國立臺灣科技大學答案卷

National Taiwan University of Science and Technology Answer Sheet

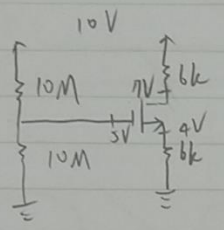
評分 Score	教師簽章 Signature of Lecturer
83	

姓名/Name 張柏豪 學號/Student ID B11002110 班級/Class 四電子二乙

科目/Course title 電子學 日期/Date 111.10.25

記分欄 從此處開始寫起。試卷用紙務須節用，非經主試認可不得續用其他紙張作答。/Please write from here.

1. $I_D = 0.5mA$, $V_{GS} = 2V$



$k_n = 0.5\ mA/V^2$

$V_t = 1V$

$\lambda = 0$, 求 I_D, V_{GS}

$V_{GS} = 5 - 6kI_D$

設在飽和區

$I_D = \frac{1}{2}(0.5m)(5-6kI_D-1)^2 \Rightarrow I_D = 0.25m(4-6kI_D)^2 \Rightarrow 2kI_D = 16 - 48kI_D + 36MI_D^2$

$\Rightarrow 36MI_D^2 - 50kI_D + 16 = 0$

$\Rightarrow I_D = 0.5m$ or $0.89\ mA$ (不合)

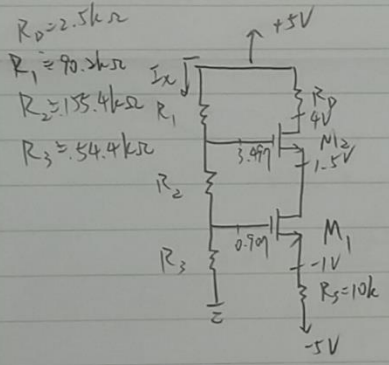
$\Rightarrow V_S = 3V \Rightarrow V_{GS} = 2V$

$6kI_D = V_S$

Check:

$V_G - V_D = -2V < V_t \Rightarrow$ 飽和區

2. $R_D = 2.5k\Omega$, $R_1 = 90.2k\Omega$, $R_2 = 155.4k\Omega$, $R_3 = 54.4k\Omega$



$V_{t1} = V_{t2} = 1.2V$

$k_{n1} = k_{n2} = 0.8\ mA/V^2$

$R_1 + R_2 + R_3 = 300k\Omega$

$I_{DQ} = 0.4\ mA$

$V_{DS1} = V_{DS2} = 2.5V$

求 R_1, R_2, R_3, R_D

$\frac{5}{12.5k}$

$V_{S1} = -5 + I_D R_S = -1V \Rightarrow V_{S2} = 1.5V \Rightarrow V_{D2} = 4V \Rightarrow \boxed{R_D = \frac{5-4}{0.4m} = 2.5k\Omega}$ #2

$I_D = \frac{0.5}{0.4m} = 0.8m(V_{GS}-1.2)^2 \Rightarrow 0.5 = V_{GS}^2 - 2.4V_{GS} + 1.44 \Rightarrow V_{GS}^2 - 2.4V_{GS} + 0.94 = 0$

$\Rightarrow V_{GS} = 0.493$ or 1.907 (不合)

$\Rightarrow V_{G1} = 0.907$, $V_{G2} = 3.407$

$I_x = \frac{5}{300k} = \frac{1}{60k}$

$\Rightarrow \boxed{R_3 = 0.907 = \frac{1}{60k} = 54.4k\Omega}$ #2

$\boxed{R_2 = (3.497 - 0.907) = \frac{1}{60k} = 155.4k\Omega}$ #2 (3.407, 150kΩ)

$\boxed{R_1 = (5 - 3.497) = \frac{1}{60k} = 90.2k\Omega}$ #2 (3.407, 95.6kΩ)

8

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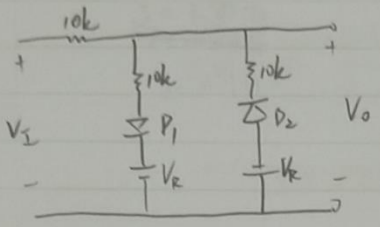
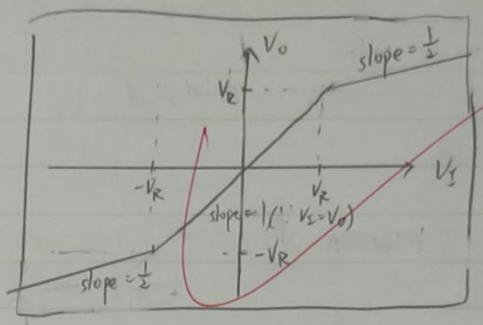
3.



