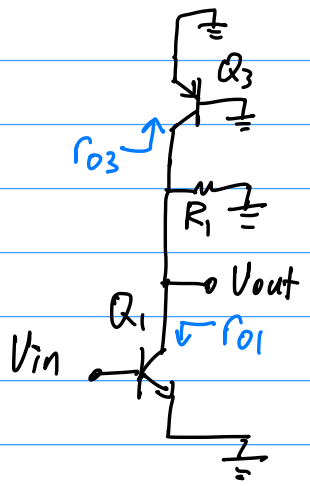
10.30 Use symmetry to find the half circuit.



$R_{out} = R_1 \parallel r_{o1} \parallel r_{o3}$.

$A_v = -g_m R_{out}$

$$r_{o1} = \frac{V_{A,n}}{I_{CQ}} = \frac{5}{0.002/2} = 5000\ \Omega$$

$$r_{o3} = \frac{V_{A,p}}{I_{CQ}} \simeq \frac{4}{0.002/2} = 4000\ \Omega$$

$$g_m = \frac{I_{CQ}}{V_T} = \frac{0.001}{0.026} = \frac{1}{26}\ S.$$

$$\therefore\ A_v \simeq 50 = \frac{1}{26} \times \frac{1}{\frac{1}{R_1} + \frac{1}{5000} + \frac{1}{4000}}$$

$$\frac{1}{1300} = \frac{1}{R_1} + \frac{1}{5000} + \frac{1}{4000}$$

$$\frac{1}{R_1} \simeq \frac{1}{1300} - \frac{1}{5000} - \frac{1}{4000}$$

$$R_1 \simeq 3.1\ k\Omega.$$