1. Fill the blanks with either 0 or ∞. [**6 pts**, each blank 1 pts]
   (a) An ideal current amplifier has its input resistance, R_{in} = ____, and output resistance, R_{out} = ____.
   (b) An ideal operational amplifier would provide ____ voltage gain, ____ input impedance, ____ output impedance, and ____ bandwidth.

2. For a saturation MOSFET, how the transconductance, g_m, changes for the following conditions? [**8 pts**, each blank 2 pts]
   (a) W/L is doubled but I_D remains constant. g_m will ________.
   (b) $V_{GS} - V_{TH}$ is doubled but I_D remains constant. g_m will ________.
   (c) I_D is doubled but W/L remains constant. g_m will ________.
   (d) I_D is doubled but $V_{GS} - V_{TH}$ remains constant. g_m will ________.

3. In Fig. 1, assume Q_1 remains at active region, and $V_A \neq \infty$. Fill the blanks with either decrease or increase. When R_E becomes larger, then gain (v_{out}/v_{in}) _____, input resistance (R_{in}) _____, and output resistance (R_{out}) _____. [**6 pts**, each blank 2 pts]

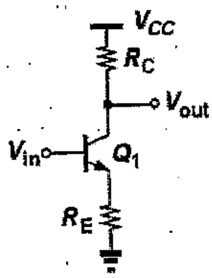

Fig. 1

$$I_D = I_S e^{\frac{V_D}{V_T}}$$

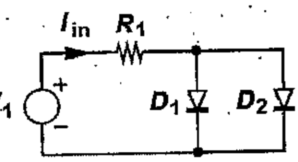

Fig. 2

4. In Fig. 2, D_1 and D_2 are identical except the reverse saturation currents are I_{S1} and I_{S2}, respectively. (a) Determine the current flowing through each diode, I_{D1} and I_{D2}, in terms of I_{in}, I_{S1} and I_{S2}. [**5 pts**] (b) What are the diode currents if $I_{S1} = 4\,I_{S2}$? [**3 pts**]

5. If the electron density in pure silicon, n_i, is equal to 1.0×10^{10} electrons/cm^3. A pn junction employs doping levels of $N_A = 2.0 \times 10^{16}$ cm^{-3} and $N_D = 5.0 \times 10^{15}$ cm^{-3}, where N_A and N_D are the acceptor and donor densities, respectively. Determine the majority and minority carrier concentrations on both sides. [**10 pts**]

6. In Fig. 3, $R_1 = 2\,R_2$. Assume D_1 behaves as an ideal switch with a turn on voltage of 0.6V. Plot the input/output characteristic. [**6 pts**]

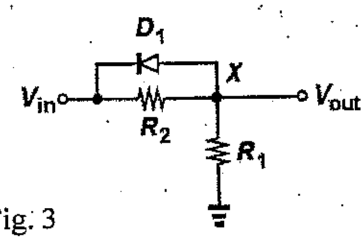

Fig. 3

科目：電子學甲 適用：電機系(電子組)

編號：452

考生注意：
1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。
3.限用藍、黑色筆作答；試題須隨卷繳回。

7. Assume $V_T = 25$ mV. An NPN transistor, Q_1, has $\beta = 100$, $V_A = 13$V, and the following I/V characteristic shown in the table.

V_{BE}(V)	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80
I_C(mA)	0.26	0.36	0.53	0.77	1.15	1.75	2.50	3.60	5.34	7.85	13.0

(a) Find the voltage at point X in Fig. 4? **[5 pts]**

(b) For the circuit in Fig. 5, determine its operating point. **[5 pts]**

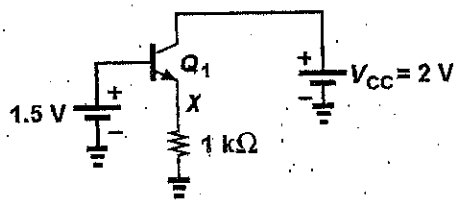

Fig. 4

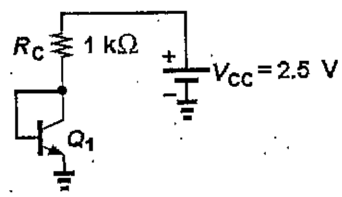

Fig. 5

8. Assume the op amp in Fig. 6 is ideal. (a) Derive the transfer function, $V_{out}/V_{in}(s)$. **[5 pts]**
(b) What type of filter the circuit realized? **[3 pts]**

