1021 Microelectronic Circuits I (Final)

date: 2014 / 01 / 09 (Thur)

time: 15:30 ~ 17:20

ps. 請在六七兩題間，擇一作答！若兩題均作答則請標記有效題，否則不予計分！

1. In the circuit shown in Fig. 1, R_1 = 10 kΩ, R_2 = 20 kΩ, R_3 = 2 kΩ, R_4 = 2.2 kΩ, and β = 60 for transistor Q_1. Find the collector, emitter, and base currents (I_C, I_E, I_B) of transistor Q_1, and voltages V_1, V_2, V_3. [9%]

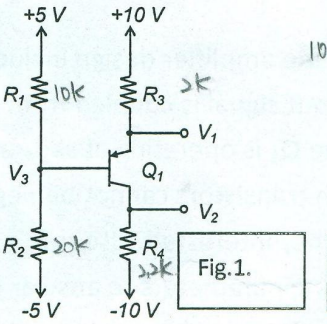

Fig.1.

2. For the circuit in Fig.2. R_B = 100kΩ.
   (a) β = 100, find I_B, I_E, I_C, V_B, V_E, V_C. [8%]
   (b) β = 120, find I_B, I_E, I_C, V_B, V_E, V_C. [8%]

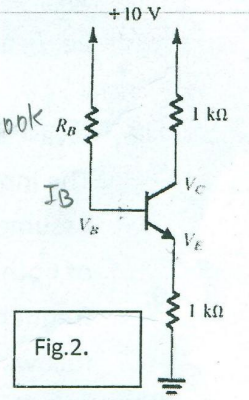

Fig.2.

3. Given that R_G is sufficiently large, and $V_{DD} > 3V_t$.
   (a) For $(W/L)_1$:$(W/L)_2$ = 64:1, find the voltage gain (v_o/v_i) of the amplifier circuit in Fig.3. [12%]
   (b) For $(W/L)_1$:$(W/L)_2$:$(W/L)_3$ = 16:16:1, find the voltage gain (v_o/v_i) of the amplifier circuit in Fig.4. [13%]

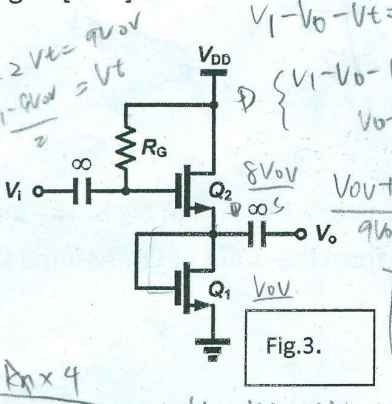

Fig.3.

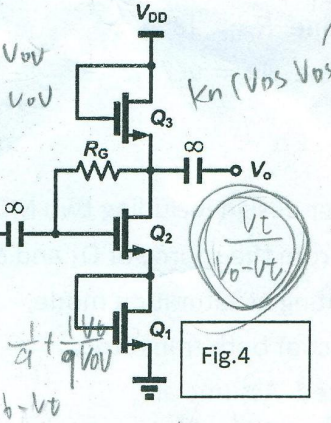

Fig.4

4. The circuit can be shown in Fig.5. Assume $V_{thn} = |V_{thp}|$ = 2V. Please calculate v_O when v_I = 0V, 3V and 6V under the following conditions.
   (a) $\mu_p C_{OX} \frac{W_2}{L_2} = \mu_n C_{OX} \frac{W_1}{L_1}$ [6%]
   (b) $\mu_p C_{OX} \frac{W_2}{L_2} = 0.1 \times \mu_n C_{OX} \frac{W_1}{L_1}$ [6%]

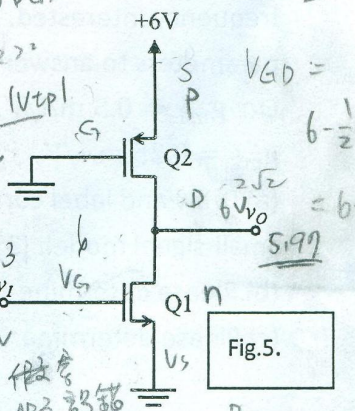

Fig.5.

