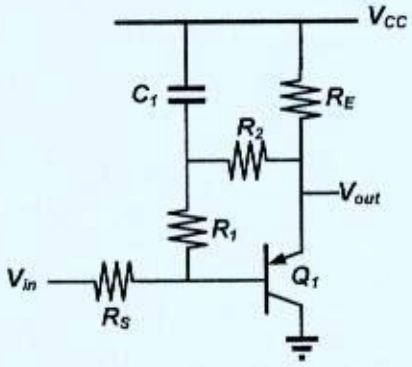
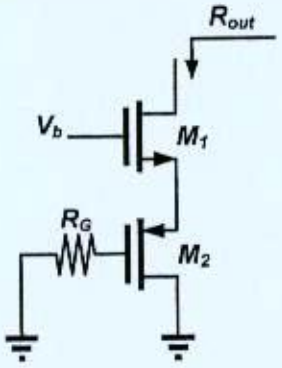
●不可使用電子計算機

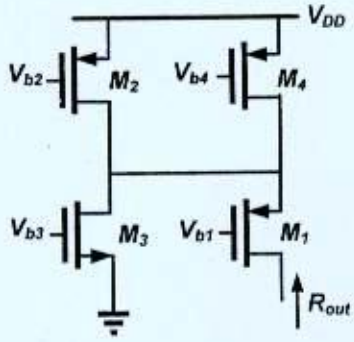
1. **(20%)** Please derive the (a) voltage gain (10%) (b) output impedance (10%) of the circuit shown below. Assume $V_A<\infty$, C_1 is quite large and the transconductance of Q_1 is g_{m1}



2. **(15%)** Please derive the output impedance of the following circuit. Assume all of the transistors operate in saturation and $g_{m1}r_{o1}= g_{m2}r_{o2}= g_{m3}r_{o3}= g_{m4}r_{o4}>>1$ and R_G=200KΩ (15%)

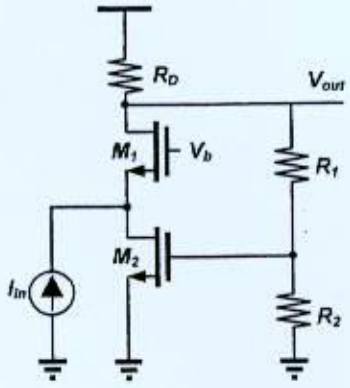


(a) (7%)



(b) (8%)

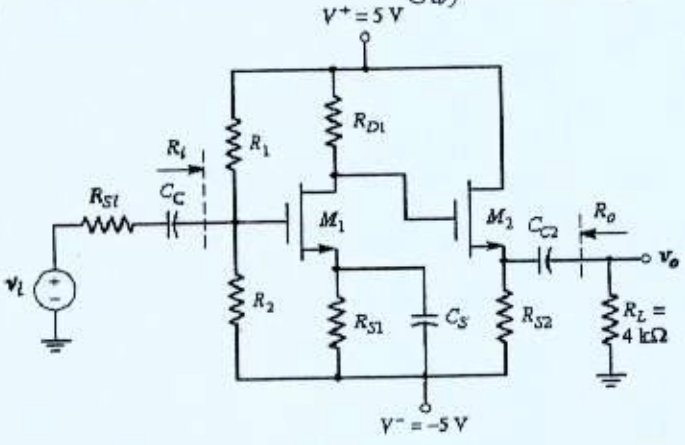
3. **(20%)** The amplifier of the following circuit is consisted of a single-stage amplifier and a feedback network. Assume R_1+R_2 is very large, the transconductance of M_1 and M_2 are g_{m1} and g_{m2}, respectively. Meanwhile all of the mosfets operate in saturation region and λ=0. (a) What type of this single-stage amplifier which determine the open-loop gain of the circuit (2%) (b) what are the components forms the feedback network (3%) (c) please compute the closed-loop gain of this amplifier (10%) (d) please derive the closed-loop input impedance of this amplifier (5%).



4. **(5%)** Please use only NMOS construct following logic function (5%)

$$Z = \overline{(A+B)(C+D)}$$

5. **(20%)** Answer the following questions about the MOSFET multi-stage amplifier. (a) Explain the reasons that we use the multistage amplifier circuit? (4%) (b) What configuration is usually used to be the output stage? Why? (4%) (c) Consider the following circuit with $\frac{1}{2}k'_{n1}(\frac{W}{L})_1 = 500\ \mu A/V^2$, $\frac{1}{2}k'_{n2}(\frac{W}{L})_2 = 0.2\ mA/V^2$, V_{tn1}= V_{tn2}=1.2V, R_{Si}=0Ω, and λ_2=λ_1=0. Design the circuit such that I_{DQ1}=0.2mA, I_{DQ2}=0.5mA, V_{DSQ1}=V_{DSQ2}=6V, and R_i=100kΩ, (d) Determine the small-signal voltage gain. (4%) (e) determine R_O. (4%)



6. **(20%)** Consider the following BJT amplifier circuit, some properties of the voltage gain function $H(s)=V_o(s)/V_{sig}(s)$ are to be investigated in the frequency domain. Neglect r_x and r_o. Please answer the following question in terms of small-signal parameters. (a) Sketch the equivalent circuits for low frequency, mid-band frequency, and high frequency, respectively (4%) (b) How many poles does $H(s)$ have? Briefly explain your answer. (3%) (c) How many zeros does $H(s)$ have? What are the frequencies of zeros? Briefly explain your answer. (3%) (d) Find the approximated lower 3-dB frequency by using time-constant technique. (5%) (e) Use the Miller's theorem to calculate the upper 3dB frequency. (5%)