电子学基础——第十二次作业

LXQ

2019.12.26

12.1 Determine the transfer function, Y/X, for the systems shown in Fig. 12-77.

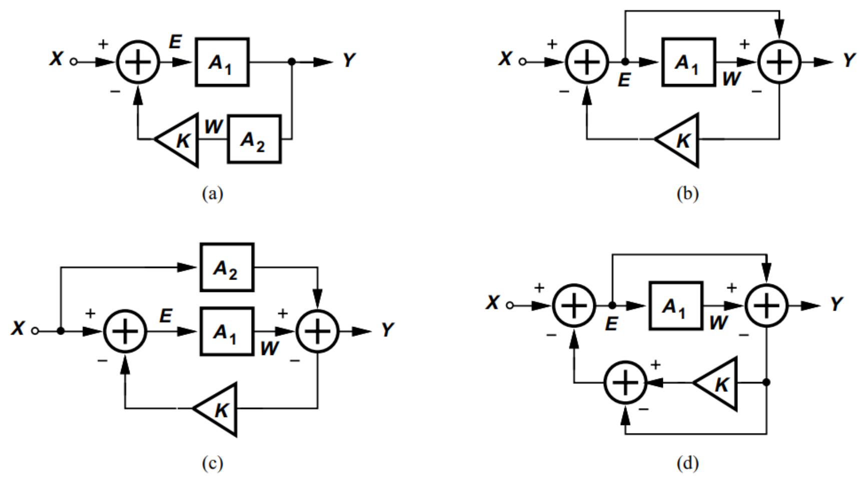

Figure 12-77

解 (a)

$$\begin{cases} E = X - EA_1A_2K \\ Y = EA_1 \end{cases}$$

$$\therefore \frac{Y}{X} = \frac{A_1}{1 + A_1A_2K}$$

(b)

$$\begin{cases} E = X - (EA_1 - E)K \\ Y = EA_1 - E \end{cases}$$

$$\therefore \frac{Y}{X} = \frac{A_1 - 1}{1 + (A_1 - 1)K}$$

(c)

$$\begin{cases} E = X - (EA_1 - A_2X)K \\ Y = EA_1 - A_2X \end{cases}$$

$$\therefore \frac{Y}{X} = \frac{A_1 - A_2}{1 + A_1K}$$

(d)

$$\begin{cases} E = X - [(EA_1 - E)K - (EA_1 - E)] \\ Y = EA_1 - E \end{cases}$$

$$\therefore \frac{Y}{X} = \frac{A_1 - 1}{1 + (K-1)(A_1 - 1)}$$

12.4 Calculate the loop gain of the circuits illustrated in Fig. 12-78. Assume the op amp exhibits an open-loop gain of A_1, but is otherwise ideal. Also $\lambda = 0$.

