淡江大學八十七學年度碩士班入學考試試題

系別：電機工程學系　　科目：電子學

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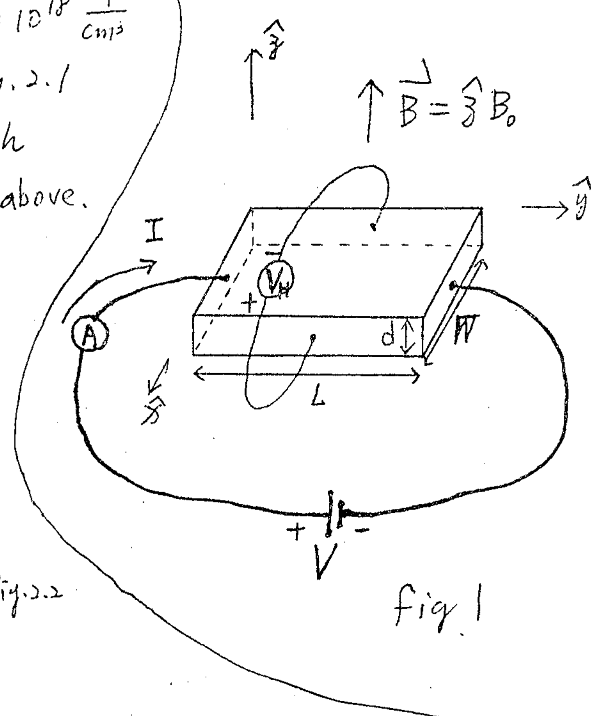
(一) (a) what is the semiconductor type in the right figure. (b) If the
10% semiconductor is uniformly doped, what is the majority carrier concentration (in terms of the measured B_0, V_H, etc.)



(二) A PN junction is formed with $N_A = 10^{18} \frac{1}{cm^3}$
10% and $N_D = 10^{15} \frac{1}{cm^3}$. The diode of fig. 2.1 and EBJ of fig. 2.2 are made with the same PN junction mentioned above.

(a) choose one answer below

① $i_D > i_E$ ② $i_D = i_E$ ③ $i_D < i_E$

(b) Explain your choice

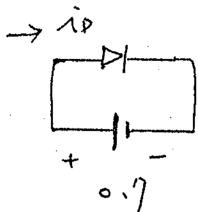


fig. 2.1

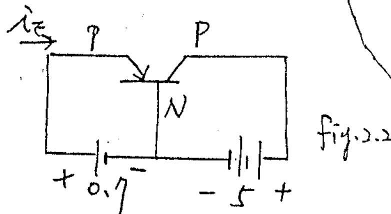


fig. 2.2

(三) One of the Ebers-Moll model of a BJT is given by
10%

$$i_C = -\alpha_F i_E - I_{CO}\left(e^{\frac{v_{BC}}{V_T}} - 1\right) \cdots ①$$

$$i_E = -I_{EO}\left(e^{\frac{v_{BE}}{V_T}} - 1\right) - \alpha_R i_C \cdots ②$$

The advantage of EM model is that α_F, α_R, I_{EO} and I_{CO} can be measured directly by experiment.

(a) Write down suitable expressions for α_F, α_R, I_{EO} and I_{CO} in terms of the terminal voltages and currents, respectively.

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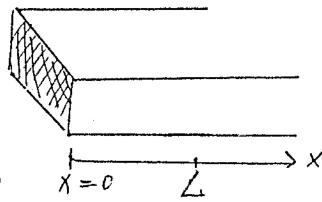
(b) According to your expressions in part (a), set up some experiments to measure α_F, α_R, I_{EO} and I_{CO}, respectively.



(四) 10% (a) An infinite-plane perfume source with constant concentration P_0 is located at $x=0$. At $t=0$, the concentration $P(x)=0$, for $x>0$ (in air). What will be the concentration $P_{L1} = P(x)|_{x=L}$ as $t\to\infty$?

(b) If the plane perfume source is replaced with a hole source with constant concentration $P_0 \gg P_{no}$, where P_{no} is the hole concentration of a doped n-semiconductor at $x>0$ and $t=0$. What will be the concentration $P_{L2} = P(x)|_{x=L}$ as $t\to\infty$? (Assume $L=L_p$, the diffusion length of hole)

(c) Which one is bigger comparing P_{L1} and P_{L2}? why?

(五) 10% Assume an NMOS FET is in triode region for a specified V_{GS}, of which the drain current i_D increases as V_{DS} increases. How does the channel resistance $\frac{V_{DS}}{i_{DS}}$ change as V_{DS} increases? (increase, decrease or unchange) Give your explanation!

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(六) Consider the channel depth of an enhanced NMOS ($V_t = 1$ volt)
10% and a depletion NMOS ($V_t = -1$ volt).
when $v_{GS} = 2, 0$ and -2 volt, respectively,
which MOS has deeper channel?

(七) Let $R = 15\,K\Omega$, $R_G = 0K$, find i_D, v_D!
10% (NMOS: $V_t = 2V$, $K = 0.1\ mA/V^2$)

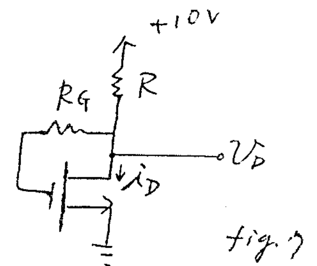

fig.7

(八) Let $R = 15K$, $R_B = 0K$, find i_c, v_c!
10% ($\beta = 100$)

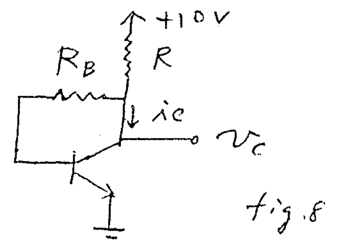

fig.8

(九) Fig.9 is an inverter. (a) Design R_D such that
10% $v_o = 0.1$ volt when $v_I = 5$ volt.
(NMOS: $V_t = 1$ volt and $K = 0.5\ mA/V^2$)
(b) what is the turn on resistance?

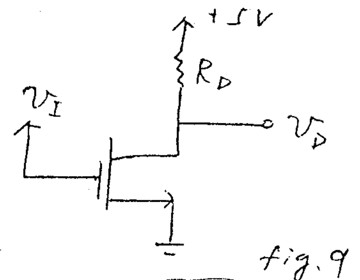

fig.9

(十) In fig.10, if V_G is set at 3 different voltages
10% 0 volt, 2 volt and 10 volt, respectively,
the MOSFET is in which region
(triode, Pinch-off, cut-off)?
(Assume NMOS: $V_t = 1$ volt, $K = 0.5\ mA/V^2$)

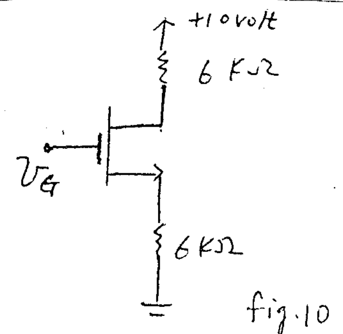

fig.10