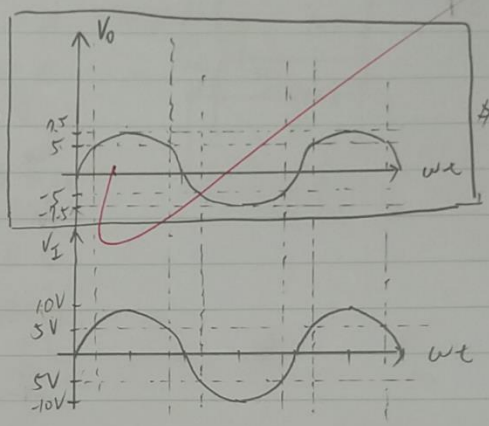


#3(a)

令 $V_R = 5V$

$V_I = 10 \sin \omega t$

畫出 $V_o(t)$ 波形



#3(b)

when $V_o > V_R$: $V_o = V_R + (V_I - V_R) \times \frac{10k}{10k + 10k} = V_R + (V_I - V_R) \times \frac{1}{2}$

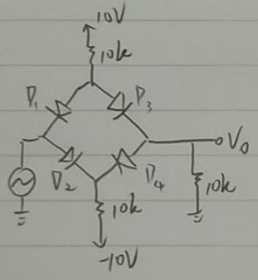
when $V_o < -V_R$: $V_o = -V_R + (V_I - (-V_R)) \times \frac{1}{2}$

$\Rightarrow V_o = -V_R + (V_I + V_R) \times \frac{1}{2}$

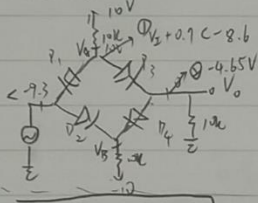
when $V_I = 10V$: $V_o = 5 + 5 \times \frac{1}{2} = 7.5V$

$5 + 6 \times \frac{1}{2} = 8$

4.



When $V_o < -9.3V$



① D_1 on first $\Rightarrow V_B = V_I + 0.7 < -8.6$

② D_4 on second $\Rightarrow V_o = \frac{-9.3}{10k} \times \frac{10k}{10k + 10k} = -4.65$

③ D_3 OFF

D_2 OFF

when $-9.3 < V_I < -4.65$

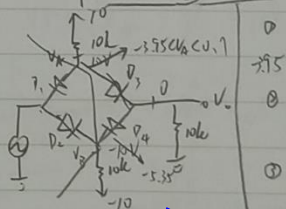
① D_1 on first $\Rightarrow V_B = V_I + 0.7 < -3.95V$

② D_4 on second $\Rightarrow V_o = -4.65V$

③ D_3 OFF

D_4 OFF

when $-0.65 < V_I < 0$:



① D_1 on first:

$-3.95 < V_B = V_I + 0.7 < 0.7$

② D_4 on second:

$V_o = -4.65$ $V_B = -5.35$ V

③ D_2, D_3 on simultaneously

$V_A - 0.7 = V_B + 0.7$

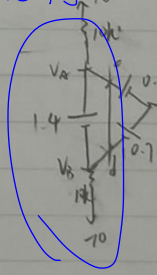
$\Rightarrow V_A = V_B + 1.4$

$R_{th(cd)} = 0$

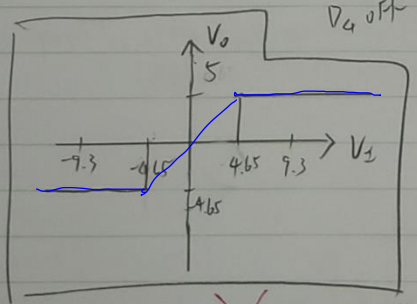
$V_{th(cd)} = 1.4V$

$\Rightarrow V_o = 0V$

不能把箭入戴維寧



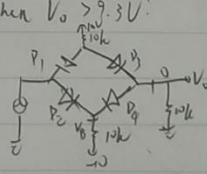
So:



#4.