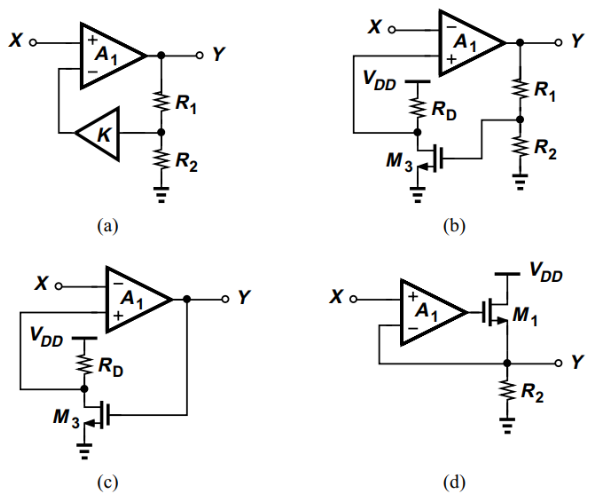

Figure 12-78

解 (a) 如图 p12-4-a，在A_1输出端断开环路。

$$v_N = \frac{-R_2 v_t K A_1}{R_1 + R_2}$$

则环路增益为$\frac{R_2 K A_1}{R_1 + R_2}$

(b) 如图 p12-4-b，在A_1输出端断开环路。

$$v_N = \frac{-R_2 v_t g_{m3} R_D A_1}{R_1 + R_2}$$

则环路增益为$\frac{R_2 g_{m3} R_D A_1}{R_1 + R_2}$

(c) 如图 p12-4-c，在A_1输出端断开环路。

$$v_N = -v_t g_{m3} R_D A_1$$

则环路增益为$g_{m3} R_D A_1$

(d) 如图 p12-4-d，在A_1反相输入端断开环路。

$$v_N = -v_t A_1 \cdot \frac{g_{m1} R_2}{1 + g_{m1} R_2}$$

则环路增益为$A_1 \cdot \frac{g_{m1} R_2}{1 + g_{m1} R_2} \approx A_1$

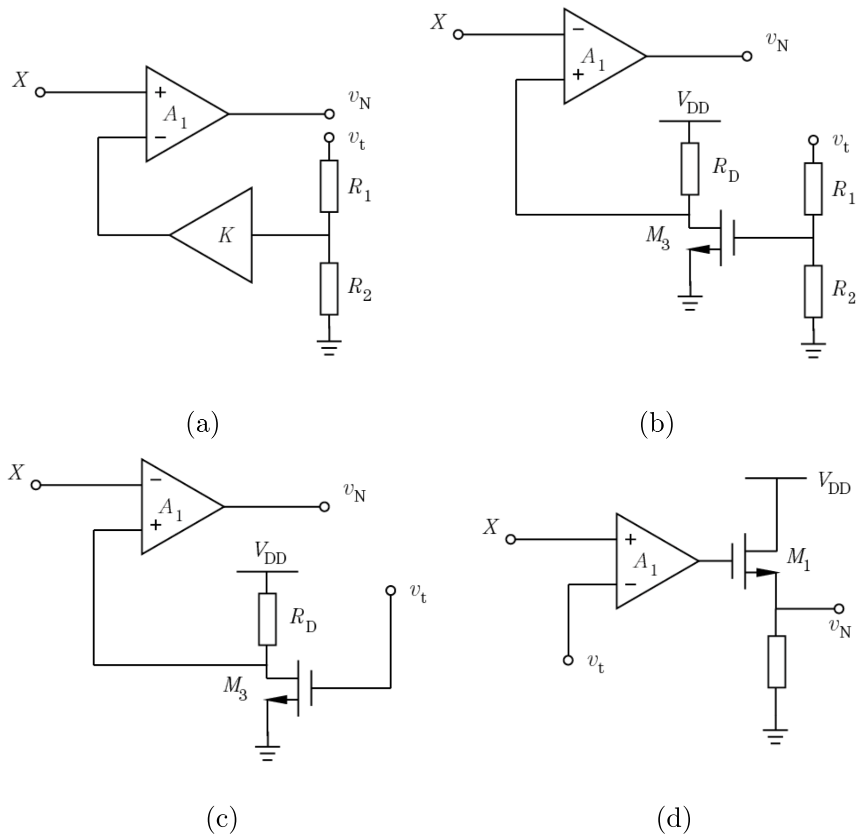

Figure p12-4

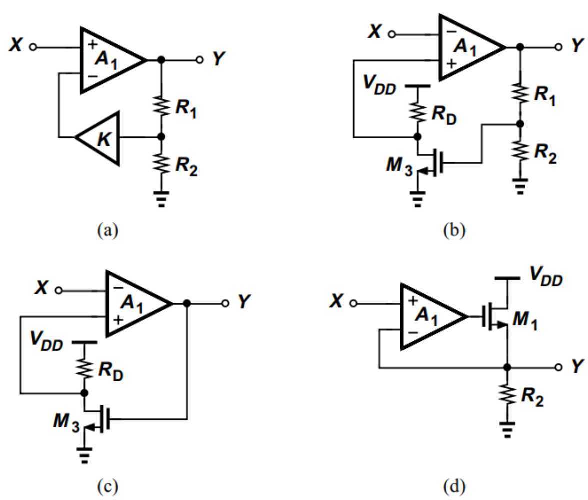

Figure 12-78

12.5 Using the results obtained in Problem 12.4, compute the closed-loop gain of the circuits shown in Fig. 12-78.

解 (a)

$$A_{v,close} = \frac{A_1}{1 + \frac{R_2 K A_1}{R_1 + R_2}}$$

(b)

$$A_{v,close} = \frac{-A_1}{1 + \frac{R_2 g_{m3} R_D A_1}{R_1 + R_2}}$$

(c)

$$A_{v,close} = \frac{-A_1}{1 + g_{m3} R_D A_1}$$

(d)

$$A_{v,close} = \frac{-A_1 g_{m1} R_2}{1 + A_1 \cdot \frac{g_{m1} R_2}{1 + g_{m1} R_2}} \approx \frac{-A_1 g_{m1} R_2}{1 + A_1}$$

12.10 The circuit of Fig. 12-80 must achieve a closed-loop -3dB bandwidth of B. Determine the required value of K. Neglect other capacitances and assume $\lambda > 0$.

