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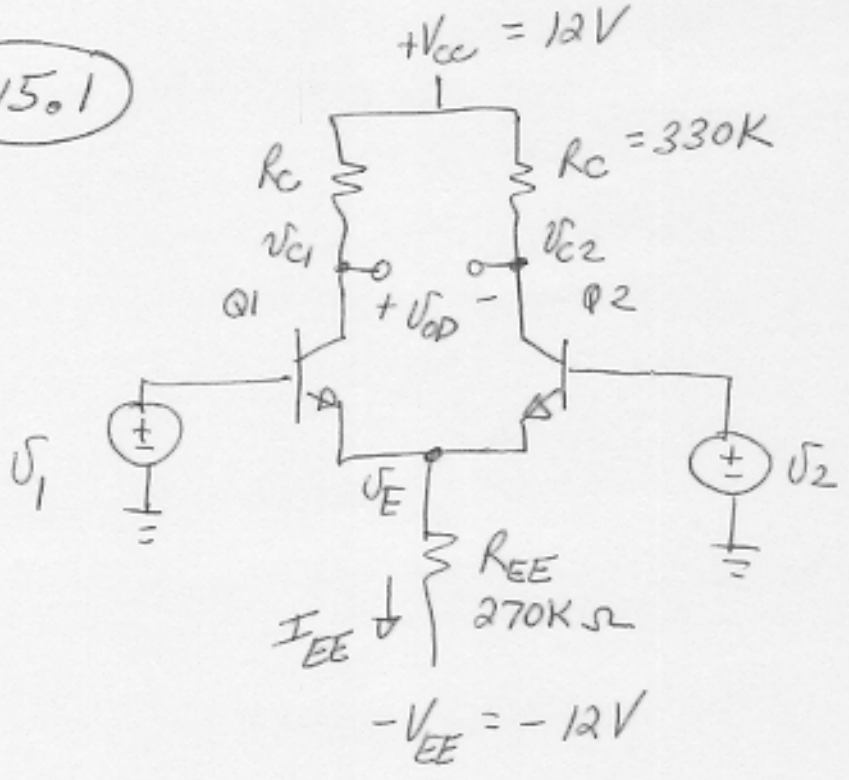
$\beta_F = 100$

15.1

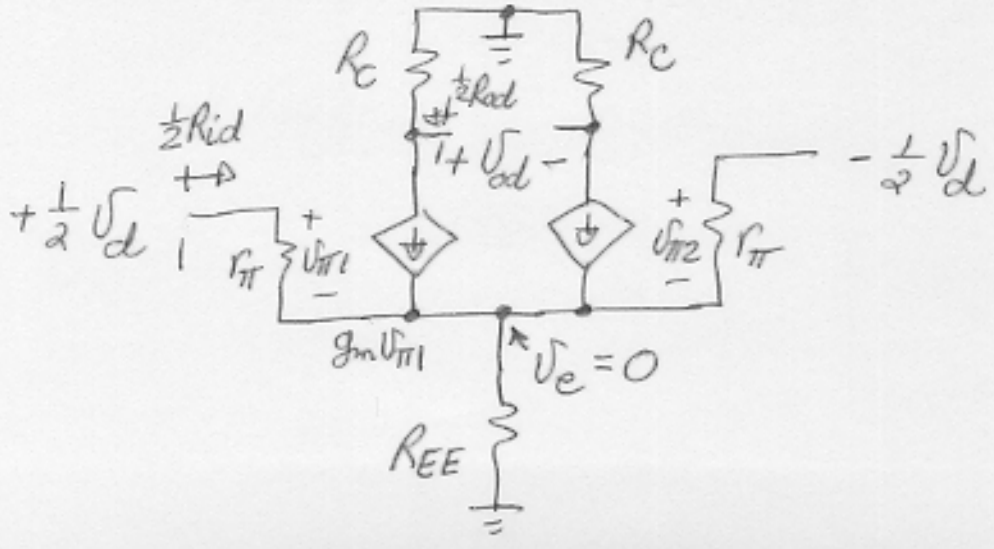


Q-points for $v_1 = v_2 = 0$. $v_E \cong -0.7V$. $I_{EE} \cong \frac{11.3V}{R_{EE}} = 42\mu A$

