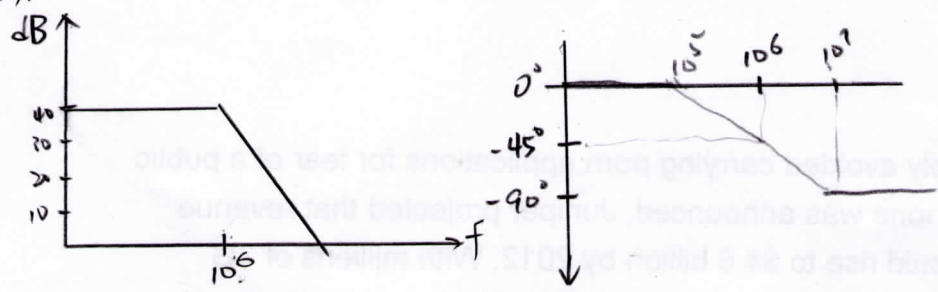


2. (a).



$$A(s) = \frac{100}{1 + \frac{s}{10^6 \times 2\pi}}$$

b) negative feedback

$$\beta = \frac{9}{9+91} = 0.09$$

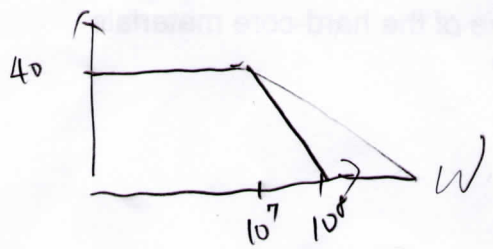
c)

$$A_F(s) = \frac{A}{1+A\beta} \times \frac{A}{1+A\beta} = \left(\frac{\frac{100}{1+\frac{s}{10^6}}}{1+\frac{9}{1+\frac{s}{10^6}}} \right)^2 = \left(\frac{100}{1+\frac{s}{10^6}+9} \right)^2 = \left(\frac{100}{10+\frac{s}{10^6}} \right)^2$$

$$= \left(\frac{10}{1+\frac{s}{10^7}} \right)^2 = \frac{100}{1+\frac{25}{10^7}+\frac{s^2}{10^{14}}}$$

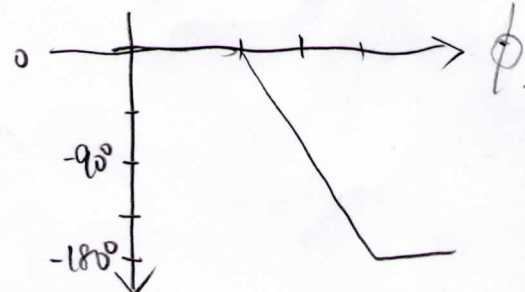
\downarrow \downarrow
 $\frac{1}{w_1} + \frac{1}{w_2}$ $w_1 w_2$

$\Rightarrow w_1 = 10^7$
 $w_2 = 10^7$



d)

$$A_F(s) = \left(\frac{80}{1+80 \times 0.09} \right)^2$$



3.

a) SR: 輸出每秒可以變化多少伏特

b) UGB: $A=1$'s BW

c) Increase input common-mode range

4.

$$-V_{SS} + V_{OV} + V_{TN} - V_{TP}$$

$$V_{DD} - V_{OV5} - V_{OV1} - V_{TP}$$

$$-1.65 + 0.35 + 0.5 - 0.5 \leq V_{ICM} \leq 1.65 - 0.35 - 0.35 - 0.5$$

$$-1.3V \leq \leq 0.45V$$

(b)

$$g_{m1} = \frac{2(\frac{I}{2})}{V_{OV1}}$$

$$r_{o2} = \frac{V_{AP} \times 1}{\frac{I}{2}} = \frac{30}{\frac{I}{2}} \quad r_{o4} = \frac{V_{AN} \times 1}{\frac{I}{2}} = \frac{30}{\frac{I}{2}}$$

$$A_1 = g_{m1} (r_{o2} \parallel r_{o4}) = g_{m1} \times \frac{10}{\frac{I}{2}} = \frac{2 \frac{I}{2}}{V_{OV1}} \times \frac{10}{\frac{I}{2}} = \frac{20}{V_{OV1}} = \frac{20}{0.2} = 100 \left(\frac{V}{V} \right)$$

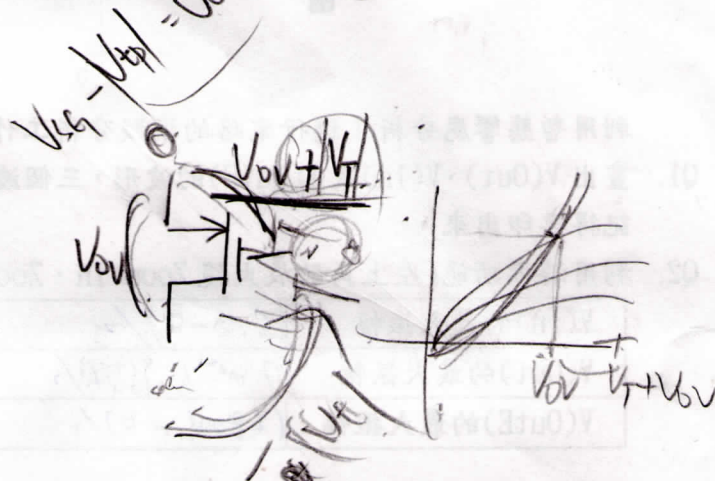


$$A_2 = g_{m6} (r_{o7} \parallel r_{o6}) = \frac{20}{V_{OV6}} = \frac{20}{0.5} = 40 \left(\frac{V}{V} \right)$$

$$A_v = A_1 A_2 = 4000 \left(\frac{V}{V} \right)$$

$$r_{o7} = \frac{20}{0.45} = \frac{400}{9} k\Omega$$

$$\Rightarrow R_o = \frac{200}{9} k\Omega$$



5.

$$\text{Max} \left\{ \begin{aligned} V_{BIAS1} &= 1.65 - V_{OV10} - V_{OV4} - V_T = 1.65 - 0.2 - 0.2 - 0.5 = 0.75V \\ V_{BIAS2} &= 1.65 - V_{OV9} - V_T = 1.65 - 0.2 - 0.5 = 0.95V \\ V_{BIAS3} &= 1.65 - V_{OV9} - V_{OV1} + V_T = 1.65 - 0.2 - 0.2 + 0.5 = 1.75V \end{aligned} \right.$$

$$\text{min} \left\{ \begin{aligned} V_{BIAS1} &= -1.65 + V_{OV8} + V_{OV6} + V_T = -1.65 + 0.2 + 0.2 + 0.5 = -0.75V \\ V_{BIAS2} &= -1.65 + V_{OV11} + V_{OV1} + V_T = -1.65 + 0.2 + 0.2 + 0.5 = -0.75V \\ V_{BIAS3} &= -1.65 + V_{OV} + V_T = -1.65 + 0.2 + 0.5 = -0.95V \end{aligned} \right.$$

$$-0.95 = -1.65 + 0.2 + 0.2 + 0.5 \leq V_{ICM} \leq 1.65 - 0.2 + 0.5 = 1.95$$

$$-1.25 = -1.65 + 0.2 + 0.2 + 0.5 \leq V_O \leq 1.65 - 0.2 - 0.2 = 1.25$$