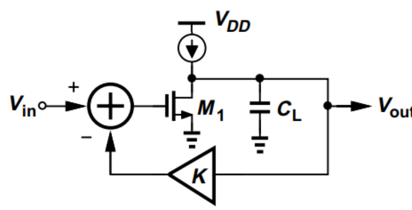

Figure 12-80

解

$$\omega_0 = \frac{1}{C_L r_{o1}}$$
$$A_0 = -g_{m1} r_{o1}$$
$$B = (1 + |A_0| K)\omega_0$$
$$\therefore K = \frac{C_L r_{o1} B - 1}{g_{m1} r_{o1}}$$

12.22 Determine the polarity of feedback in each of the stages illustrated in Fig. 12-87.

解 (a) 设M_1栅端电压V_1上升，由M_1栅漏反极性可知V_{out}下降，又由M_2栅源同极性知V_1下降，从而为负反馈。

(b) 设M_1栅端电压V_1上升，由M_1栅漏反极性可知V_{out}下降，又由M_2栅漏反极性知V_1上升，从而为正反馈。

(c) 设M_1栅端电压V_1上升，由M_1栅漏反极性可知V_{out}下降，又由M_2源漏同极性知V_1下降，从而为负反馈。

(d) 设M_1源端电压V_1上升，由M_1源漏同极性可知V_{out}上升，又由M_2栅漏反极性知V_1下降，从而为负反馈。

12.25 Consider the feedback circuit shown in Fig. 12-88, where $R_1 + R_2 >> R_D$. Compute the closed-loop gaina and I/0 impedances of the circuit. Assume $\lambda \neq 0$.

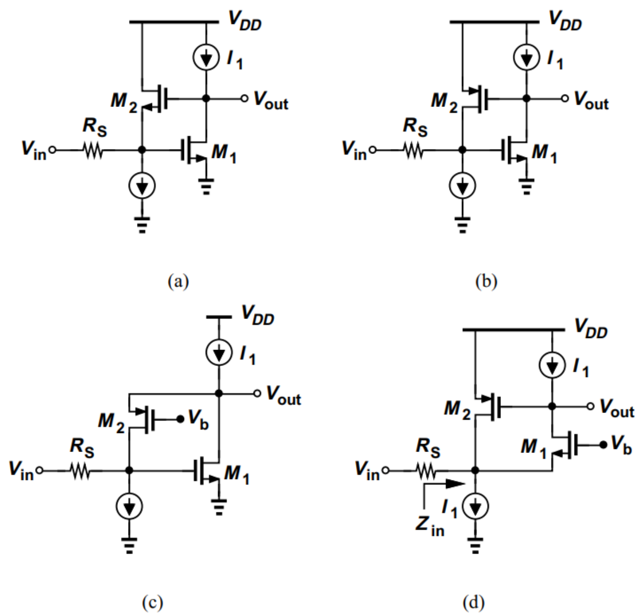

Figure 12-87

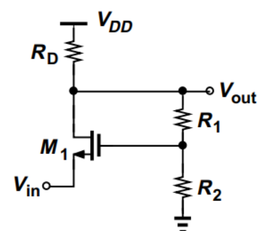

Figure 12-88

解

$$
\begin{aligned}
A_0 &= g_{m1}[R_D//(R_1+R_2)//r_{o1}] \approx g_{m1}(R_D//r_{o1}) \\
K &= \frac{R_2}{R_1+R_2} \\
R_{in} &= \frac{1}{g_{m1}} \\
R_{out} &= R_D//(R_1+R_2)//r_{o1} \approx R_D//r_{o1}
\end{aligned}
$$

$$
\begin{aligned}
\therefore A_{v,close} &= \frac{g_{m1}(R_D//r_{o1})}{1+\frac{g_{m1}(R_D//r_{o1})R_2}{R_1+R_2}} \\
R_{in,close} &= \frac{1}{g_{m1}}\left[1+\frac{g_{m1}(R_D//r_{o1})R_2}{R_1+R_2}\right] \\
R_{out,close} &= \frac{R_D//r_{o1}}{1+\frac{g_{m1}(R_D//r_{o1})R_2}{R_1+R_2}}
\end{aligned}
$$

12.33 The amplifier depicted in Fig. 12-95 consists of a common-gate stage (M_1 and R_D) and a feedback network (R_1, R_2 and M_2). Assuming R_1+R_2 is very large and $\lambda = 0$, compute the closed-loop gain and I/O impedances.

