國立中央大學105學年度碩士班考試入學試題

所別： 光電科學與工程學系 碩士班 不分組(一般生)　　共2頁 第1頁

科目： 電子學

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷(卡)內作答

1. (40%) A p-n junction is formed in Si whose Fermi level on the p-side is 25 meV above the valence bandedge E_v. The n-side material is doped at a concentration of $N_d = 10^{15}$ cm^{-3}. Given the electric field of $E(0) = -1.583 \times 10^4$ V/cm at the junction ($x = 0$), the junction area of 0.02 cm^3, minority carrier life time $\tau_n = \tau_p = 1.0$ μs, and the temperature 300 K, answer the following questions:
   (a) (5 %) Explain the purpose(s) of having the acceptor level very close to E_v.
   (b) (5 %) Determine the contact potential energy qV_0, where q is the elementary charge.
   (c) (10 %) Derive, showing all the work, the expression for the electric field at the junction [i.e. $E(0)$].
   (d) (5 %) Calculate the total width W of the space charge layer.
   (e) (5 %) Calculate the current flow under a forward bias of 0.60 V.
   (f) (10 %) What is the effective injection rate of holes into the n side under the bias condition given in (e)?

   Constants: $q = 1.602 \times 10^{-19}$ C; $kT = 0.0259$ eV; $\epsilon_0 = 8.854 \times 10^{-14}$ F/cm
   For Si: $D_p = 12.43$ cm^2/s, $D_n = 35.0$ cm^2/s, $E_g = 1.11$ eV, $n_i = 1.5 \times 10^{10}$/cm^3, $\epsilon_r = 11.8$,
   Diode equation: $I = eA\left[\frac{D_n}{L_n}n_{p0} + \frac{D_p}{L_p}p_{n0}\right]\left[\exp\left(\frac{qV}{kT}\right) - 1\right]$

2. (10%) Assume both carriers present in a semiconductor sample in thermal equilibrium. Derive, showing all the work, the minimum conductivity of this sample in terms of the mobility of each carrier species and the intrinsic concentration n_i.

3. For the circuit shown in Fig. 1(a), the input and output voltages that are zero at $t = 0$ is driven by the input signal v_I shown in Fig. 1(b). The resistance and capacitance in the circuit are $C_1 = 0.2$ μF and $R_2 = 5$ KΩ. Determine the maximum value (5%) and minimum value (5%) of output signal v_O. Sketch and label the resulting output waveform v_O versus time (5%).

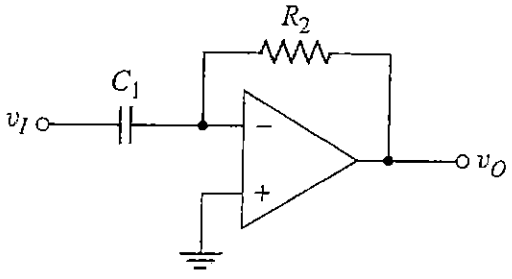

Fig. 1(a)

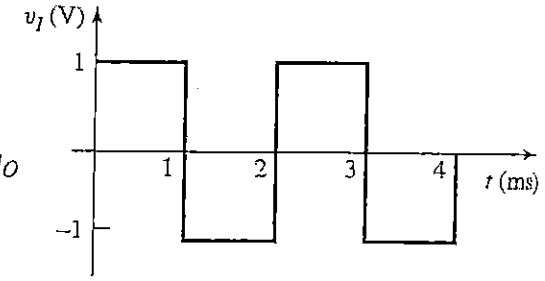

Fig. 1(b)

注意:背面有試題

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4. For the circuit shown in Fig. 2, assume small-signal output resistances of transistors $r_{o1} \sim r_{o4}$ are finite and r_{o5} is infinite.
   (a) Determine the small-signal voltage gain $A_v = v_O/v_I$ (10%).
   (b) Determine the output resistance R_o (5%).

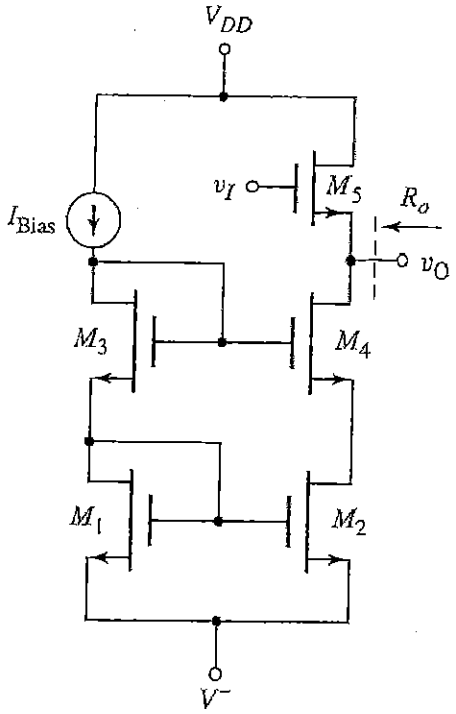

Fig. 2

5. For the circuit shown in Fig. 3, derive the expressions for the voltage transfer function $T(s) = V_o(s)/V_i(s)$ (5%), determine the cutoff frequency f_{3dB} (5%), and sketch Bode plots of magnitude (5%) and phase (5%) for the circuit. .

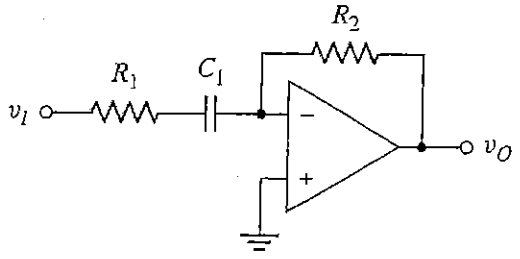

Fig. 3

注意:背面有試題