1. Consider the parallel-based clipper circuit of Fig. 1 for R_1=20KΩ, R_2=10kΩ, V_1=1.8V, V_2=4.3V. Assume diode cut-in voltages of V_r=0.7V. Draw the voltage transfer characteristics curve. (10%)

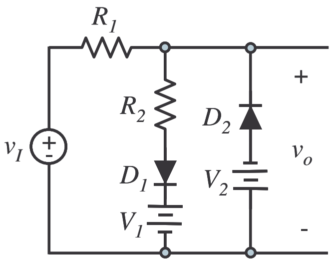

Fig. 1

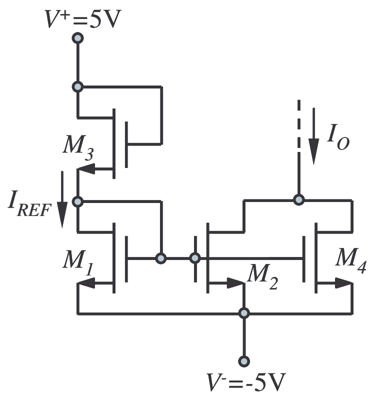

Fig.2

2. Consider the circuit shown in Fig. 2. The transistor parameters are: the threshold voltage V_{TN}=2V, the conduction parameters $K_{n1}=K_{n2}=K_{n4}$=0.25mA/V^2, K_{n3}=0.1mA/V^2, and the channel-length parameter λ=0. Determine I_{REF} and I_O. (10%)

3. For a bipolar transistor, the unity-gain bandwidth is f_T=2GHz and the low-frequency current gain is β_o=150. (a) Determine the beta cutoff frequency f_β. (5%) (b) Find the frequency at which the magnitude of the small-signal current gain h_{fe} is 10. (5%)

4. Consider the difference-amplifier circuit of Fig. 3 for the case $R_1=R_3$=2kΩ and $R_2=R_4$=200kΩ. (a) Find the value of the differential gain A_d. (5%) (b) Find the value of the differential input resistance R_{id} and the output resistance R_O. (5%) (c) If the resistors have 1% tolerance (i.e. each can be within ±1% of its nominal value), find the worst-case common-mode gain A_{cm} and the corresponding value of CMRR. (5%) (Note: The op amp is ideal.)

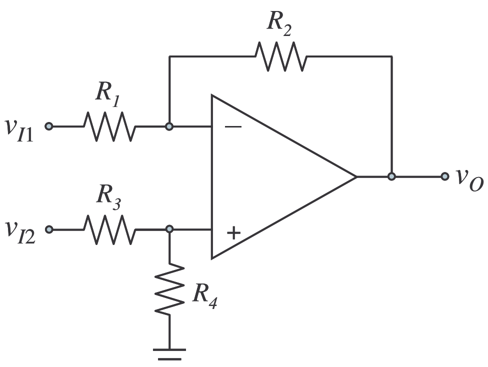

Fig. 3

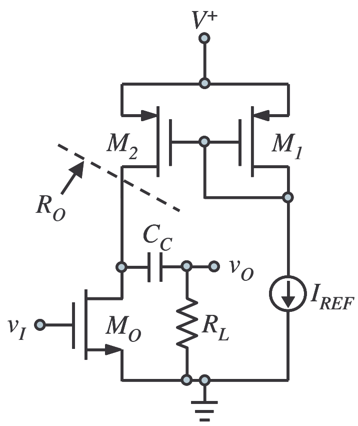

Fig. 4

5. The MOSFET amplifier with active load is shown in Fig. 4. The transistor parameters are: the channel-length parameters $\lambda_n=\lambda_p=0.01V^{-1}$, the threshold voltage of n-channel MOSFET V_{TN}=1V, the threshold voltage of p-channel MOSFET V_{TP}=-0.5V, the conduction parameter of n-channel MOSFET K_n=1mA/V^2, the conduction parameter of p-channel MOSFET K_p=2mA/V^2, R_L=100kΩ. Assuming M_1 and M_2 are matched and I_{REF}=0.5mA. (a) Calculate the small-signal equivalent output resistance R_O of active load. (5%) (b) Calculate the small-signal voltage gain. (5%)

