系所組別：光電科學與工程學系乙組

考試科目：電子學 考試日期：0224，節次：1

※ 考生請注意：本試題不可使用計算機

1. (15%) For an abrupt p-n junction diode with accepter and donor concentration of $10^{16}\,cm^{-3}$ and $10^{15}\,cm^{-3}$, respectively. The junction area is 400 μm^2. The intrinsic carrier concentration is $10^{10}\,cm^{-3}$. ε_s of semiconductor is $11.7\varepsilon_0$, respectively. When the diode is biased at -5V, please calculate:
   (a) the junction build-in voltage (3%)
   (b) the depletion width (3%)
   (c) the depletion width on each p and n side (3%)
   (d) the stored charges on either side of junction (3%)
   (e) the junction capacitance C_j. (3%)

2. (15%) Please find the Vo of the circuit shown in **Figure 1**.

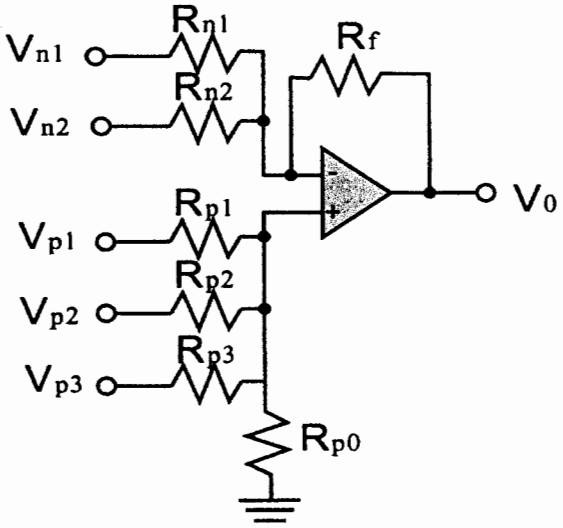

Figure 1

3. (20%) For a circuit shown in **Figure 2**. All transistors have $|V_t|$=1V, λ=0, γ=0, $\mu_n C_{ox}$=50 $\mu A/V^2$, L= 1 μm, and W =10μm.
   (a) Please find the V_2 and I_2. (10%)
   (b) Please also find the V2 and I2 when the W of the Q3 and Q4 is 100μm. (10%)

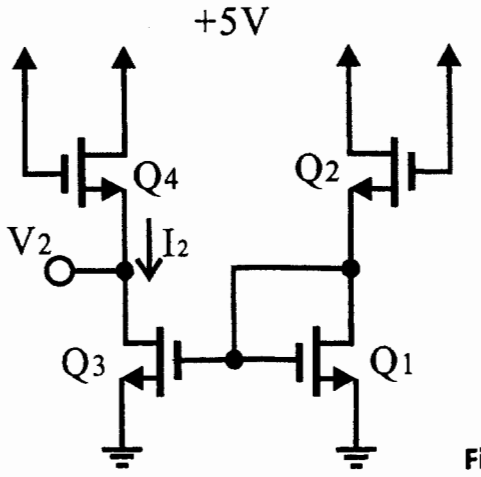

Figure 2

(背面仍有題目,請繼續作答)

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4. (20%) **Figure 3** shows a folded-cascode CMOS amplifier utilizing a simple current source Q_2, supplying a current $2I$, and a cascaded current-source (Q_4, Q_5) supplying a current I. Assume, for simplicity, that all transistors have equal parameters transconductance g_m and output resistance r_0.

(a) Give approximate expressions for all the resistances indicated.

(b) Find the amplifier output resistance R_0.

(c) Show that the short-circuit transconductance G_m is approximately equal to g_{m1}.

(d) Find the overall voltage gain v_0/v_i and evaluate its value for the case g_{m1} = 2mA/V amd A_0=20.

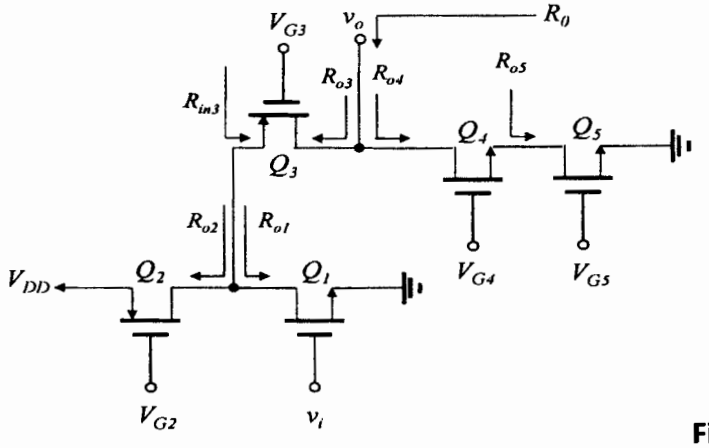

Figure 3

5. (15%) An NMOS differential amplifier employing equal drain resistors, R_D = 47 kΩ has a differential gain A_d of 20 V/V.

(a) What is the value of g_m for each of the two transistors?

(b) If each of the two transistors is operating at an overdrive voltage V_{OV} = 0.2V, what must the value of I be?

(c) For v_{id} = 0. What is the dc voltage across each R_D?

(d) If v_{id} is 20-mV peak-to-peak sine wave applied in a balanced manner but superimposed on the common-mode voltage V_{CM} = 0.5 V, what is the lowest value that V_{DD} must have to ensure saturation-mode operation for Q_1 and Q_2 at all times? Assume V_t = 0.5 V.

6. (15%) Design the inverter circuit in **Figure 4** to provide output high level V_{OH} = 2 V, output low level V_{OL}=0.1 V, and so that the current drawn from the supply in the low-output state is 20 μA. The transistor has V_t =0.5 V, $\mu_n C_{ox}$ =100 μA/V^2, and device parameter λ = 0. Specify the required values of V_{DD}, R_D, and W/L. How much power is drawn from the supply when the output is high? When the output is low?

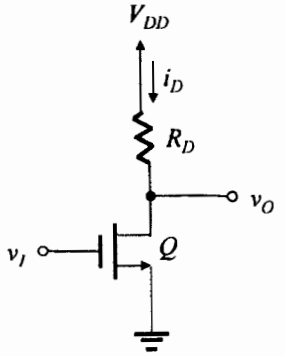

Figure 4