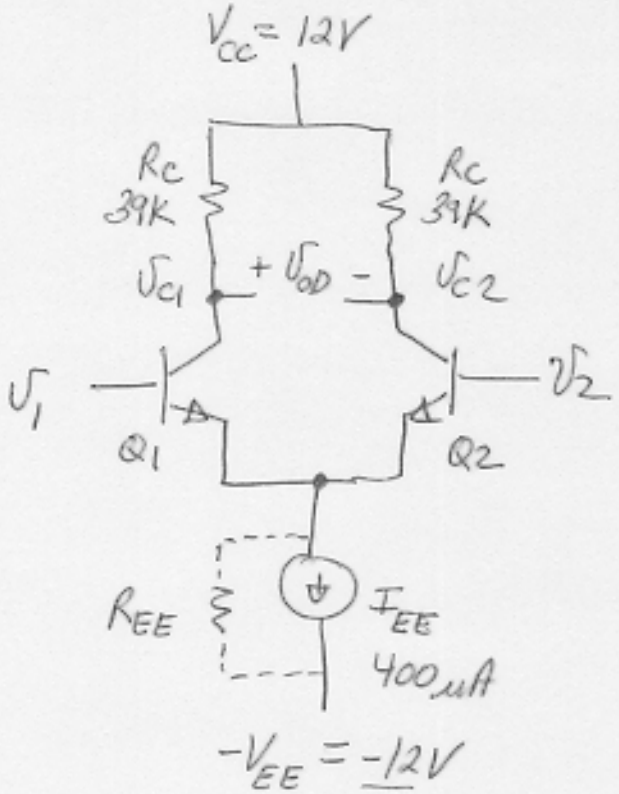
Jaeger 3rd ed

15.8



$\beta_F = 100$

$R_{EE} = 200K\Omega$

$V_A = \infty$

$g_m = 7.92\ mS$

$r_\pi = 12.6K\Omega$

(assume $\beta_o \cong \beta_F$)

(a) Q-point at $v_1 = v_2 = 0$

$I_{E1} = I_{E2} = 200\mu A$

$I_{C1} = I_{C2} = 198\mu A$ $\quad V_{C1} = V_{C2} = V_{CC} - I_{C1} R_C = +4.28V$

$V_{CE1} = V_{CE2} = +5.0\ V$ $\quad V_{E1} = V_{E2} \cong -0.7V$

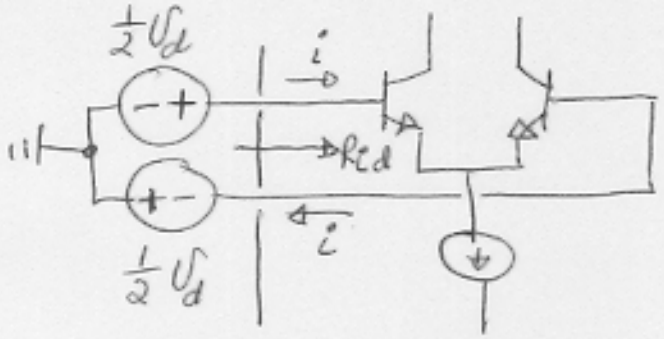
(b) For Single-Ended Output $\quad v_d \equiv (v_1 - v_2)$

$$A_d \equiv \frac{v_{o1} \text{ or } v_{o2}}{v_d} = \pm \frac{1}{2} g_m R_C = \pm 155$$

$$A_{cm} \equiv \frac{v_{c1} \text{ or } v_{c2}}{v_{cm}} \cong \frac{-R_C}{2R_{EE}} = -0.098$$

$$CMRR = \left| \frac{A_d}{A_{cm}} \right| = 1580 \quad (+64\ dB)$$

15.8 cont

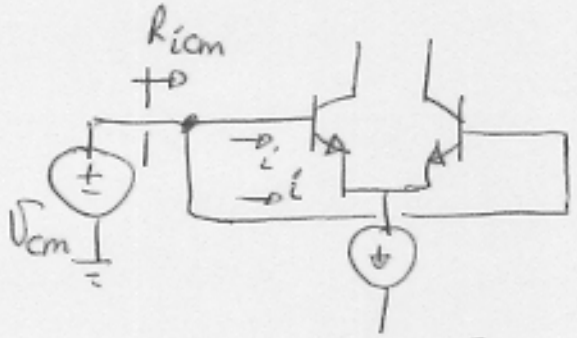


$R_{id} = 2r_\pi = 25K\Omega$

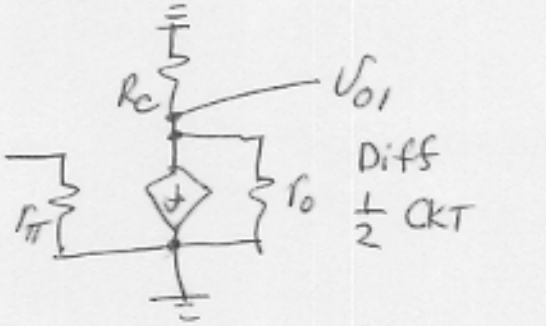
$R_{icm} = \left[r_\pi + (1+\beta_o)2R_{EE}\right] \| \left[\text{same thing}\right]$

$= \frac{r_\pi}{2} + (1+\beta_o)R_{EE}$

$\cong (1+\beta_o)R_{EE} = 20M\Omega$

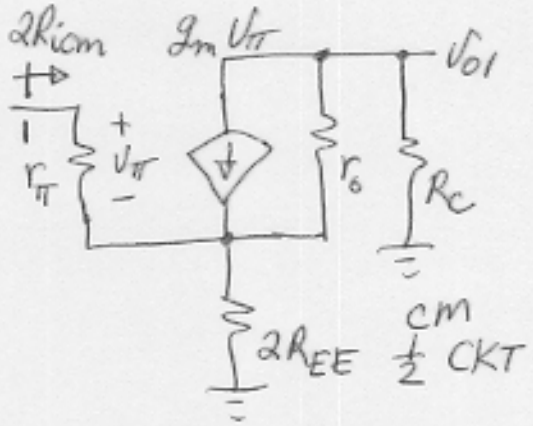


(c) For $V_A = 50V$, $r_o \cong 252\,K\Omega$



$A_d = \frac{v_{o1}}{v_d} = \pm\frac{1}{2}g_m(r_o \| R_C) = \pm 134$

$$A_{cm} = \frac{v_{c1}}{v_{cm}} = -\frac{g_\pi + g_m - \frac{g_m}{g_m+g_o}\left(g_\pi + g_m + \frac{1}{2}G_{EE} + g_o\right)}{g_o - \frac{g_o+G_C}{g_m+g_o}\left(g_\pi + g_m + \frac{1}{2}G_{EE} + g_o\right)}$$



$$\cong -\frac{R_C}{2R_{EE}} - \frac{R_C}{r_o} = \frac{-R_C}{2R_{EE} \| r_o} = -0.25$$

$R_{id} \cong 2r_\pi = 25K\Omega$ (same as without r_o)

$R_{icm} \cong (1+\beta_o)(R_{EE} \| \frac{r_o}{2}) = 7.8\,M\Omega$