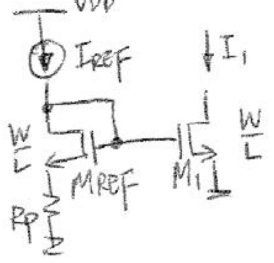
Chapter 9

50. 

Determine R_P such that $I_1 = 2I_{REF}$.

First calculate $V_{GS,1}$:

$$V_{GS_1} = \sqrt{\frac{2I_1}{\mu_n C_{ox}\left(\frac{W}{L}\right)}} + V_{TH} = 2\sqrt{\frac{I_{REF}}{\mu_n C_{ox}\left(\frac{W}{L}\right)}} + V_{TH} \quad -①$$

Assuming I_1 is in saturation:

$$I_{REF} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)\left(V_{GS,REF} - V_{TH}\right)^2$$

$$= \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)\left[V_{GS_1} - I_{REF}R_P - V_{TH}\right]^2$$

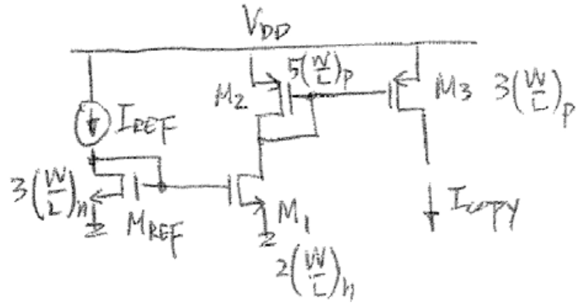
Substitute ① into I_{REF}:

$$I_{REF} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)\left[2\sqrt{\frac{I_{REF}}{\mu_n C_{ox}\left(\frac{W}{L}\right)}} - I_{REF}R_P\right]^2 \quad -②$$

Solve for R_P: $R_P = \dfrac{(2-\sqrt{2})}{\sqrt{I_{REF}\cdot \mu_n C_{ox}\left(\frac{W}{L}\right)}}$

From ②, we find that R_P is <u>independent</u> of any change in V_{TH}, ΔV !!

52. (a)

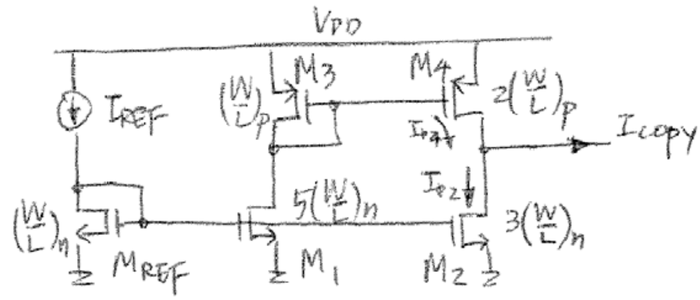


$$V_{GS,REF} = V_{GS,1} : \Rightarrow I_{D,1} = \frac{2}{3} I_{REF}$$

$$V_{GS,2} = V_{GS,3} : \Rightarrow I_{copy} = \frac{3}{5} I_{D,2} = \frac{3}{5} I_{D,1}$$

$$= \frac{3}{5} \cdot \left(\frac{2}{3} I_{REF}\right) = \frac{2}{5} I_{REF}$$

(b)



$$V_{GS,REF} = V_{GS,1} : \quad I_{D,1} = 5 I_{REF}$$

$$V_{GS,3} = V_{GS,4} : \quad I_{D4} = 2 I_{D3} = 2 I_{D,1} = 10 I_{REF}$$

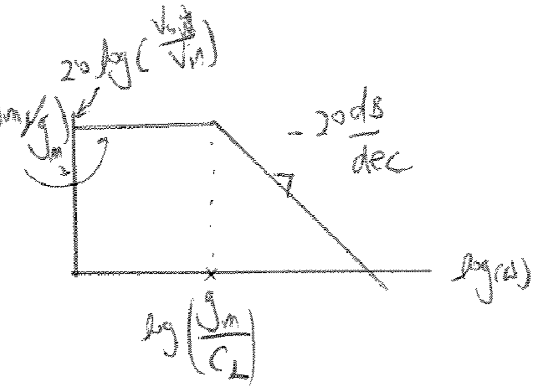
$$V_{GS,REF} = V_{GS,2} : \quad I_{D2} = 3 I_{REF}$$

