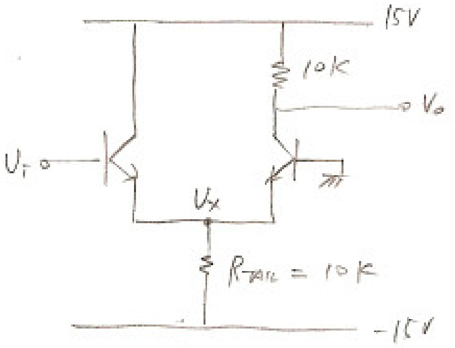
3.20



R_{in}

A_v

R_{out}

$I_{c1} = I_{c2} = \frac{1}{2} \cdot \frac{15-0.7}{10K} = 0.71\,mA$ assume $V_{be} = 0.7V$

$g_{m1} = g_{m2} = \frac{0.71m}{26m} = 27.3\ mA/V$

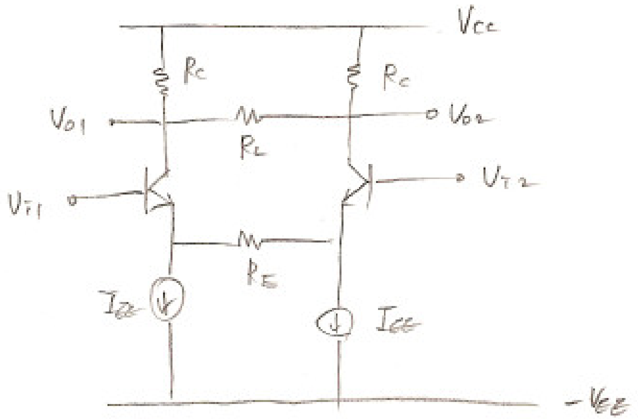
$r_{\pi 1} = r_{\pi 2} = \frac{\beta}{g_m} = \frac{200}{27.3m} = 7.33\ k\Omega.$

$R_{IN} = r_{\pi 1} + (1+\beta)\left(\frac{1}{g_{m2}} \parallel R_{tail}\right) \approx 2r_\pi = 14.6\ k\Omega$

$A_v = \frac{V_x}{V_i} \cdot \frac{V_o}{V_x} \approx \frac{1}{2} \cdot g_{m2} \cdot R_C = 136.5$

$R_O = R_C = 10K\Omega.$

3.21



A_{cm}

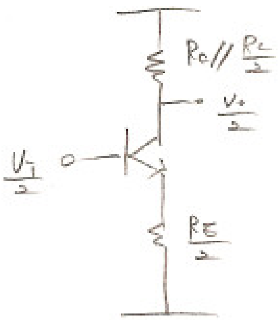
A_{dm}

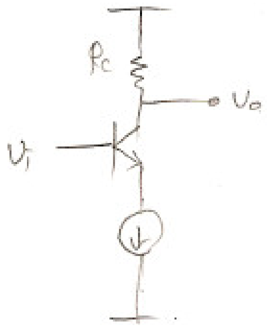
$R_{in,cm}$

$R_{in,dm}$

half circuit (DM)

half circuit (CM)





$$R_{in,dm} = 2\left\{ r_\pi + (1+\beta)\frac{R_E}{2} \right\}$$

$$= 2r_\pi + (1+\beta) R_E$$

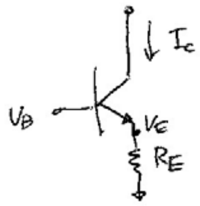
$$A_{dm} = -\frac{g_m \left(R_C /\!/ \frac{R_L}{2}\right)}{1 + g_m \frac{R_E}{2}\left(1+\frac{1}{\beta}\right)}$$

$$= -\frac{r_\pi g_m \left(R_C /\!/ \frac{R_L}{2}\right)}{r_\pi + (\beta+1)\frac{R_E}{2}}$$

$$R_{in,cm} = \infty$$

$$A_{cm} = 0$$

3.



$$\frac{dI_c}{dV_B}\left(= G_m\right) \equiv \frac{I_c}{V_{T,eff}} \cdots ① , \quad \frac{dI_c}{dV_{BE}}\left(= g_m\right) = \frac{I_c}{V_T} \cdots ②$$

$$\frac{②}{①} \Rightarrow \frac{dV_B}{dV_{BE}} = \frac{V_{T,eff}}{V_T} \cdots ③$$

$$V_B \cong V_{BE} + I_c R_E \Rightarrow \frac{dV_B}{dV_{BE}} = 1 + \frac{dI_c}{dV_{BE}} \cdot R_E \cdots ④$$

from ③. ④

$$V_{T,eff} = V_T\left(1 + \frac{dI_c}{dV_{BE}} R_E\right) = V_T\left(1 + g_m R_E\right)$$