场效应晶体管放大电路 习题

知识点1:

Ex.1. D

Ex.2. 耗尽 增强

Ex.3. N沟道增强型

Ex.4. $V_{TH}>0$ $V_{TH}<0$

Ex.8. 场效应管放大→饱和区

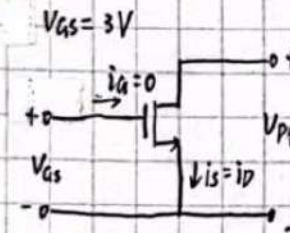
Ex.9. A

Ex.10. A

Ex.11. > < < >

知识点2:

Ex.1. $V_t=1V$ $k_n'\frac{W}{L}=0.05mA/V^2$ $V_T=26mV$



临界条件是 $V_{GS}-V_t=2V$

① $V_{DS}=1V<V_{GS}-V_t$ ∴处于放大区.

故 $i_D=k_n'\frac{W}{L}[(V_{GS}-V_t)V_{DS}-\frac{1}{2}V_{DS}^2]$

$=0.05\times(2-\frac{1}{2})=\underline{0.075mA}$

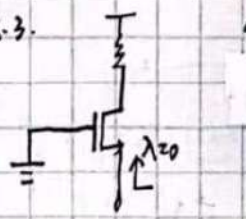
② $V_{DS}=4V>V_{GS}-V_t$ ∴处于饱和区

故 $i_D=\frac{1}{2}k_n'\frac{W}{L}(V_{GS}-V_t)^2$

$=\frac{1}{2}\times0.05\times4=\underline{0.1mA}$

Ex.2. $V_{DS}\geq V_{GS}-V_t$ D.

Ex.3.



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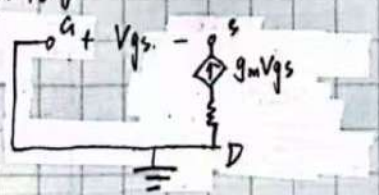
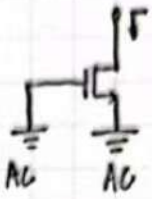


$r_o=\frac{V_{gs}}{g_mV_{gs}}=\frac{1}{g_m}$



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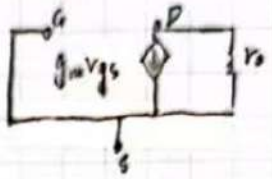
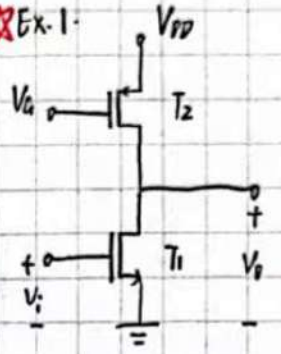


$\underline{r_o}$.

Ex.5. 饱和区 栅极和源极

知识点3:

双Ex.1.



$(\frac{W}{L})_1=1$ $(\frac{W}{L})_2=\frac{1}{4}$

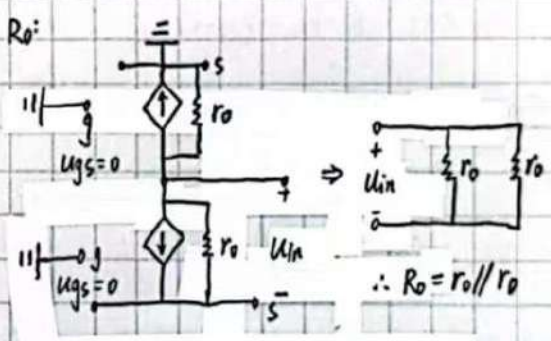
$\mu C_{ox}=20\mu A/V^2$ $V_A=50V$

$I_D=200\mu A$

R_o; A_V

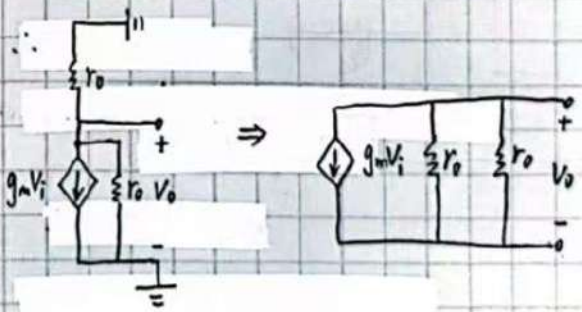
$k_n'=\mu C_{ox}=20\mu A/V^2$

R_o:



∴ $R_o=r_o/\!/r_o$

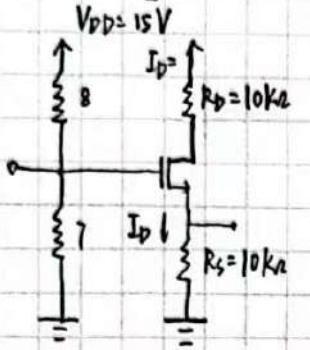
A_V: 交流通路, 直流源 V_G 接地.



∴ $V_o=-g_mV_i\cdot(r_o/\!/r_o)$

$A_V=\frac{V_o}{V_i}=-g_mR_o=-g_m(r_o/\!/r_o)$

Ex.2. $V_t = 1V$ $\frac{W}{L} = 5$ $\mu_n C_{ox} = 0.2mA/V^2$ 求 I_D.



$V_{GS} = 7 - 10I$

$\therefore I_D = \frac{1}{2} k_n' \cdot \frac{W}{L} (V_{GS} - V_t)^2$

$I = \frac{1}{2} \cdot (6-10I)^2$

$2I = (10I-6)^2$

$100I^2 - 120I + 36 = 2I$

$50I^2 - 61I + 18 = 0$

$I_1 = 0.72mA$ $I_2 = 0.5mA$

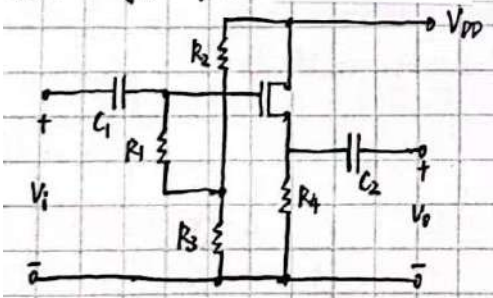
校验饱和区: $V_{GS} > V_t$. 且 $V_{DS} > V_{GS} - V_t$.

$V_{DS} = 15 - 20I > 6 - 10I$ $I < 0.9mA$

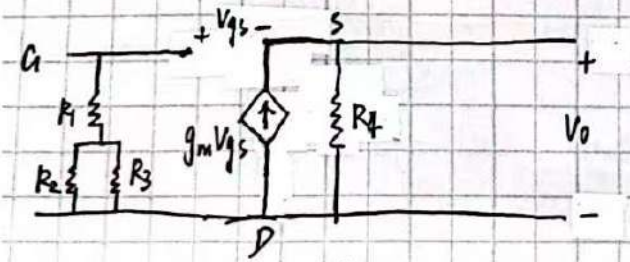
$7 - 10I > 1$ $I < 0.6mA$

$\therefore$ 取 $I_2 = 0.5mA$ 故 $\underline{I_D = 0.5mA}$

Ex.3. $g_m = 0.9mS$



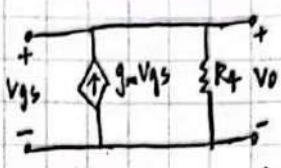
等效小信号:



$A_u = \frac{g_m V_{gs} R_4}{g_m V_{gs} R_4 + V_{gs}} = \frac{g_m R_4}{g_m R_4 + 1} \approx 0.92$

$R_i = R_1 + R_2 // R_3 \approx 20.75k\Omega$

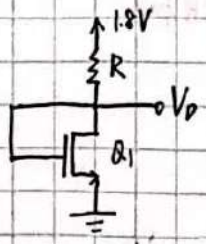
R_o: V_i 置零



$R_o = \frac{V_o}{\frac{V_o}{R_4} + g_m V_o} = \frac{1}{g_m + \frac{1}{R_4}} \approx 1.02k\Omega$