$$\therefore I_{copy} = I_{D4} - I_{D2} = 7 I_{REF}.$$

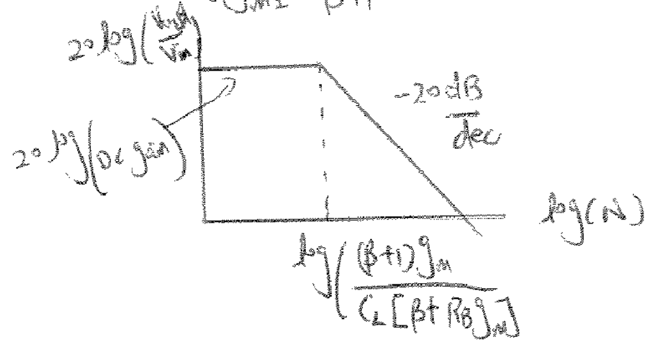
Chapter 10

4)

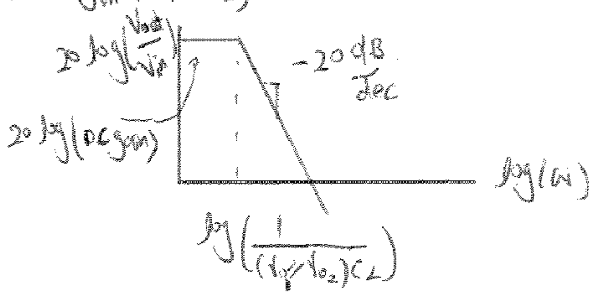
a) $|\text{DC gain}| = \dfrac{g_{m1}}{g_{m2}}$



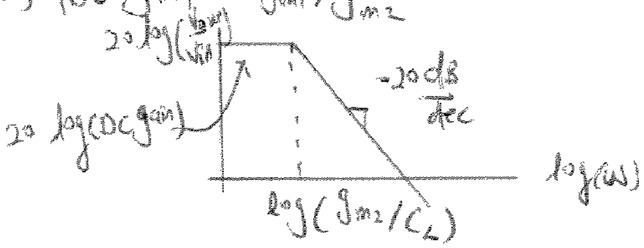
b) $|\text{DC gain}| = g_{m1}\left(\dfrac{1}{g_{m2}} + \dfrac{R_B}{\beta+1}\right)$



c) $|\text{DC gain}| = g_m(r_{o1} // r_{o2})$



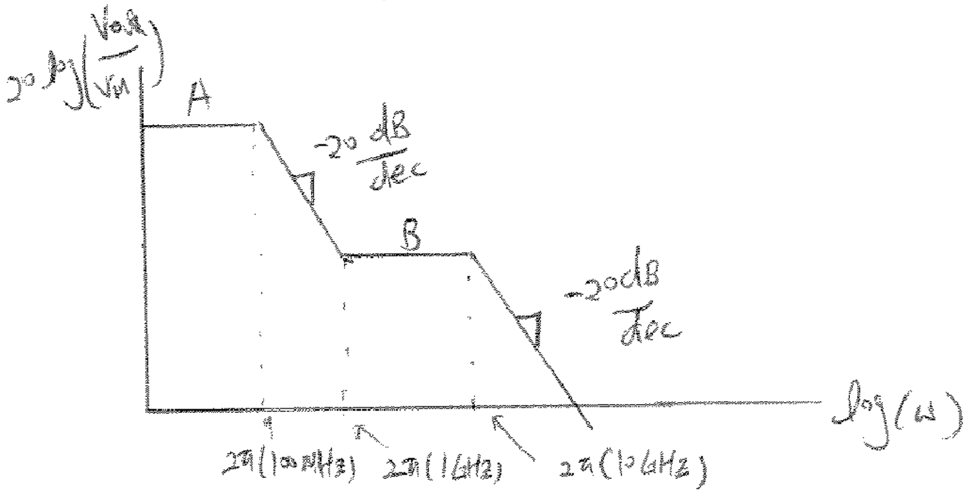
d) $|\text{DC gain}| = g_{m1}/g_{m2}$



6)

Poles at 100 MHz, 10 GHz

Zero at 1 GHz.

