

國 立 清 華 大 學 命 題 紙

八十四學年度 電機 所 丙 組碩士班研究生入學考試

科目 固態電子元件 科號 2405 共 3 頁第 1 頁 *請在試卷【答案卷】內作答

The following numbers may be used throughout this examination:

$\ln(2)=0.693$, $\ln(3)=1.099$, $\ln(5)=1.609$, $\ln(7)=1.946$, and $kT/q=25.8\text{mV}$ at room temperature.

1. (a) Plot the energy band diagrams of an ideal MOS capacitor fabricated on p-type silicon in (I) accumulation (II) depletion and (III) inversion. Indicate E_c , E_v , E_f , and E_i on your diagrams.

(b) Plot the charge density, electric field and electrostatic potential of a MOS capacitor fabricated on p-type silicon in inversion. (20%)

2. Determine the metal-semiconductor work function difference in a MOS structure with p-type silicon for the case when the gate is (I) aluminum (II) n' polysilicon and (III) p' polysilicon. Assume the following parameters: the dopant concentration in the p-type substrate is $N_A=3 \times 10^{15}\text{cm}^{-3}$, the work function of aluminum is 4.20 eV, the electron affinity of silicon is 4.05 eV, the energy gap of silicon is 1.12 eV and the intrinsic carrier concentration of silicon is $1.5 \times 10^{10}\text{cm}^{-3}$. (15%)

3. Explain in a p-n junction, (I) the formation of space-charge region, (II) the absorption of photons, the generation of carriers, the recombination of carriers and the collection of carriers when the p-n junction is under illumination, (III) the current-voltage relation when the p-n junction is in the dark and under illumination, preferable using a plot. (15%)

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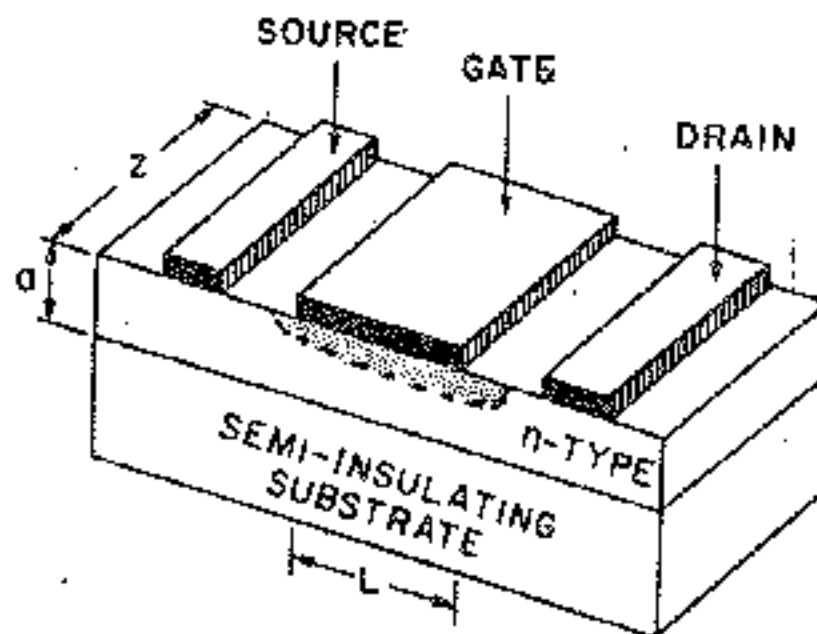
科目 固態電子元件 科號 2405 共 3 頁第 2 頁 *請在試卷【答案卷】內作答

4. The following data are obtained from various germanium samples at 50K, where R_H is the Hall coefficient and ρ is the resistivity.

Sample number	I	II	III	IV	V
R_H (cm ³ /coulomb)	8×10^5	6×10^4	6×10^3	3.5×10^2	9
ρ (Ω -cm)	10	1	0.2	7×10^{-2}	8×10^{-3}

Calculate the electron mobilities, μ , in different samples. Examine the tendency of the variation of μ with respect to ρ and cite the possible cause for the observed variation in μ . If two different collision process are present, it is necessary to add up the effects due to each process. Between the two possible choices $\mu = \mu_1 + \mu_2$ and $(1/\mu) = (1/\mu_1) + (1/\mu_2)$, pick up the equation that you think is reasonable. Give reasons. How would you then treat the data presented above? (20%)

5. A GaAs MESFET is shown below. What channel type (n or p) and mode (depletion or enhancement) is it? why? (5%)
Plot the high-frequency small-signal equivalent circuit of this device. Give each component a very brief explanation. (10%)



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6. Plot the common emitter current gain as a function of the base current I_B from 0 to $25\mu\text{A}$ at a fixed V_{CE} of 5V for the transistor shown below. (7%) Explain the trend in your curve. (8%)