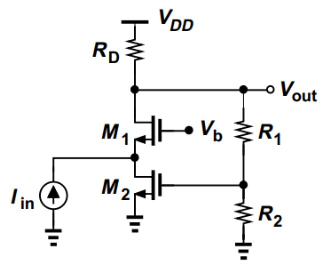

Figure 12-95

解

$$
\begin{aligned}
R_0 &= \frac{1}{g_{m1}} \cdot g_{m1}[R_D//(R_1+R_2)] \approx R_D \\
K &= \frac{R_2 g_{m2}}{R_1+R_2} \\
R_{in} &= \frac{1}{g_{m1}} \\
R_{out} &= R_D//(R_1+R_2) \approx R_D
\end{aligned}
$$

$$
\begin{aligned}
\therefore R_{v,close} &= \frac{R_D}{1+\frac{R_D R_2 g_{m2}}{R_1+R_2}} \\
R_{in,close} &= \frac{1}{g_{m1}\left(1+\frac{R_D R_2 g_{m2}}{R_1+R_2}\right)} \\
R_{out,close} &= \frac{R_D}{1+\frac{R_D R_2 g_{m2}}{R_1+R_2}}
\end{aligned}
$$

12.56 Compute the closed-loop gain and I/O impedances of the stages illustrated in Fig. 12-117.

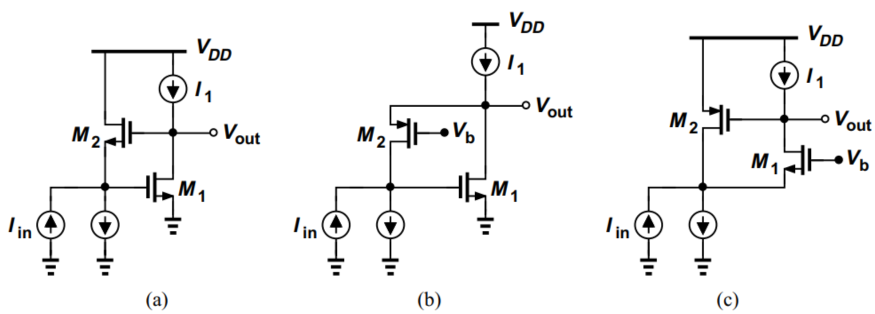

Figure 12-117

解 (a) 视M_2为反馈部分。

$$
\begin{aligned}
R_{in} &= \frac{1}{g_{m2}} \\
R_{out} &= r_{o1}//r_{o2} \\
R_0 &= -\frac{g_{m1}}{g_{m2}}(r_{o1}//r_{o2}) \\
K &= g_{m2} \cdot \frac{g_{m2}r_{o2}}{1+g_{m2}r_{o2}} \approx g_{m2}
\end{aligned}
$$

$$
\begin{aligned}
\therefore R_{v,close} &= \frac{-\frac{g_{m1}}{g_{m2}}(r_{o1}//r_{o2})}{1+g_{m1}(r_{o1}//r_{o2})} \\
R_{in,close} &= \frac{1}{g_{m2}[1+g_{m1}(r_{o1}//r_{o2})]} \\
R_{out,close} &= \frac{r_{o1}//r_{o2}}{1+g_{m1}(r_{o1}//r_{o2})}
\end{aligned}
$$

(b) 视M_2为反馈部分。

$$
\begin{aligned}
R_{in} &= r_{o2} \\
R_{out} &= r_{o1}//\frac{1}{g_{m2}} \approx \frac{1}{g_{m2}} \\
R_0 &= -r_{o1}g_{m1}(\frac{1}{g_{m2}}//r_{o1}) \approx -\frac{r_{o2}g_{m1}}{g_{m2}} \\
K &= g_{m2}
\end{aligned}
$$

$$
\begin{aligned}
\therefore R_{v,close} &= \frac{-r_{o2}g_{m1}}{g_{m2}(1+g_{m1}r_{o2})} \\
R_{in,close} &= \frac{r_{o2}}{1+g_{m1}r_{o2}} \\
R_{out,close} &= \frac{1}{g_{m2}(1+g_{m1}r_{o2})}
\end{aligned}
$$

(c) 视M_2为反馈部分。

$$
\begin{aligned}
R_{in} &= r_{o2}//\frac{1}{g_{m1}} \approx \frac{1}{g_{m1}} \\
R_{out} &= r_{o1} \\
R_0 &= \frac{1}{g_{m1}} \cdot g_{m1}r_{o1} = r_{o1} \\
K &= -\frac{1}{g_{m1}} \cdot g_{m2}g_{m1} = -g_{m2}
\end{aligned}
$$

$$
\begin{aligned}
\therefore R_{v,close} &= \frac{r_{o1}}{1+r_{o1}g_{m2}} \\
R_{in,close} &= \frac{1}{(1+r_{o1}g_{m2})g_{m1}} \\
R_{out,close} &= \frac{r_{o1}}{1+r_{o1}g_{m2}}
\end{aligned}
$$