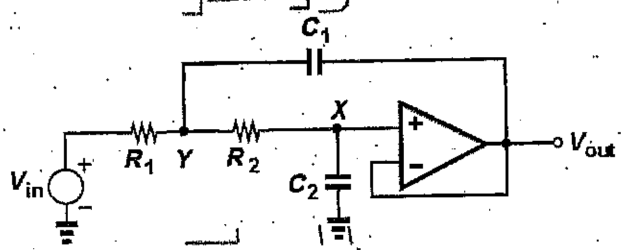

Fig. 6

9. Determine R_1, R_2, R_D, and R_S for the circuit in Fig. 7 with a voltage gain of 6.4, $R_{in} = 10$ kΩ, and power consumption less than 4 mW. Assume $\mu_n C_{ox} = 100$ μA/V^2, $V_{TH} = 0.5$ V; $\lambda = 0$, and $V_{DD} = 1.5$ V. Also, assume V_{GS1} is 0.75 V, (W/L) of M_1 is 800, and the voltage drop across R_S is 250 mV. **[12 pts]**

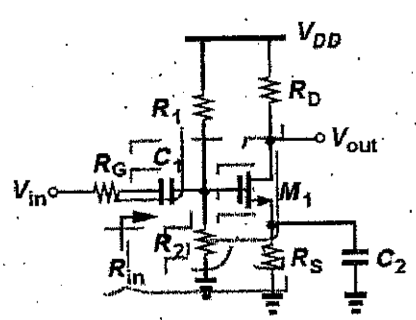

Fig. 7

10. Assume M_1 in Fig. 8 is at saturation and $\lambda = 0$. Use Miller's theorem to estimate the poles of the circuit. **[6 pts]**

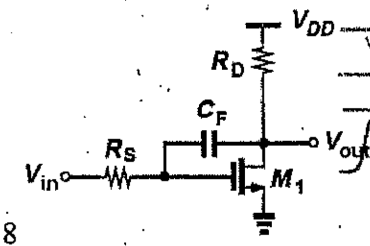

Fig. 8

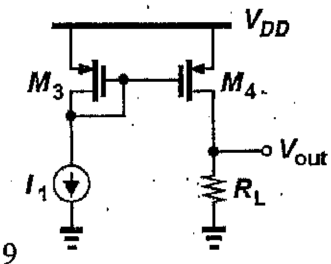

Fig. 9

11. Derive the small-signal gain v_{out}/i_1 of the circuit in Fig. 9 if $(W/L)_3 = N\,(W/L)_4$. **[5 pts]**

12. Determine the value of R_P in Fig. 10 such that $I_1 = I_{REF}/2$. **[5 pts]**

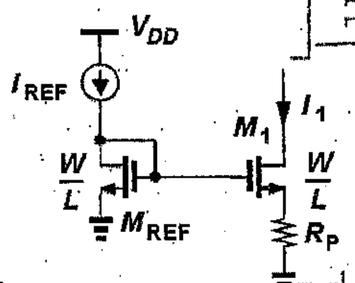

Fig. 10

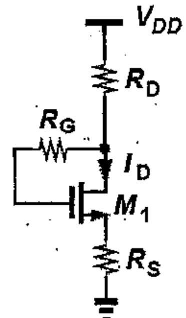

Fig. 11

13. Calculate the drain current of M_1 in Fig. 11 if $\mu_n C_{ox} = 100\ \mu A/V^2$, $V_{TH} = 0.5$ V, $\lambda = 0$, $V_{DD} = 2.5$ V, $R_D = 800\ \Omega$, $R_G = 20$ kΩ, $R_S = 200\ \Omega$, and $(W/L)_1 = 20$. **[10 pts]**