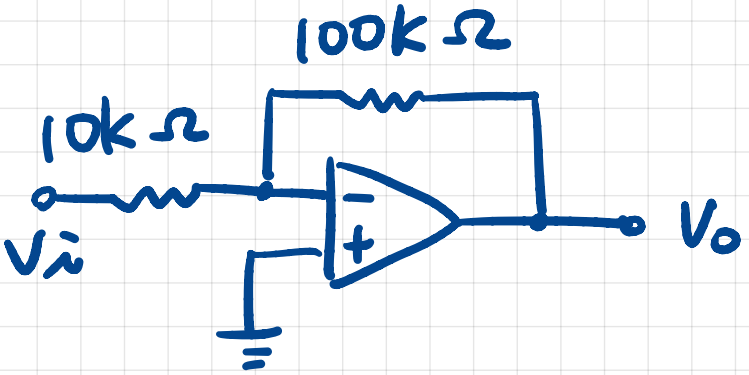
(c) $\frac{V_o}{V_i} = -\frac{100}{20} = -5\ V/V$ #

$R_m = 20k\Omega$ #

(d) $\frac{V_o}{V_i} = -\frac{100}{20} = -5\ V/V$ #

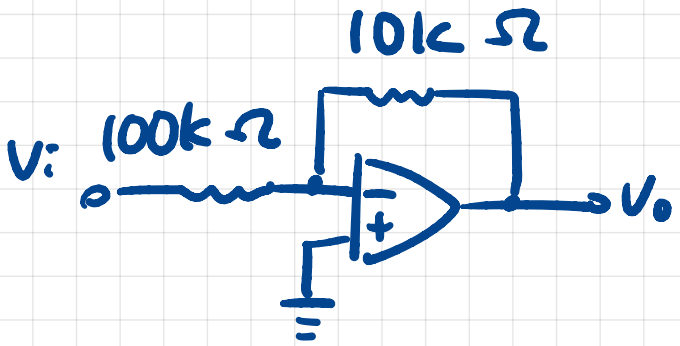
$R_m = 20k\Omega$ #

3.(a)



(b) $-20\ dB = 20 \log \left|\frac{V_o}{V_i}\right|$

$$\left|\frac{V_o}{V_i}\right| = \frac{1}{10} \Rightarrow \frac{V_o}{V_i} = -\frac{1}{10}$$



(c) $40\ dB = 20 \log \left|\frac{V_o}{V_i}\right|$

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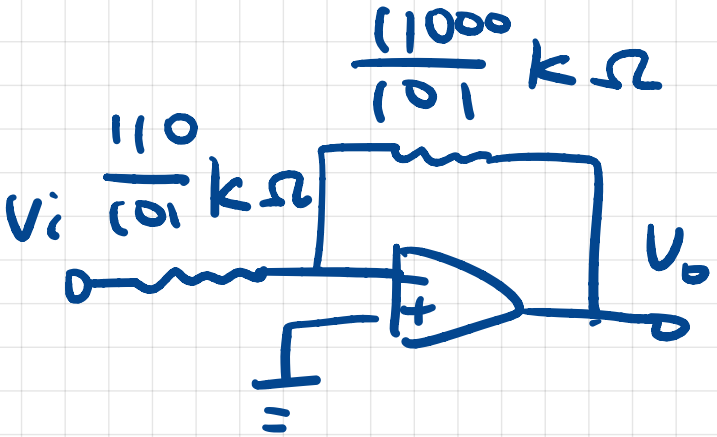
$$\frac{V_o}{V_i} = -100 \Rightarrow \frac{R_2}{R_1} = 100$$

$$100 = \frac{110 - R_1}{R_1}$$

$$101 R_1 = 110$$

$$R_2 = 110 - \frac{110}{101}$$

$$= \frac{11000}{101}$$



4.(a) $A=\infty \Rightarrow V_{\dot{\imath}}=0$

$V_o = V_{\dot{\imath}} - \dot{\imath}\cdot R_f$

$R_m = \frac{V_o}{\dot{\imath}} = -R_f$ #

$R_m = \frac{V_{\dot{\imath}}}{\dot{\imath}} = 0$ #

(b) $V_{\dot{\imath}} = -\frac{V_o}{A}$

$V_o = V_{\dot{\imath}} - \dot{\imath}\cdot R_f$

$\Rightarrow V_o + \frac{V_o}{A} = -\dot{\imath}\cdot R_f$

$\Rightarrow V_o = \frac{-\dot{\imath}\cdot R_f}{(1+\frac{1}{A})}$

$R_m = \frac{V_o}{\dot{\imath}} = -\frac{R_f}{(1+\frac{1}{A})}$ #

$R_m = \frac{V_{\dot{\imath}}}{\dot{\imath}} = \frac{R_f}{1+A}$ #

5. ① $\frac{V_O}{V_I} = \frac{R_1+R_2}{R_1} = 1+\frac{(1-X)}{X} = \frac{1}{X} \Rightarrow \frac{V_o}{V_I} \geq 1$ #

② $\frac{V_O}{V_I} = \frac{10X+R+(1-X)10}{10X+R} = 11$ (Max)

$X=0,\ \frac{V_O}{V_I} = \frac{R+10}{R} \Rightarrow R = 1k\Omega$ #

6.(a) $I_1 = \frac{0-1}{10k} = 10^{-4}\,A$ #

$I_2 = I_1 = 10^{-4}\,A$ #

$V_X = -I_2 \cdot 10 = -1\,V$ #

$I_3 = \frac{1-0}{100} = 10^{-2}\,A$ #

$I_L = 10^{-2} + 10^{-4} = 0.0101\,A$ #

(b) $V_X - V_O = R_L \cdot L$

$\Rightarrow R_L = \frac{V_X - V_O}{L}$

$= \frac{-1+13}{0.0101} \doteq 1188.1\,k\Omega$ #

(c) $V_X - V_O = R_L \cdot L$

$V_O = V_X - R_L \cdot L$

$= -1 - R_L \cdot (0.0101)$

① $R_L = 0.1\,k\Omega$

$V_O = -2.01\,V$

② $R_L = 1\,k\Omega$

$V_O = -11.1\,V$

$\Rightarrow -11.1\,V \leq V_O \leq -2.01\,V$ #

7. (a) $R_1 = R$

$R_2 = \frac{R}{2} + \frac{R}{2} = R$

$R_3 = \frac{R}{2} + \frac{R}{2} = R$

$R_4 = \frac{R}{2} + \frac{R}{2} = R$ *

(b) $I_1 = I$ *

$I_x = I + I_1 = 2I$

$V_2 = -I_x \cdot \frac{R}{2} + V_1$

$= -IR - IR$

$= -2IR$

$I_2 = 2I$ *

$I_y = I_x + I_2 = 4I$

$V_3 = -I_y \cdot \frac{R}{2} + V_2$

$= -2IR - 2IR$

$= -4IR$

$I_3 = 4I$ *

$I_z = I_y + I_3$

$= 4I + 4I$

$= 8I$

$I_4 = -8I$ #

(c) $V_1 = -IR$ #

$V_2 = -2IR$ *

$V_3 = -4IR$ #

$V_4 = -8IR$ #

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