國立雲林科技大學
100學年度碩士班暨碩士在職專班招生考試試題

系所：電機系
科目：電子學(1)

1. Two diodes with identical reverse saturation currents of I_S are placed in series as shown in Fig. 1. Calculate I_B, V_{D1}, and V_{D2} in terms of V_B and I_S. (10%)

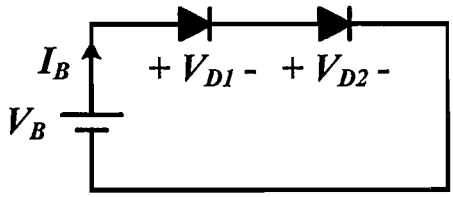

Figure 1

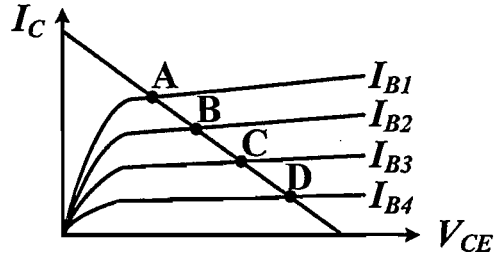

Figure 2

2. Figure 2 shows the output characteristics of a bipolar junction transistor. The load line is inserted with four operating points A, B, C and D with different base currents. Answer the following questions and explain why.
   (a) Which operating point leads to the largest transconductance, g_m ? (5%)
   (b) Which operating point leads to the largest output resistance, r_O ? (5%)

3. The bipolar *pnp* amplifier is depicted in Fig. 3. Assume $r_O < \infty$.
   (a) Draw the small signal equivalent circuit diagram. (5%)
   (b) Compute the output impedance. (5%)
   (c) Calculate the voltage gain. (5%)

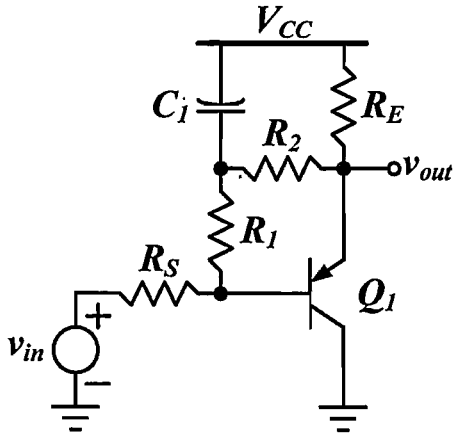

Figure 3

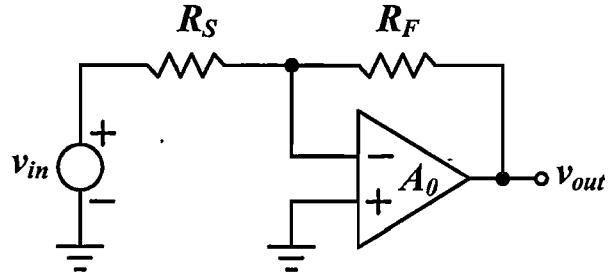

Figure 4

4. Answer the questions below for the Op-Amp-based circuitry shown in Fig.4.
   (a) Which type is this amplifier? (5%)
   (b) If the gain of Op-Amp, A_0, is infinite, calculate the voltage gain, v_{out}/v_{in}. (5%)
   (c) If the gain of Op-Amp, A_0, is finite, calculate the voltage gain, v_{out}/v_{in}. (5%)

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5. For the MOS cascode amplifier illustrated in Fig. 5, we assume that the transistors are symmetric, i.e., M_1, M_3, M_5 and M_7 are identical to M_2, M_4, M_6 and M_8, respectively. Two equal resistors, R_1 and R_2, appear across the source and drain of M_5 and M_6 due to the non-ideal IC process. Assume $\lambda \neq 0$ and all the MOS transistors operate in saturation region.
   (a) Draw the equivalent half circuit. (5%)
   (b) Calculate the output resistance. (5%)
   (c) Calculate the differential voltage gain. (5%)
   (Note : All the small signal parameters of MOS transistors are added with suffix equal to the number of their corresponding transistor. For example, the transconductance and output resistance of M_1 are written as g_{m1} and r_{O1}.)

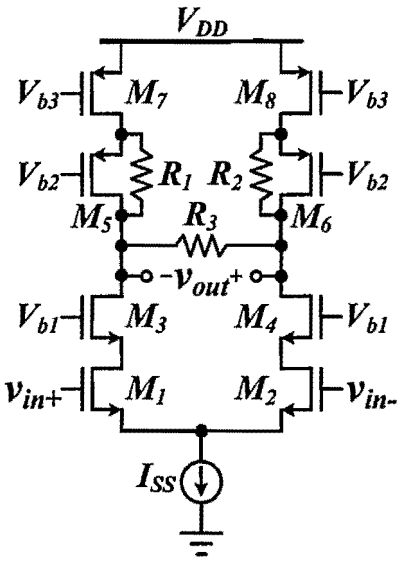

Figure 5

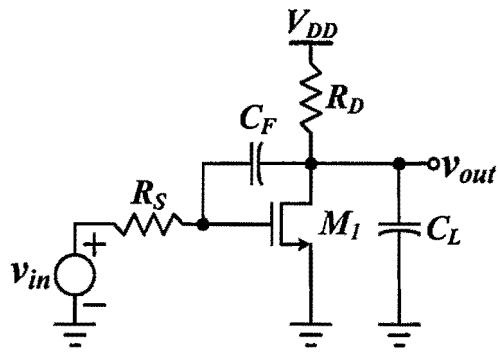

Figure 6

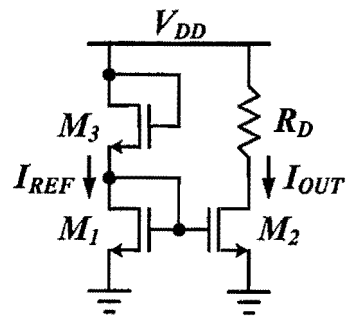

Figure 7

6. For the amplifier shown in Fig. 6, the MOS transistor, M_1, operates in saturation region. Assume $\lambda \neq 0$.
   (a) Draw the small signal equivalent circuit diagram of this amplifier with all parasitic capacitances. (5%)
   (b) Calculate the mid-band voltage gain, v_{out}/v_{in}. (5%)
   (c) Use Miller's theorem to estimate the input and output poles with all parasitic capacitances. (10%)

7. The current mirror shown in Fig. 7 uses two NMOS transistors to determine the output current. The parameters of the transistors are V_{TH} = 0.4V, $\mu_n C_{ox}$= 20μA/V^2 and λ = 0. Let V_{DD} be 2V. The aspect ratio (W/L) of M_1, M_2 and M_3 are 4, 6 and 1, respectively. Neglect the body effect.
   (a) Calculate I_{OUT}, I_{REF}, V_{GS1} and V_{GS3}. (10%)
   (b) What is the largest value of R_D such that M_2 still works in the saturation region? (5%)