Ex.5. $V_{Th} = 0.5V$, $\mu_n C_{ox} = 0.4mA/V^2$

$\frac{W}{L} = 4$. $V_D = 0.7V$. 求 R



解: $k_n' = 0.4mA/V^2$

$V_D = 1.8 - IR$ 即求 I_D

$\because V_{GS} = V_{DS} > V_{GS} - V_t$

$\therefore$ 处于饱和区

$I_D = \frac{1}{2} k_n' \cdot \frac{W}{L} (V_{GS} - V_t)^2$

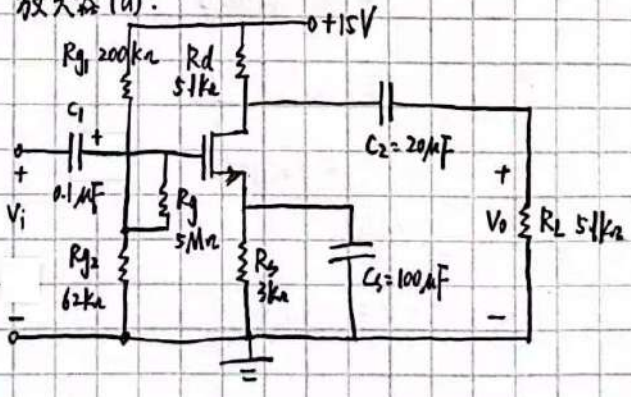
$= \frac{1}{2} \times 0.4 \times 4 \times (0.7 - 0.5)^2$

$= \frac{1}{2} \times 1.6 \times 0.04 = 0.032mA$

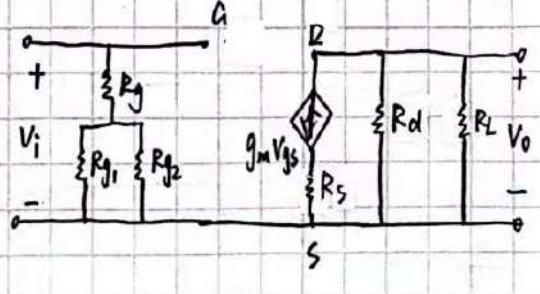
$\therefore R = \frac{1.1V}{0.032mA} = 34.4k\Omega$.

Ex.6.

放大器(a):



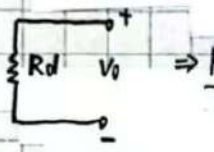
等效电路图:



$$A_u = \frac{-g_m V_{gs}(R_d // R_L)}{V_{gs}} = -g_m(R_d // R_L)$$

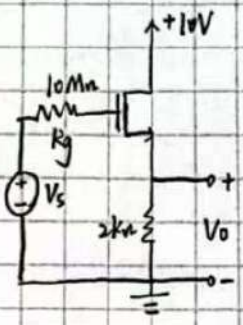
$$R_i = R_g + R_{g1} // R_{g2}$$

R_o：$V_i = 0$，$V_{gs} = 0$，开 R_L：

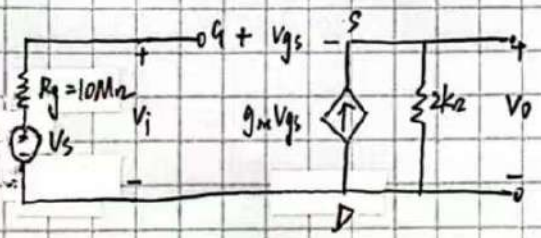


$\Rightarrow R_o = R_d$

放大(b)：



等效电路图：



$$A_u = \frac{V_o}{V_i} = \frac{g_m V_{gs} R}{V_{gs} + g_m V_{gs} R} = \frac{g_m R}{1 + g_m R}$$

$R_i = \infty$（开路）

$$R_o = \frac{V_o}{g_m V_o + \frac{V_o}{R}} = \frac{1}{g_m + \frac{1}{R}}$$