※ 考生請注意：本試題可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Consider the folded-cascode amplifier of Fig. 1 for the following case: V_{DD}=1.8 V, $\mu_p C_{ox}=1/4\mu_n C_{ox}$, and $V_{tn}=-V_{tp}$=0.5 V, To operate Q_1 and Q_2 at equal bias currents I, I_1=2I and I_2=I. While current source I_1 is implemented using the simple circuit and current source I_2 is realized using a cascoded circuit. The transistor W/L ratios are selected so that each operates at an overdrive voltage of 0.2 V. (20%)
   (a) What must the relationship of $(W/L)_2$ to $(W/L)_1$ be? (4%)
   (b) What is the minimum dc voltage required across current source I_1 for proper operation? If a 0.1-V peak-to-peak signal swing is to be allowed at the drain of Q_1, what is the highest dc bias voltage that can be used at that node? (4%)
   (c) What is the value of V_{SG} of Q_2, and hence what is the largest value to which V_{G2} can be set? (4%)
   (d) What is the minimum dc voltage required across current-source I_2 for proper operation? (4%)
   (e) Given the results of (c) and (d), what is the allowable range of signal swing at the output? (4%)

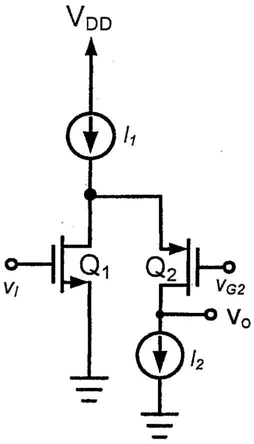

Fig. 1

2. Consider the integrated-circuit CS amplifier in Fig. 2 for the case I_{BIAS}=100 μA, Q_2 and Q_3 are matched, and R_{sig}= 200 kΩ. For Q_1: $\mu_n C_{ox}$=90 μA/V², $|V_A|$=12.8 V, W/L=100 μm/1.0 μm, C_{gs}=0.2 pF, C_{gd}=0.015 pF. For Q_2: $|V_A|$=19.2 V. Neglecting the effect of the capacitance inevitably present at the output node. (14%)
   (a) Find the low-frequency gain (5%)
   (b) Find the 3-dB frequency f_H (5%)
   (c) Find the frequency of the zero f_Z (4%)

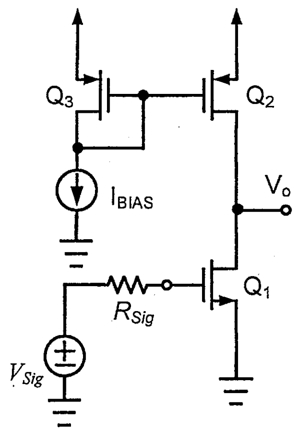

Fig. 2

3. Fig. 3 shows the feedback circuit with the case $g_{m1}=g_{m2}=2$ mA/V, $R_{sig}=200$ kΩ, $R_{D1}=R_{D2}=10$ kΩ, $R_1=1$ kΩ, and $R_2=9$ kΩ. For simplicity, neglect r_o of each of Q_1 and Q_2. (16%)
   (a) Find the loop gain βA (4%)
   (b) Find the voltage gain V_o/V_s (4%)
   (c) Find the input resistance R_{in} (4%)
   (d) Find the output resistance R_{out}. (4%)

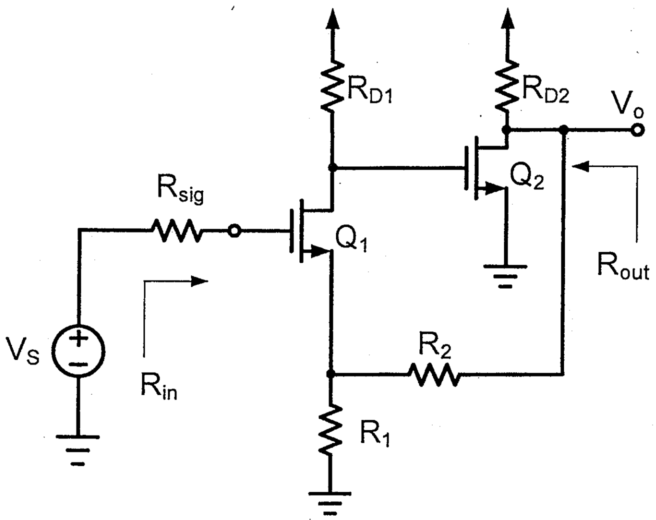

Fig. 3

4. For the Class AB output stage shown in Fig. 4, we know that Q_3 and Q_4 are the major power BJTs which deliver current to load resistance R_L. Please give your answer and brief explanation for the following questions: (15%)
   (a) In addition to provide two V_{BE} voltage drop for biasing the Q_3 and Q_4 like the conventional diode-connected biasing circuit does, what is the major advantage of the input stage which consists of Q_1 Q_2, R_1 and R_2? (5%)
   (b) What is the major purpose of the last stage which consists of Q_5 Q_6, R_3 and R_4? (5%)
   (c) What is the major purpose of the resistors R_5 and R_6? (5%)