X

When $V_o > 9.3V$:

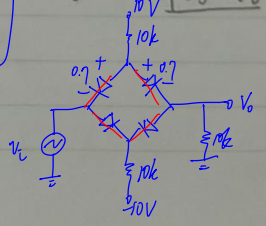


① D_2 ON first $\Rightarrow V_B - V_o = 0.7$

② D_3 ON second, $V_o = 5V$

③ D_4 OFF

D_1 OFF



$V_o = V_i + 0.7 - 0.7$

$= V_i$

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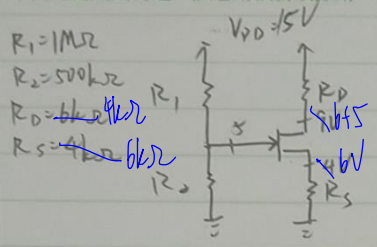
5.



$R_1=1M\Omega$
$R_2=500k\Omega$
$R_D=6k\Omega$
$R_S=4k\Omega$

JFET, $V_P=-2$
$I_{DSS}=4mA$

(a) 使 $V_{DS}=5V$, $I_D=1mA$, $V_{DS}=5V$

$I_{R_1}=I_{R_2}=0.01mA$, 飽和區:

$R_1=\frac{15-5}{0.01m}=10\times10^5=1M\Omega$ #5(a)

$R_2=\frac{5}{0.01m}=500k\Omega$ #5(a)

$I_D=1m=4m\left(1-\frac{V_{GS}}{-2}\right)^2 \Rightarrow 0.25=1+V_{GS}+\frac{V_{GS}^2}{4}$

$\Rightarrow 1=4+4V_{GS}+V_{GS}^2 \Rightarrow V_{GS}^2+4V_{GS}+3=0$

$(X+3)(X+1)$ $V_{GS}=-1V$

$R_D=\frac{15-5}{1m}=6k\Omega$ #5(a)

$R_S=\frac{5}{1m}=4k\Omega$ #5(a)

(b):

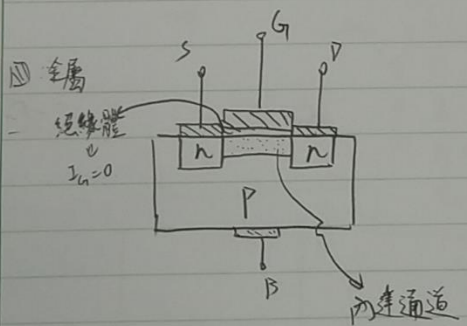
令 JFET 在飽和區, $V_{GD}\le -2 \Rightarrow V_D\ge 7$

$\Rightarrow R_D\le\frac{15-7}{1m}=8k\Omega$

$R_D=8k\Omega$ #5(b)

6. 空乏型 NMOS 工作原理：透過在 V_G V_S V_D 端加上壓差來使通道增加或減小來控制 I_D

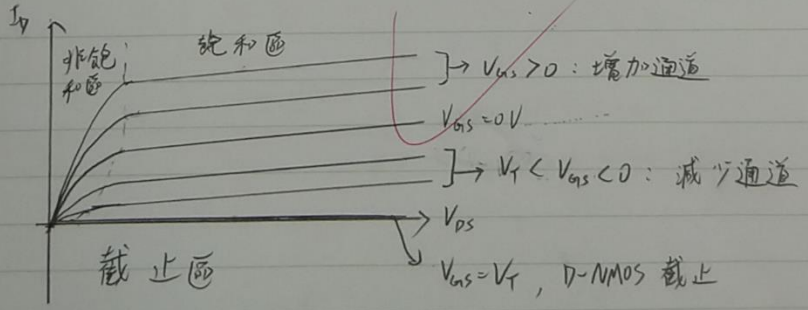
V_T 為使通道開閉之電壓 $\Rightarrow V_T<0$



飽和條件: $V_{GD}<V_T$ → G-D 端夾止, $V_{GS}>V_T$

非飽和條件: $V_{GD}>V_T$, $V_{GS}>V_T$

截止條件: $V_{GS}<V_T$



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