8.1

$$r_e = \frac{V_T}{I_E} = \frac{25\ mV}{0.1\ mA} = 250\ \Omega$$

$$\frac{V_o}{V_i} = \frac{a \times Total\ resistance\ in\ collectors}{Total\ resistance\ in\ emmiters} = \frac{0.99 \times 25k\Omega}{2r_e + 500\Omega} = \frac{0.99 \times 25k\Omega}{500 + 500} \cong 25\frac{V}{V}$$

$$R_{in} = (1+\beta)(2r_e + 500) = 101 \times (2 \times 250 + 500) = 101\ k\Omega$$

8.2

A 2-mV input offset voltage corresponds to a different ΔR_C between the two collector resistances,

$2 = V_T \frac{\Delta R_C}{R_C} = 25 \times \frac{\Delta R_C}{20} \rightarrow \Delta R_C = 1.6\ k\Omega$

Thus a 2-mV offset can be nulled out by adjusting one of the collector resistances by $1.6\ k\Omega$. If the adjustment mechanism raises one R_C and lowers the other, then each need to be adjusted by only $1.6\frac{k\Omega}{2} = 0.8\ k\Omega$

If a potentiometer is used, the total resistance of the potentiometer must be as least $1.6\ k\Omega$.

8.3

$$G_m = g_{m1,2} = \frac{\frac{I}{2}}{V_T} \rightarrow 5 = \frac{\frac{I}{2}}{V_T} \rightarrow I = 0.25\ mA$$

Utilizing two matched transistors, Q5 and Q6, the value of R can be found from:

$$I = \frac{0 - (-5) - 0.7}{R} = 0.25\ mA \ \rightarrow \ R = 17.2\ k\Omega$$

$$R_{id} = 2r_\pi = 2\frac{\beta}{g_m} = 2 \times \frac{100}{5} = 40k\Omega$$

$$R_o = r_{o2}||r_{o4} \qquad ; \quad r_{o2} = r_{o4} = \frac{|V_A|}{\frac{I}{2}} = \frac{100}{0.125} = 800\ k\Omega$$

Thus

$$R_o = 800||800 = 400\ k\Omega$$

$$A_d = G_m \times R_o = 5 \times 400 = 2000\frac{V}{V}$$

$$A_{cm} = -\frac{r_{o4}}{\beta_3 R_{EE}} \quad ; \quad r_{o4} = \frac{|V_A|}{\frac{I}{2}} = \frac{100}{0.125} = 800\ k\Omega$$

$$\beta_3 = 100$$

$$R_{EE} = r_{o5} = \frac{|V_A|}{I} = \frac{100}{0.25} = 400\ k\Omega$$

$$A_{cm} = -\frac{800}{100 \times 400} = -0.02\frac{V}{V}$$

The CMRR can be found as:

CMRR=$\frac{|A_d|}{|A_{cm}|} = \frac{2000}{0.02} = 100000\ or\ 100\ dB$