6. Consider the cascade circuit in Fig. 5. Let the low-frequency current gain β=100, $V_{BE(on)}$=0.7V, and Early voltage $V_A=\infty$ for each transistor. Assume V_{CC}=12V, R_L=2kΩ, and R_E=0.5kΩ. (a) Find R_C, R_1, R_2, and R_3 such that I_{CQ2}=0.5mA and $V_{CE1}=V_{CE2}$=4V. Let $R_1+R_2+R_3$=100kΩ. (8%) (Hint: Neglect the dc base currents and assume $I_C=I_E$ in both Q_1 and Q_2.) (b) Determine the small-signal voltage gain $A_v=V_o/V_s$. (7%)

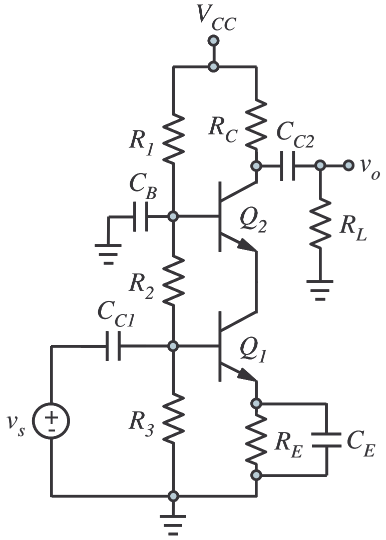

Fig. 5

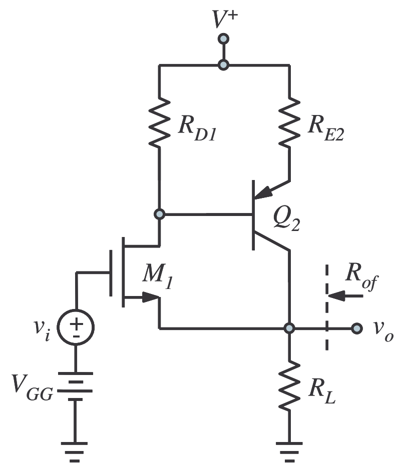

Fig.6

7. Consider the BiCMOS circuit in Fig. 6. The transistor parameters are: the conduction parameter of n-channel MOSFET K_n=0.2mA/V^2, the threshold voltage of n-channel MOSFET V_{TN}=1V, the channel-length parameter λ=0 for M_1; and the low-frequency current gain h_{FE}=100, the transistor cut-in voltage $V_{EB(on)}$=0.7V, the Early voltage $V_A=\infty$ for Q_2. (a) Find the small-signal voltage gain $A_{vf}=v_o/v_i$. (8%) (b) Determine the output resistance R_{of}. (7%)

8. Consider the astable multivibrator circuit in Fig. 7. Let the op-amp saturation positive and negative saturation voltages are L_+ and L_-, respectively. (a) Draw the waveforms v_o, v_+, and v_-.

(8%) (b) Find the frequency of oscillation. (7%)

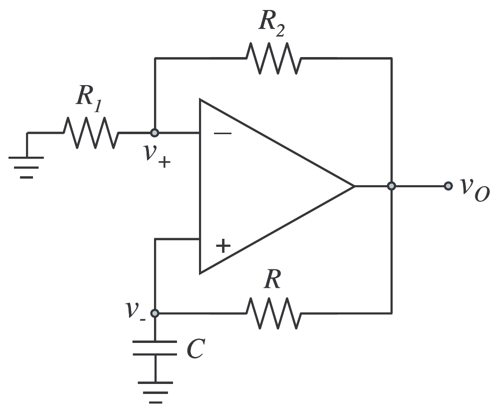

Fig. 7