國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：電機工程系碩士班　　組別：乙組　　科目：電子學

1. Consider the modified difference amplifier in Figure 1. Find the differential voltage gain v_o / v_d. (10%)

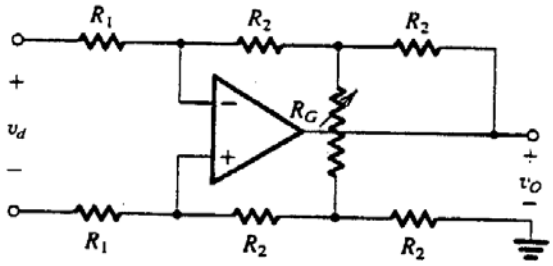

Figure 1.

2. For the follower circuit in Figure 2, let transistor Q_1 have $\beta = 20$ and transistor Q_2 have $\beta = 200$, and neglect the effect of r_o. Use $V_{BE} = 0.7$ volts.
   (1) Find the dc emitter current of Q_1 and Q_2. Also find the dc voltage V_{B1} and V_{B2}. (4%)
   (2) If a load resistance $R_L = 1\,\text{k}\Omega$ is connected to the output terminal, find the voltage gain from the base to the emitter of Q_2, v_o / v_{b2}, and find the input resistance R_{ib2} looking into the base of Q_2. (4%)
   (3) Replacing Q_2 with its input resistance R_{ib2} found in (2), analyze the circuit of emitter follower Q_1 to determine its input resistance R_i, and the gain from its base to its emitter, v_{e1} / v_{b1}. (4%)
   (4) If the circuit is fed with a source having a 100kΩ resistance, find the transmission to the base of Q_1, v_{b1} / v_s. (4%)
   (5) Find the overall voltage gain v_o / v_s. (4%)

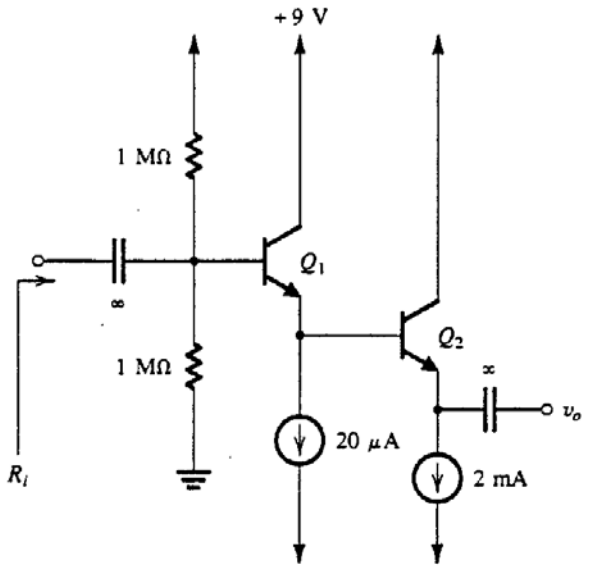

Figure 2

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3. The differential amplifier circuit in Figure 3 utilizes a resistor connected to the negative power supply to establish the bias current I.
   (1) For $v_{B1} = v_d/2$ and $v_{B2} = -v_d/2$ where v_d is a small signal with zero average. Find the magnitude of the differential gain, $|v_o/v_d|$. (5%)
   (2) For $v_{B1} = v_{B2} = v_{CM}$, find the magnitude of the common-mode gain, $|v_o/v_{CM}|$. (5%)
   (3) Calculate the CMRR. (5%)
   (4) If $v_{B1} = 0.1\sin 2\pi \times 60t + 0.005\sin 2\pi \times 1000t$, volts, $v_{B2} = 0.1\sin 2\pi \times 60t - 0.005\sin 2\pi \times 1000t$, volts, find v_o. (5%)

