中原大學 102 學年度 碩士班 入學考試
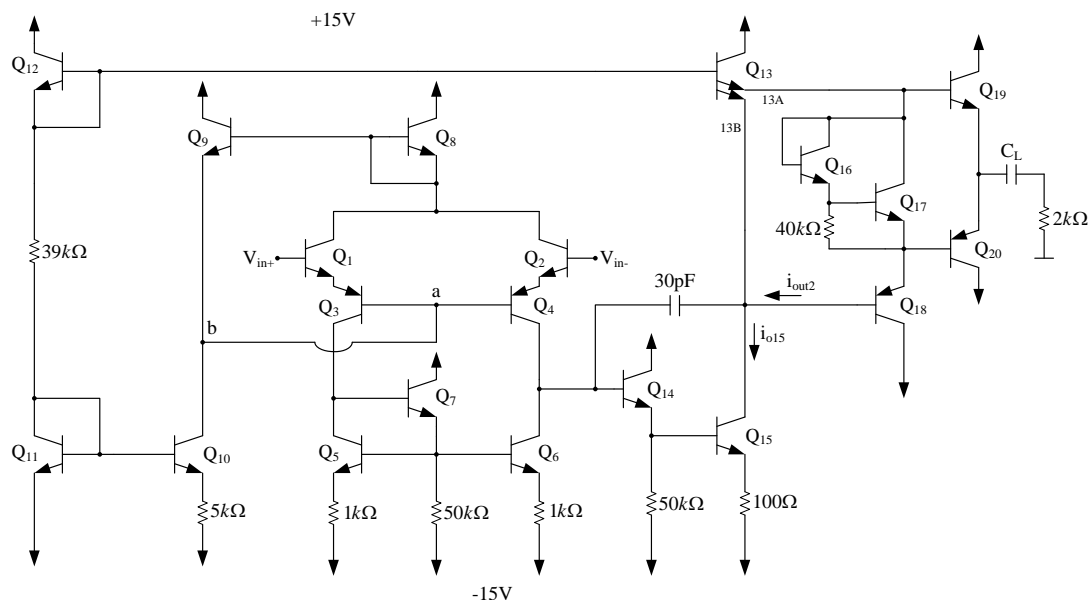
Fig. 1

1. For the standard npn and pnp transistors shown in Fig. 1 the following parameters will be used:

   npn: $I_S = 10^{-14} A$, $\beta = 200$, $\mu = 5000$; pnp: $I_S = 10^{-14} A$, $\beta = 50$, $\mu = 2000$;

   except Q_{13}, Q_{19}, and Q_{20} whose saturation currents are respectively

   $I_{S13A} = 0.25x10^{-14} A$, $I_{S13B} = 0.75x10^{-14} A$, and $I_{S19} = I_{S20} = 3.0x10^{-14} A$.

   Referring to Fig. 1, please specify (i) the DC analysis of the output stage with the transistors Q_{13A}, and Q_{16} to Q_{20}, (10%) (ii) the small signal analysis of the output stage, (12%) (iii) the reason why the usage of the middle capacitor 30pF, (10%) (iv) the reason why the usage of Q_{16} and Q_{17} for the output response given by Q_{19} and Q_{20}, (10%) (v) the reason why the usage of the load capacitor C_L, (4%) (v) the reason why the connection of the base and the collector of Q_{11} for a current mirror, (6%) (vi) the reason why the connected node of the two bases of the transistors Q_3 and Q4 is like a grounded node, and the terminal a-b is like an open circuit, for a small signal analysis, (6%) (vii) the reason why the base of Q_6 is like a grounded node when we would like to find R_{o6} from the collector of Q_6, (4%) (viii) the reason why the emitter of Q_4 is in series with the r_{e2} of Q_2 to the ground when we would like to find R_{o4} from the collector of Q_4, (4%) and (ix) the reason why $i_{out2} = i_{o15}$, (4%). (70%)

2. Please (i) do the circuit analysis to find the $V_o/(V_1-V_2)$ of the operational amplifier-based circuit shown in Fig. 2 if the three operational amplifiers are operated in active region (15%); and (ii) decide the polarities of the two input terminals of an operational amplifier shown in Fig. 2 when the three operational amplifiers are operated in active region (15%). (30%)
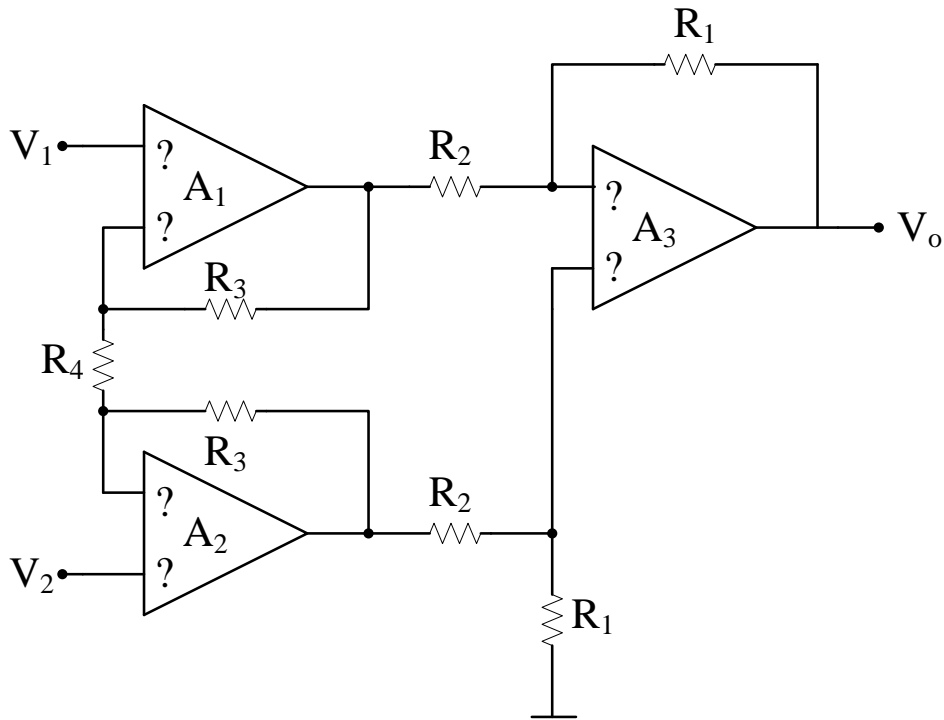

Fig. 2