So, for each transistor

(a) $I_E = 21\mu A$, $I_B = 207\,nA$, $I_C = 21\mu A$, $V_{CE} = 12 + 0.7 - I_C R_C$
$= +5.9\,V$

and $v_{OD} = 0$.



for $I_C = 21\mu A$

$\beta_o \cong 100$

$g_m = 840\mu S$

$r_\pi = 119\,K\Omega$

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15.1 cont

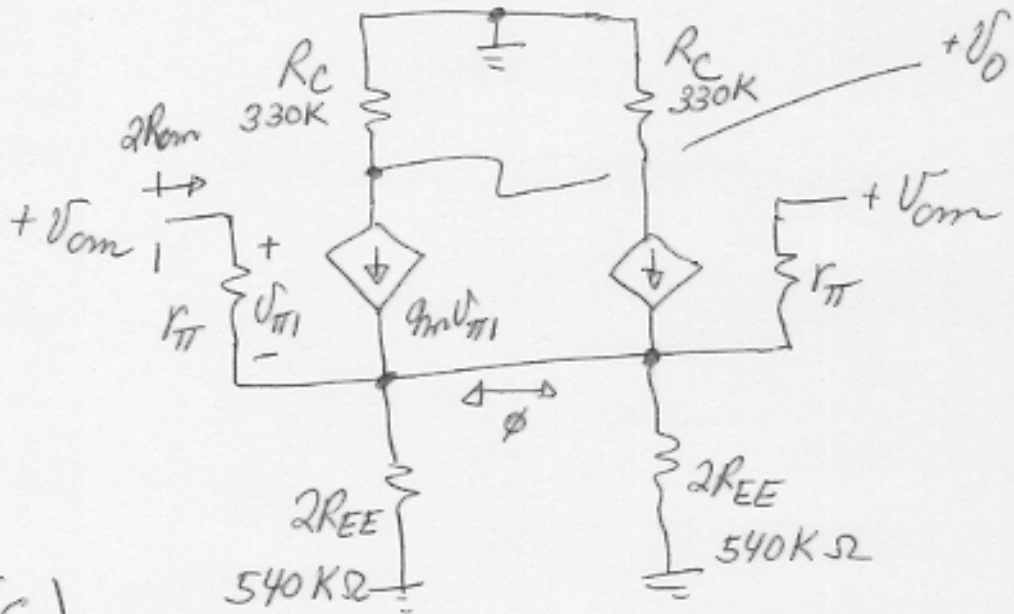
gain (diff) $\frac{1}{2} v_{od} = -g_m R_C \left(\frac{1}{2} v_d\right)$

so $A_d = \frac{v_{od}}{v_d} = \pm g_m R_C = \pm 277$

(b) (gain sign easily reversed by interchanging the two input or output terminals)

$\frac{1}{2} R_{id} = r_\pi$ so $R_{id} = 2r_\pi = 238\ K\Omega$

$\frac{1}{2} R_{od} = R_C$ so $R_{od} = 2R_C = 660\ K\Omega$



$v_o = -g_m R_C v_{\pi 1}$

$= \frac{r_\pi v_{cm}}{r_\pi + 2R_{EE}(1+\beta_o)} (-g_m R_C)$

$\cong \frac{-r_\pi g_m R_C v_{cm}}{2 R_{EE}(1+\beta_o)}$

$= \frac{-\alpha R_C}{2 R_{EE}} v_{cm}$

(c) $A_{cm} = \frac{v_o}{v_{cm}} \cong \frac{-R_C}{2R_{EE}} = -0.61$

$A_d = \frac{v_o}{v_d} = \pm \frac{1}{2} g_m R_C = \pm 138$

$CMRR = \left|\frac{A_d}{A_{cm}}\right| = 227\ (+47dB)$

$R_{icm} \cong R_{EE}(1+\beta_o)$
$= 27\ M\Omega$