

8.1

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

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

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

8.2

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

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

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

If a potentiometer is used, the total resistance of the potentiometer must be at least 1.6 k Ω .

8.3

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

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

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

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

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

Thus

$$R_o = 800 || 800 = 400 \text{ k}\Omega$$

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

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

$$\beta_3 = 100$$

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

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

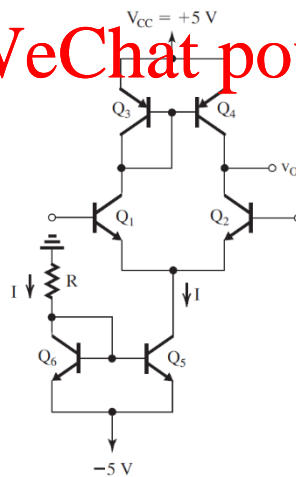
The CMRR can be found as:

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

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