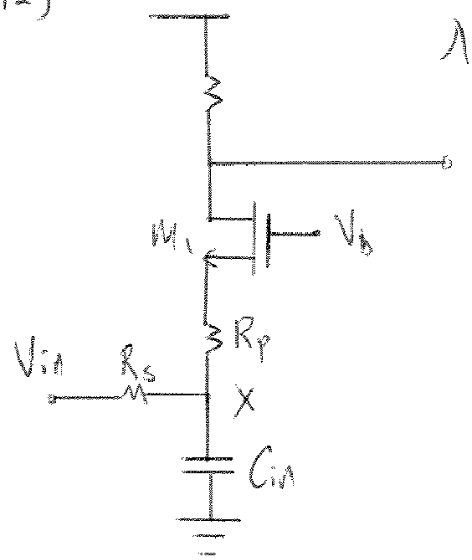


$A(100\,MHz) = B(1\,GHz)$

$B = 0.1A$

图中横坐标应为 log(2π *10^8), log(2π *10^9), log(2π *10^10).

12)



$\lambda = 0$

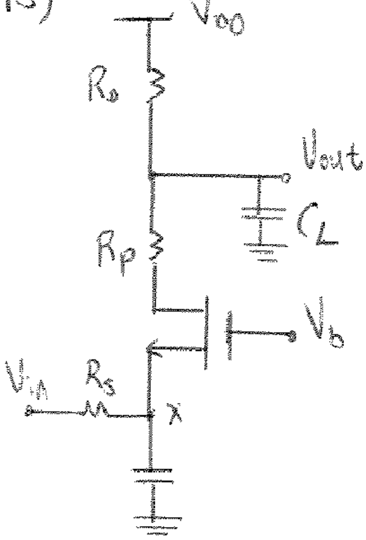
To find input pole, let $V_{in} = 0$ and find the equivalent resistance and capacitance from node X to ground.

$$R_x = R_s // \left(R_p + \frac{1}{g_{m_1}} \right), \quad C_x = C_{in}$$

$$\omega_{p,in} = \frac{1}{C_{in}\left[R_s // \left(R_p + \frac{1}{g_m}\right)\right]}$$

$$\omega_{p,out} = \frac{1}{R_D C_L}$$

13)



$\lambda = 0$, neglect all other Caps.

$R_X = R_S // \frac{1}{g_m}$

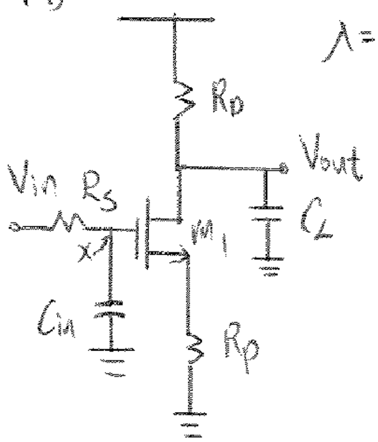
$C_X = C_{in}$

$R_{out} = R_D$ (Since $r_o = \infty$)

$C_{out} = C_L$

$\omega_{pin} = \frac{1}{(R_S // \frac{1}{g_m})\, C_{in}}$, $\omega_{pout} = \frac{1}{R_D C_L}$

14)



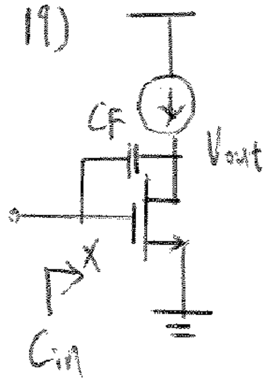
$\lambda = 0$

$R_X = R_S$, $R_{out} = R_D$

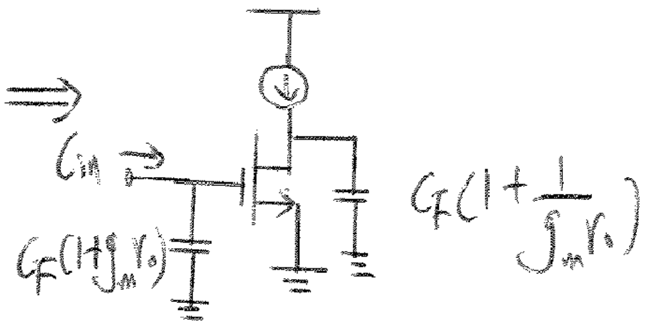
$C_X = C_{in}$, $C_{out} = C_L$

$\omega_{pin} = \frac{1}{R_S C_{in}}$, $\omega_{pout} = \frac{1}{R_D C_L}$

19)



$\lambda > 0$, DC gain = $-g_m r_o$



$C_{in} = C_F(1+g_m r_o)$, neglecting other caps.

As $\lambda \to 0$, $r_o \to \infty$, DC gain $\to \infty$,

$C_{in} \to \infty$, this bandwidth will $\to 0$.