# 國立中山大學100學年度碩士班招生考試試題

科目：半導體概論【電機系碩士班甲組】

1. The lattice constant of Ge is 5.65× $10^{-8}$ cm for a diamond crystal structure. Calculate

   (a) the distance from the center of one Ge atom to the center of its nearest neighbor. (10%)

   (b) the number density of Ge atoms on <110> plane ( # per $cm^2$ ) (10%)

2. An Au-n-GaAs Schottky Contact is at T=300K$^o$ with $N_d$ =2× $10^{16}$ $cm^{-3}$ ( $\phi_m$ =5.1 Volt, $\chi$ =4.07 Volt, $N_c$ =4.7× $10^{17}$ $cm^{-3}$ , $\epsilon = 13.1\epsilon_o$ ,$\epsilon_o = 8.85 \times 10^{-14}$ $F/cm$ ). Calculate

   (a) the depletion region width for a revrese bias voltage of 0.5V. (10%)

   (b) the maximum electric filed in the above condition .(10%)

3. Consider the p-n-p bipolar junction transistor with base width $W_b$ . The base doping concentration is $N_d$ and the base hole diffusion coefficient is $D_p$ . The emitter doping concentration is $N_a$, the emitter electron diffusion coefficient is $D_n$, and the emitter width is $W_e$ which is much smaller than the electron diffusion length in the emitter. Derive the expression of the emitter injection efficiency $\gamma$. (20%)

4. A MOS transistor is fabricated on a p-type silicon substrate with $N_a$ =3× $10^{15}$ $cm^{-3}$ . The oxide thickness is $t_{ox}$ =600× $10^{-8}$ cm and the equivalent fixed oxide charge is $Q'_{SS}$ =1.5× $10^{11}$ $cm^{-2}$ . Calculate the threshold voltage when the source/bulk bias voltage $V_{SB}$ is equal to 0.6 V for an $n^+$ -polysilicon gate. ( Si : $n_i = 1.5 \times 10^{10} cm^{-3}$ , $\epsilon_{Si} = 11.8\ \epsilon_o, \epsilon_{SiO_2} = 3.9\ \epsilon_o$ , $\epsilon_o = 8.85 \times 10^{-14}\ F/cm$,$E_g$= 1.12eV . Note: kT/q = 0.0259 V,$q = 1.6 \times 10^{-19} C$ ) (20%)

5. A direct semiconductor has the recombination rate R=$\alpha$ (pn-$n_i^2$) where $\alpha$ =1× $10^{-8}$ $cm^3/s$ and $n_i$ = $10^{10}$ $cm^{-3}$ . The semiconductor is doped with $N_d$ =2× $10^{15}$ $cm^{-3}$. The sample is uniformly exposed to a steady optical generation rate of $g_{op}$ = 1× $10^{22}$ EHP/$cm^3$ -s. For this excitation, calculate the electron concentration $n$. (20%)