(10) $$\frac{V_{out}}{V_{in}} = 1 + \frac{R_1}{R_s}$$

$\because V_{in} = 1V,$ $$V_{out} = 1 + \frac{R_1}{R_0 + \alpha w}$$

$$\frac{dV_{out}}{dw} = -R_1 \alpha \left(R_0 + \alpha w \right)^{-2}$$

$$= \frac{-R_1 \alpha}{(R_0 + \alpha w)^2}$$

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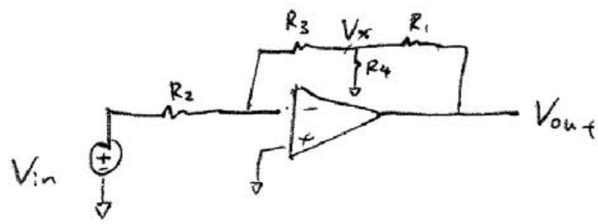

$$V_- = V_+ = 0 \qquad (\because A = \infty)$$

$$\frac{V_{in}}{R_2} = -\frac{V_x}{R_3} \longrightarrow ①$$

$$V_x = \frac{R_3 // R_4}{R_1 + R_3 // R_4} V_{out} \longrightarrow ②$$

Combining ① and ②,

$$\frac{V_{in}}{R_2} = -\frac{R_3 // R_4}{R_3 (R_1 + R_3 // R_4)} V_{out}$$

$$\frac{V_{out}}{V_{in}} = -\frac{R_3}{R_2} \frac{(R_1 + R_3 // R_4)}{R_3 // R_4} \quad //$$

if $R_1 \longrightarrow 0$,

$$\frac{V_{out}}{V_{in}} = -\frac{R_3}{R_2} \quad // \qquad \text{(typical inverting amplifier)}$$

if $R_3 \longrightarrow 0$,

$$\frac{V_{out}}{V_{in}} = -\frac{R_1}{R_2} \quad // \qquad \text{(typical inverting amplifier)}$$

(19) From eq. (8.31),

$$V_{out} = -\frac{1}{R_1 C_1} \int V_{in}\, dt$$

$$= -\frac{1}{R_1 C_1} \int V_0 \sin \omega t \, dt$$

$$= \frac{V_0}{R_1 C_1 \omega} \cos \omega t$$

$\therefore$ Amplitude of output $= \dfrac{V_0}{R_1 C_1 \omega}$

24 $\because A_o = \infty$

$$|A_v| = \frac{R_1}{\frac{1}{\omega C_1}}$$

$$= \omega R_1 C_1$$

$$= 5$$

$$\therefore R_1 C_1 = \frac{5}{\omega}$$

$$= \frac{5}{2\pi \times 10^6}$$

$$= 7.958 \times 10^{-7}$$

(32) For $A_0 = \infty$,

$V_+ = V_- = 0$,

$\therefore$ No current flows through R_P,

i.e. No effect due to R_P

$$V_{out} = -R_F \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} \right)$$

For $A_0 \neq \infty$,

By KCL

$$\frac{V_1 - V_x}{R_1} + \frac{V_2 - V_x}{R_2} - \frac{V_x}{R_P} = -\frac{V_{out} - V_x}{R_F}$$

$$\because \quad V_x = \frac{-V_{out}}{A_0},$$

$$\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} \right) + \frac{V_{out}}{A_0} \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_p} + \frac{1}{R_p} \right. = -\frac{V_{out}}{R_p}$$

$$V_{out} = -\left[\frac{1}{R_F} + \frac{1}{A_0} \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_p} + \frac{1}{R_F} \right) \right]^{-1} \times \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} \right)$$

$$Vout = -\left(\frac{V_1}{R_2} + \frac{V_2}{R_1} \right) \left[\frac{1}{R_F} + \frac{1}{A_0} \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_P} + \frac{1}{R_F} \right) \right]^{-1}$$

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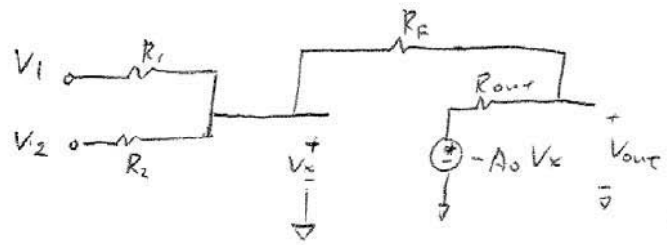


