

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

1. A PN junction is doped with boron (B) of $N_A = 5 \times 10^{16} \text{ cm}^{-3}$ and with phosphorous (P) of $N_D = 2 \times 10^{17} \text{ cm}^{-3}$ on P and N sides, respectively. Use $n_i = 1.0 \times 10^{10} \text{ cm}^{-3}$, and $V_T = 25 \text{ mV}$.
 - (a) Determine the majority and minority carrier concentrations on P and N sides. [5%]
 - (b) Determine the built-in barrier potential. (Use $\ln 10 = 2.3$) [5%]
2. In Fig. 1, assume the diode has a constant-voltage model with $V_{D,ON} = 0.8 \text{ V}$.
 - (a) If V_S is 10V, calculate node voltage V_X and the diode current I_D . [5%]
 - (b) Determine the value of V_S such that the diode is turned off (i.e. $I_D = 0$). [5%]

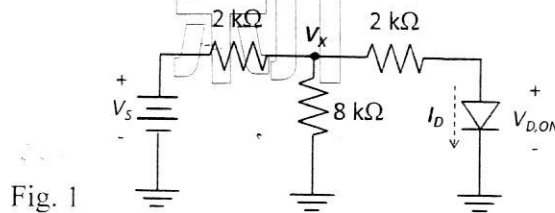


Fig. 1

3. In Fig. 2, assume the diode has a constant-voltage model with $V_{D,ON} = 0.8 \text{ V}$, plot the input/output characteristic for the following circuit. [10%]

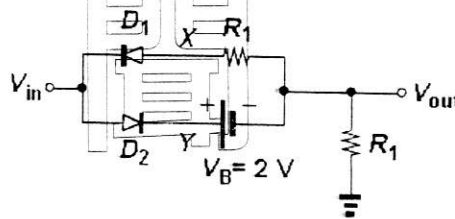


Fig. 2

4. In the circuit of Fig. 3, Q_1 and Q_2 are identical, and have their V_{BE} and I_C relation as listed in the following Table, and $I_{S1} = I_{S2} = 1.5 \times 10^{-16} \text{ A}$.

| | | | | | | | | | | | |
|----------------------|------|------|------|------|------|------|------|------|------|------|------|
| $V_{BE} \text{ (V)}$ | 0.70 | 0.71 | 0.72 | 0.73 | 0.74 | 0.75 | 0.76 | 0.77 | 0.78 | 0.79 | 0.80 |
| $I_C \text{ (mA)}$ | 0.15 | 0.22 | 0.31 | 0.47 | 0.70 | 1.00 | 1.50 | 2.20 | 3.22 | 4.71 | 6.92 |

- (a) For what value of V_B to make $I_X = 3.0 \text{ mA}$? [5%]
- (b) With the value of V_B found in part (a), what is I_{S3} of Q_3 to make $I_Y = 5.0 \text{ mA}$. [5%]
- (c) Using the current in part (b) find the small signal parameters of Q_3 , i.e. calculate g_{m3} , $r_{\pi 3}$, and r_{O3} if $\beta = 100$, $V_A = 30 \text{ V}$, and $V_T = 25 \text{ mV}$. [5%]

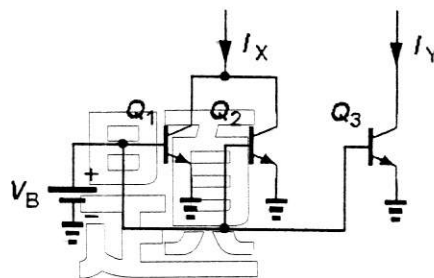


Fig. 3

科目：電子學一(元件)

適用：電機系

考生注意：

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5. For the MOSFET M_1 shown in Fig. 4 is biased at four different cases. Assume the threshold voltage, V_{T1} , of M_1 is 0.5V. What is its operation mode for each case? Answer each with *cutoff*, *linear*, or *saturation*. [10%]

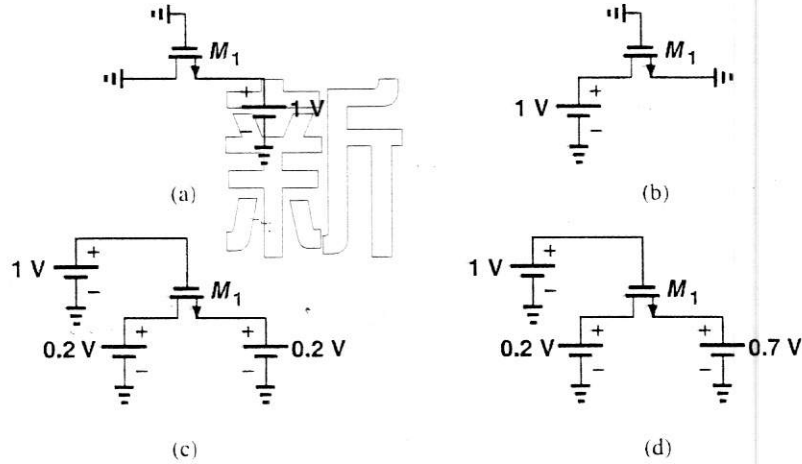


Fig. 4

6. For the circuit in Fig. 5, determine V_{GS} , I_D and g_m of M_1 .
Use $\mu_n C_{ox} = 200 \mu A/V^2$, $V_{TH} = 0.5 V$, $\lambda = 0$. [10%]

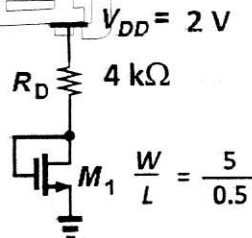


Fig. 5

7. Please briefly explain the following terms or questions.

- (a) Drift and Diffusion currents in semiconductor [5%]
- (b) Depletion region of a diode. [5%]
- (c) Early effect in BJT [5%]
- (d) Body effect in MOSFET [5%]
- (e) Why CMOS displacing BJT [5%]

8. Complete the English for the following acronym. [10%]

- (a) BJT = B _____ J _____
- (b) CMOS = C _____ M _____ O _____ S _____
- (c) LED = L _____ E _____ D _____