1. (20%) Assume that $V_{CC} = 30\text{V}$ and a power BJT is operating with an average collector current of $I_C = 1.4\text{A}$. Consider that the power BJT is able to be fixed onto a heat sink. The thermal resistance parameters related to the heat sink are $\theta_{\text{case-snk}} = 1^o\text{C/W}$, $\theta_{\text{snk-amb}} = 3^o\text{C/W}$, and $\theta_{\text{case-amb}} = 43^o\text{C/W}$. Suppose that the BJT junction temperature is 150^oC and the ambient temperature is 24^oC when the power BJT works for $R_L = 20\Omega$ without the heat sink. Determine the minimum R_L with which the power BJT can work at the same temperature when the heat sink is used.
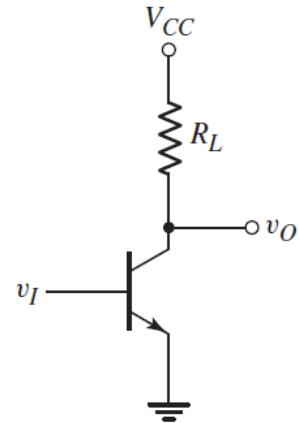

2. (30%) Consider the MOSFET class-AB output stage. The circuit parameters are $V_{DD} = 15\text{V}$ and $R_L = 25\Omega$. The transistors are matched with parameters $K = 0.25\,\text{A/V}^2$ and $|V_T| = 1.2\text{V}$. The quiescent drain currents are to be 20 percent of the load current when $v_O = 8\text{V}$.

 (a) Determine V_{BB}. (15%)

 (b) Find the input voltage v_I and explain the operating status of transistors M_n and M_p when $v_O = -12\text{V}$. (15%)
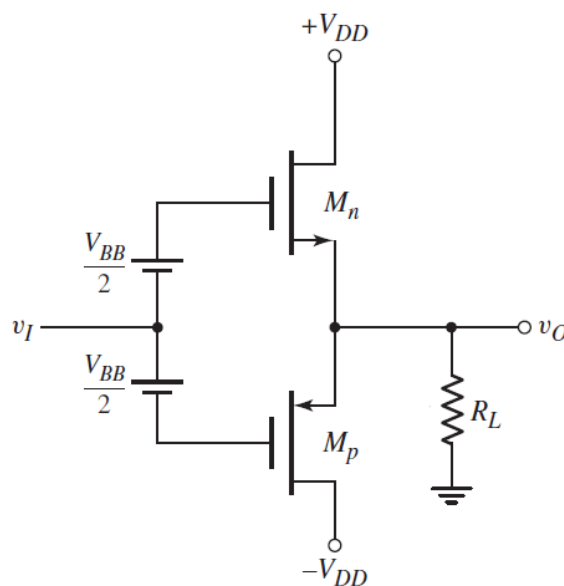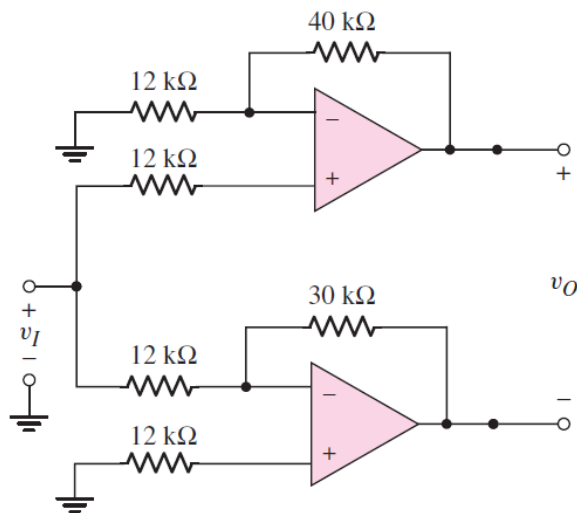
3. (25%)
   (a) Find the voltage transfer function of the right circuit in terms of the input signal frequency f. (10%)
   (b) Is the circuit a lowpass or a highpass filter and why? (5%)
   (c) Find the 3dB corner frequency. (10%)
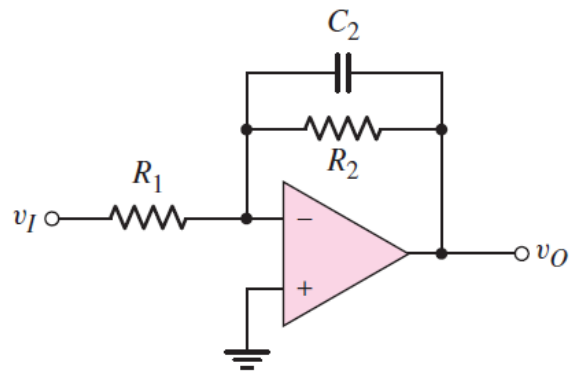
4. (10%) Find the voltage gain v_o / v_I.

5. (15%)
   (a) Find the gain v_o / v_{cm}. (10%)
   (b) On what condition is the gain to be zero? (5%)