$\mu_p C_{OX} \frac{W_2}{L_2} = 0.01 \times \mu_n C_{OX} \frac{W_1}{L_1}$ [6%]

5. As shown in Fig.6. The two MOSFETs are perfectly matched. $\mu_p C_{OX} \frac{W_2}{L_2} = \mu_n C_{OX} \frac{W_1}{L_1} = 25\mu A/V^2$ and $V_{thn} = |V_{thp}| = 2V$. Please obtain the DC bias condition, i.e. I_D and V_D. [7%]

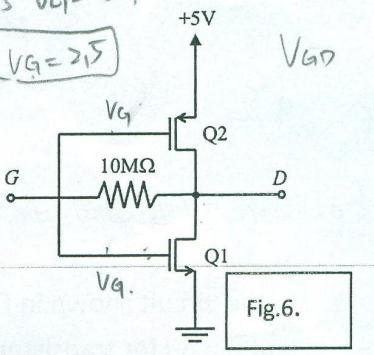

Fig.6.

6. A cascade amplifier design including one MOS and one BJT transistor is shown in Fig.7. The input signal is coupled from the gate of Q_1 and output from the emitter of Q_2. Assume Q_1 is operating at saturation mode and Q_2 is at active mode, and the Early effect of both transistors cannot be neglected. Assume all capacitors are infinite large at the frequency interested. Use the following parameters to answer the questions.

Q_1: $g_{m1} = 0.5\ mA/V$, $r_{o1} = 25\ k\Omega$; Q_2: $\beta = 100$, $g_{m2} = 50\ mA/V$, $r_{o2} = 25\ k\Omega$.

(a) Draw and label correctly the small-signal model. [3%]

(b) Please determine R_{out}. [8%]

(c) Please determine $A_v = v_o/v_i$. [14%]

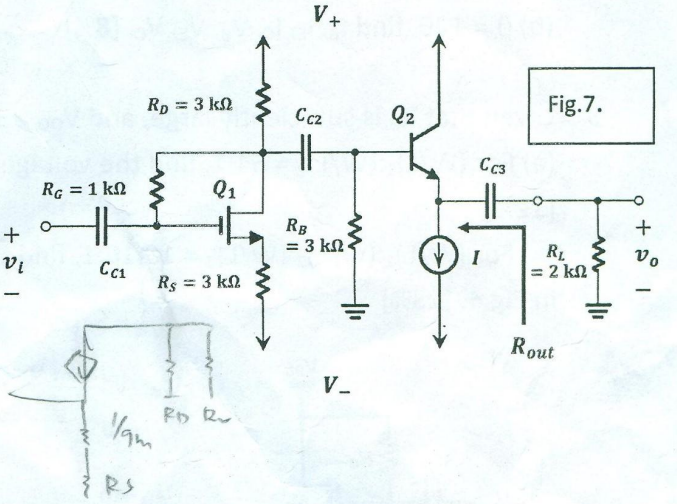

Fig.7.

7. A cascade amplifier design including two MOS transistors is shown in Fig.8. The input signal is coupled from the source of Q_1 and output from the drain of Q_2. Assume Q_1 and Q_2 are both operating at saturation mode, and the Early effect of both transistors cannot be neglected. Assume all capacitors are infinite large at the frequency interested. Use the following parameters to answer the questions.

Q_1: $g_{m1} = 0.5\ mA/V$, $r_{o1} = 25\ k\Omega$; Q_2: $g_{m2} = 0.25\ mA/V$, $r_{o2} = 20\ k\Omega$.

(a) Draw and label correctly the small-signal model. [3%]

(b) Please determine R_{out}. [8%]

(c) Please determine $A_v = v_o/v_i$. [14%]

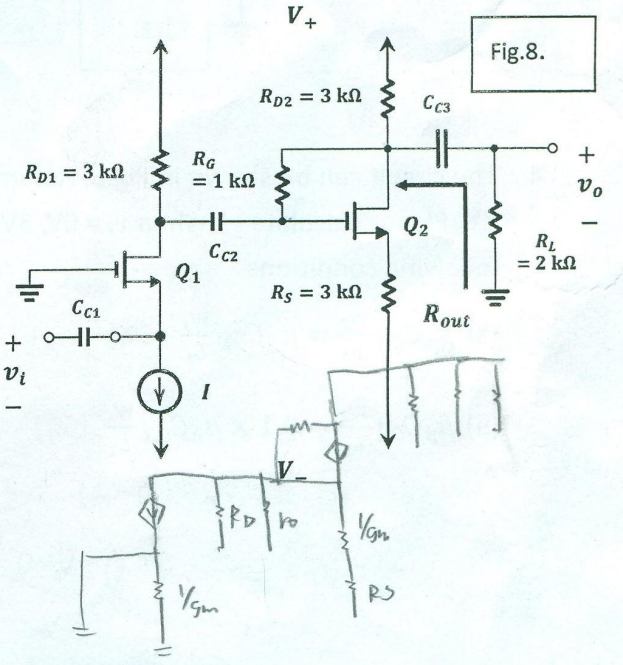

Fig.8.