By KCL,

$$\frac{V_1 - V_x}{R_1} + \frac{V_2 - V_x}{R_2} = \frac{V_x (A_0 + 1)}{R_F + R_{out}}$$

$$\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} \right) = V_x \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{A_0 + 1}{R_F + R_{out}} \right]$$

$$\because V_{out} = (-A_0 V_x - V_x) \frac{R_F}{R_F + R_{out}}$$

$$= -V_x (1 + A_0) \frac{R_F}{R_F + R_{out}}$$

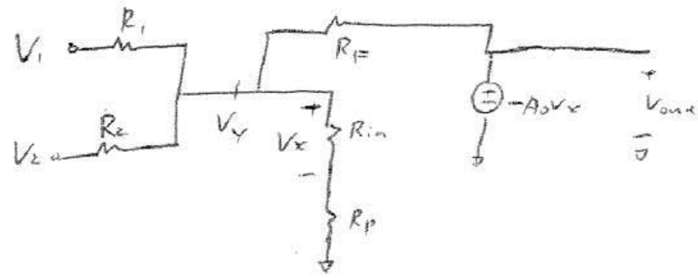
$$\therefore \frac{V_1}{R_1} + \frac{V_2}{R_2} = -\frac{R_F + R_{out}}{R_F (A_0 + 1)} \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{A_0 + 1}{R_F + R_{out}} \right] V_{out}$$

$$V_{out} = -\frac{R_F (A_0 + 1)}{R_F + R_{out}} \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{A_0 + 1}{R_F + R_{out}} \right)^{-1}$$

$$\times \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} \right)$$

$$Vout = \left(\frac{R_{out} - A_0 R_F}{R_F + R_{out}} \right) \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{A_0 + 1}{R_F + R_{out}} \right)^{-1} \left(\frac{V_1}{R_2} + \frac{V_2}{R_1} \right)$$

(34)



By KCL,

$$\frac{V_1 - V_Y}{R_1} + \frac{V_2 - V_Y}{R_2} = \frac{V_Y + A_0 V_X}{R_F} + \frac{V_Y}{R_{in} + R_p}$$

Using voltage divider,

$$V_X = V_Y \frac{R_{in}}{R_{in} + R_p}$$

$$V_Y = \frac{R_{in} + R_p}{R_p} V_X$$

$$\therefore \left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right) = V_Y\left(\frac{1}{R_F} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_{in}+R_p}\right) + \frac{A_0 V_X}{R_F}$$

$$= \left[\left(\frac{R_{in} + R_p}{R_p}\right)\left(\frac{1}{R_F} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_{in}+R_p}\right) + \frac{A_0}{R_F}\right] \times V_X$$

$$\because V_{out} = -A_0 V_X$$

$$\therefore \frac{V_1}{R_1} + \frac{V_2}{R_2} = -\left(\frac{V_{out}}{A_0}\right)\left[\left(\frac{R_{in}+R_p}{R_p}\right)\left(\frac{1}{R_F} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_{in}+R_p}\right) + \frac{A_0}{R_F}\right]$$

$$V_{out} = -A_0\left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right) \times \left[\left(\frac{R_{in}+R_p}{R_p}\right)\left(\frac{1}{R_F} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_{in}+R_p}\right) + \frac{A_0}{R_F}\right]^{-1}$$

$$Vout = -A_0\left(\frac{V_1}{R_2} + \frac{V_2}{R_1}\right)\left[\frac{R_{in}+R_p}{R_{in}}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_F} + \frac{1}{R_{in}+R_p}\right) + \frac{A_0}{R_F}\right]^{-1}$$

(46) By KCL,

$$\frac{V_x - V_{in}}{R_1} = I_{sp,\,m_1}$$

Assume $A_0 = \infty$, $\therefore V_x = V_+ = 0V$.

$$\therefore -\frac{V_{in}}{R_1} = \frac{1}{2} k' (V_{GS} - |V_{TH}|)^2,$$

where $K' = \mu_p \frac{W}{L} C_{ox}$.

$$\therefore V_{\ } = -V_{out}$$

$$\therefore -\frac{V_{in}}{R_1} = \frac{1}{2} k' (- V_{out} - |V_{TH}|)^2$$

$$-\frac{2 V_{in}}{R_1 k'} = (V_{out} + |V_{TH}|)^2.$$

$$\therefore V_{out} = \sqrt{-\frac{2V_{in}}{R_1 k'}} - |V_{TH}|$$