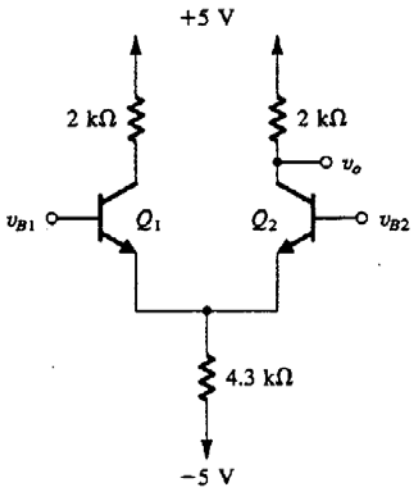

Figure 3

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4. A differential amplifier having a transfer function $A(s) = \dfrac{1000}{(1+\frac{s}{2\pi\times10^6})(1+\frac{s}{2\pi\times10^7})}$ is connected as a differentiator which is shown in Figure 4.

(a) On the basis of the rate-of-closure rule, what is the smallest time-constant RC for which operation is stable? (15%)

(b) What is the corresponding approximate phase margin?(5%)

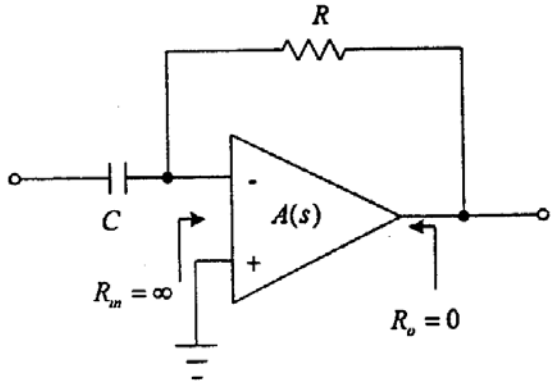

Figure 4

5. For the circuit in Figure 5, let Q_1 and Q_2 be identical, $\beta=100$, $C_\mu=2pF$, and $f_T=400MHz$. The small signal equivalent circuit of Figure 5 is shown in Figure 6.

(a) Calculate the values of r_π, g_m, and C_π.(10%)

(b) Calculate the midband voltage gain and the upper 3-dB frequency.(10%)

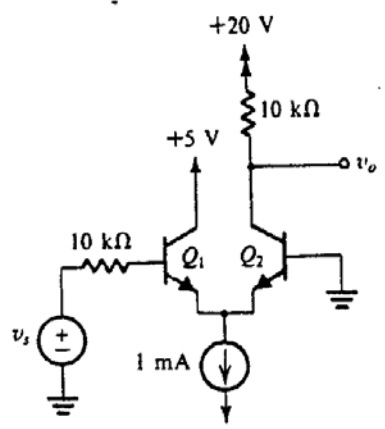

Figure 5

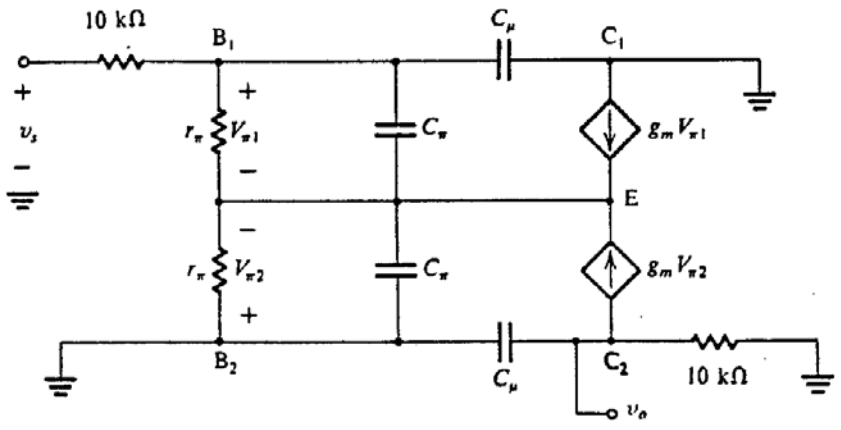

Figure 6.

6. Explain (a) all-pole filter and (b) input bias current of an op amp.(10%)