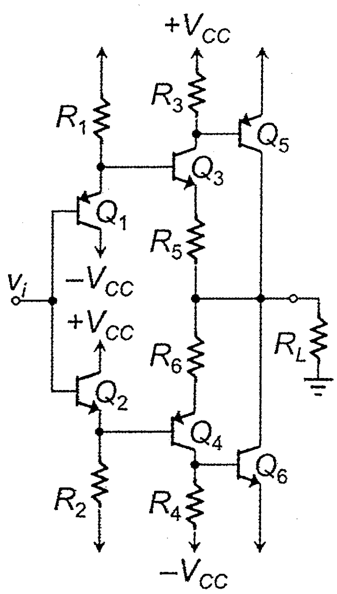

Fig. 4

5. Fig. 5 shows a three-stage feedback amplifier: (20%)

A_1 has an 82-kΩ differential input resistance, a 20-V/V open-circuit differential voltage gain, and a 3.2-kΩ output resistance.

A_2 has a 5-kΩ input resistance, a 20-mA/V short-circuit transconductance, and a 20-kΩ output resistance.

A_3 has an 20-kΩ input resistance, unity open-circuit voltage gain, and a 1-kΩ output resistance.

The feedback amplifier feeds a 1-kΩ load resistance and is fed by a signal source with a 9-kΩ resistance.

(a) If R_1 = 20 kΩ, find the value of R_2 that results in a closed-loop gain V_o/V_s that is ideally 5V/V. (4%)

(b) Find the feedback amplifier's input resistance R_{in}. (4%)

(c) Find the feedback amplifier's output resistance R_{out}. (4%)

(d) If the high-frequency response if the open-loop gain A is dominated by a pole at 100Hz, what is the upper 3-dB frequency of the closed-loop gain? (4%)

(e) If for some reason, A_1 drops to half its nominal value, what is the percentage change in the closed-loop gain A_f? (4%)

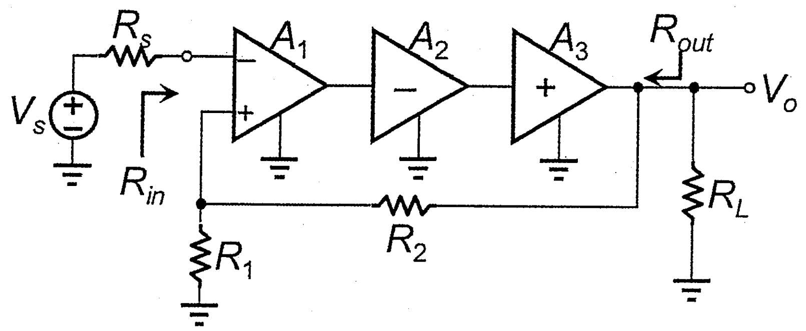

Fig. 5

6. Please analysis and design an oscillator which uses a bistable circuit. (15%)

(a) Fig. 6. shows a square waveform generator. The positive and negative saturation levels of the op-amp used in the bistable circuit are L_+ and L_-, respectively. The trigger levels are V_+ and V_-. If $V_\pm = \beta L_\pm$, derive a relationship between the oscillator period and the time-constant τ = RC. (5%)

(b) Follow 6(a), how to modify the circuit of Fig. 6 to generate a triangular waveform. You are allowed to use one more op amp. (5%)

(c) Based on the conditions of 6(a), please derive a relationship between the oscillator period and the RC for the circuit you design in 6(b). (5%)

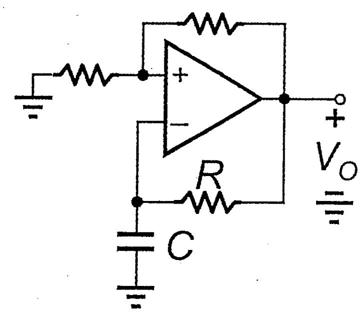

Fig. 6