國立彰化師範大學 97 學年度碩士班招生考試試題

系所：電機工程學系碩士班　　科目：電子學

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1. Consider the high-frequency equivalent circuit of a CS amplifier as shown in Figure 1. The transistor parameters are $g_m = 3\,\text{mA/V}$, $r_o = 15\,\text{k}\Omega$, $C_{gd} = 5\,\text{pF}$, and $C_{gs} = 50\,\text{pF}$. For $r_i = R_D = 10\,\text{k}\Omega$, find the low-frequency gain V_o/V_i, the upper 3-dB frequency f_H, and the unit-gain frequency f_t. (15%)

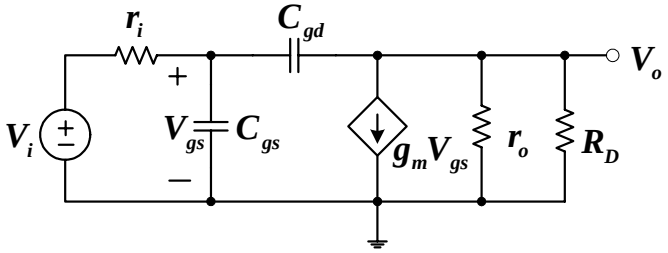

Figure 1

2. Use a power supply of $V_{CC} = 3\,\text{V}$ to design a feedback bias circuit of Figure 2 so that it can provide $I_C = 3\,\text{mA}$ and $V_C = V_{CC}/2$ for $\beta = 100$ and $V_{BE} = 0.7\,\text{V}$. Determine the required resistance of R_B and R_C. (10%)

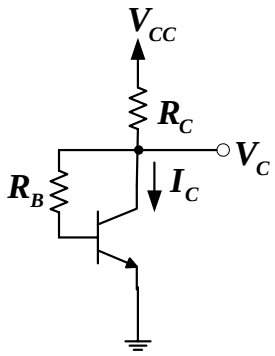

Figure 2

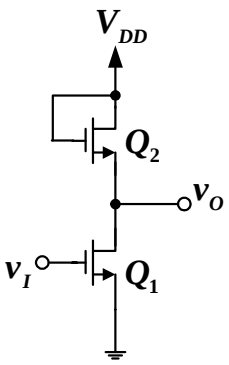

Figure 3

3. Consider the CS amplifier of Figure 3 for case of $V_{DD} = 5\,\text{V}$, $k'(W/L)_1 = 50\ \mu\text{A/V}^2$, $k'(W/L)_2 = 10\ \mu\text{A/V}^2$, and $V_{t1} = V_{t2} = 1\,\text{V}$.

   (a) If $v_I = 1.5\,\text{V}$, find i_{D1} and v_O. (10%)
   (b) If $v_I = 5\,\text{V}$, find i_{D1} and v_O. (10%)

4. Consider the folded-cascode amplifier in Figure 4. Assume that for the BJT $|V_{BE}| = 0.7\,\text{V}$, $\beta = 100$, and $|V_A| = 100\,\text{V}$ and for the NMOS $k'(W/L) = 2\,\text{mA/V}^2$, $|V_A| = 5\,\text{V}$, and $V_t = 0.6\,\text{V}$. Also, let $I = 100\ \mu\text{A}$ and $V_{\text{BIAS}} = +1\,\text{V}$, and assume that the output resistance of

current source I is equal to the output resistance of its connected circuit. However, the current source $2I$ is assumed to be ideal.

(a) Find g_m and r_o for each transistor. (10%)

(b) Find the output resistance and the voltage gain of the amplifier. (10%)

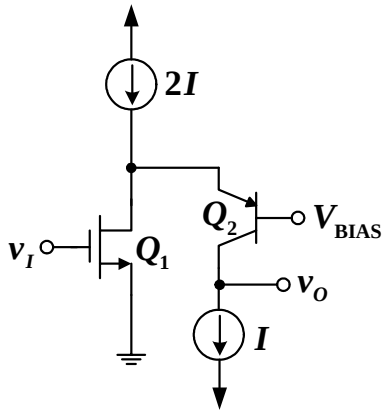

Figure 4

5. Consider the voltage amplifier in Figure 5. The op-amp has $A_v = 5\times10^3$, $R_i = 10\ \text{k}\Omega$, and $R_o = 1\ \text{k}\Omega$, and the transistor parameters are $\beta = 100$, $V_{BE} = 0.7\ \text{V}$, and $V_A = \infty$, and for case of $R_1 = 1\,\text{k}\Omega$ and $R_2 = 10\,\text{k}\Omega$.

(a) Determine the feedback topology and the feedback factor β (5%).

(b) Find A_{if}, R_{if}, and R_{of}. (15%)

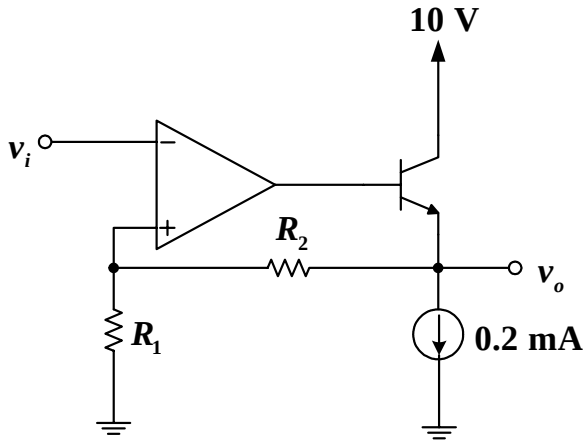

Figure 5

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6. Consider the quadrature oscillator in Figure 6. Assume that op-amps are ideal.

(a) Derive an expression for the loop gain of the oscillator. (10%)

(b) Find the required value of R_F for sinusoidal oscillation? (5%)

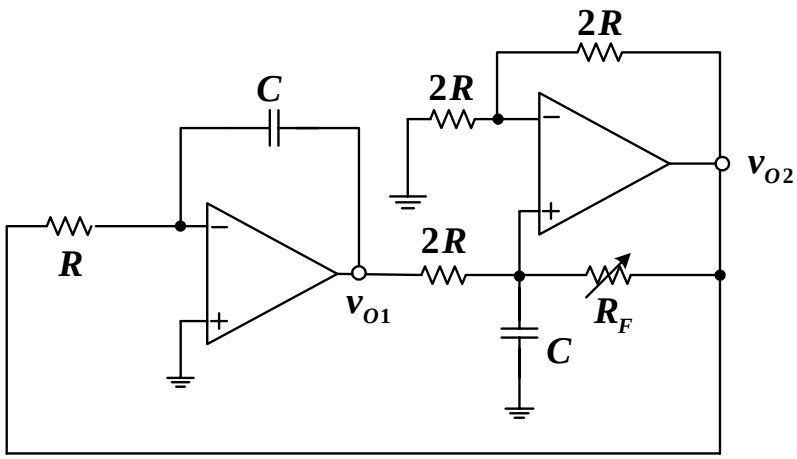

Figure 6