$\beta_F = \beta_0 = 100$

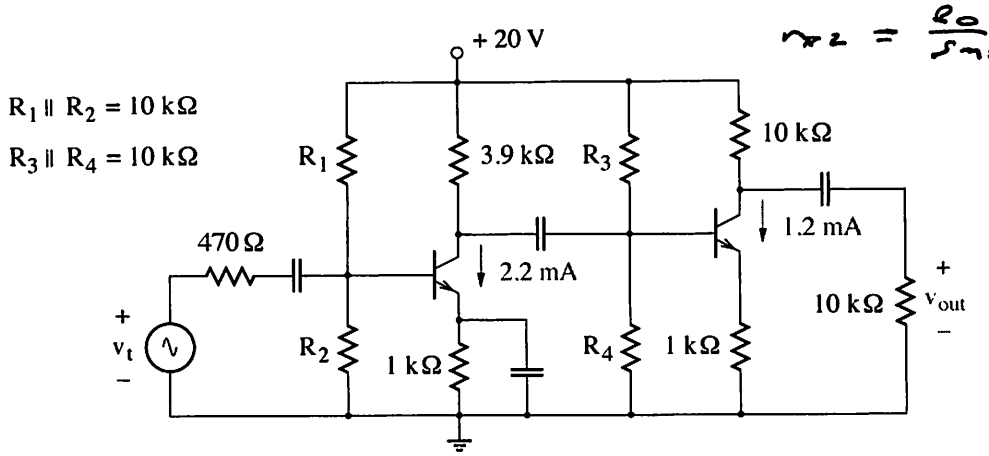
7.60

$$g_{m1} = \frac{2.2\ mA}{25.9\ mV} = 84.9 \times 10^{-3}\ \mathcal{V}$$

$$r_{\pi 1} = \frac{\beta_0}{g_{m1}} = 1.18\ k$$

$$g_{m2} = \frac{1.2\ mA}{25.9\ mV} = 46.3 \times 10^{-3}\ \mathcal{V}$$

$$r_{\pi 2} = \frac{\beta_0}{g_{m2}} = 2.16\ k$$



stage 1 CE

stage 2 CE

$10k \,//\, 10k$

$$A_{vm}^{(2)} = \frac{-g_{m2} r_{c2}'}{1 + g_{m2} r_{e1}' (1 + 1/\beta_0)} = -4.85$$

(r_{c2}': 1k; r_{e1}': 1k)

$$r_{in}^{(2)} = r_3 \,//\, r_4 \,//\, \underbrace{[r_{\pi 2} + (1+\beta_0) r_{e2}']}_{103k} = 9.12k$$

(r_{e2}': 1k)

$$A_{vm}^{(1)} = -g_{m1} r_{c1}' = -232$$

$r_{c1}' = 3.9k \,//\, r_{in}^{(2)} = 2.73k$

$$r_{in}^{(1)} = r_1 \,//\, r_2 \,//\, r_{\pi 1} = 1.06k$$

$$LF = \frac{r_{in}^{(1)}}{r_{in}^{(1)} + r_E} = \frac{1.06}{1.06 + 0.47} = 0.693$$

$$A_{vm}^{TOTAL} = LF \times A_{vm}^{(1)} \times A_{vm}^{(2)} = \underline{780}$$

7.61 $\beta_F = \beta_0 = 100$

$K'\frac{W}{L} = 4.2\ mA/V^2$, $V_T = 0.6\ V$

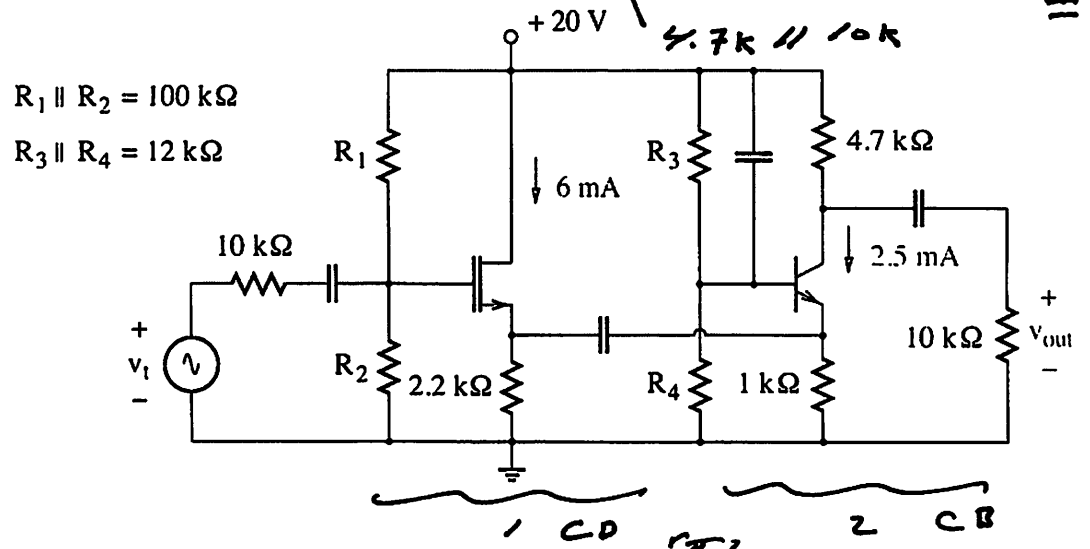
$g_{m1} = \sqrt{2 \times 4.2 \frac{mA}{V^2} \times 6\ mA} = 7.10 \times 10^{-3}\ \mho$

$g_{m2} = \frac{2.5\ mA}{25.9\ mV} = 96.5 \times 10^{-3}\ \mho$

$r_{\pi 2} = \frac{\beta_0}{g_{m2}} = 1.04\ k$

$A_{vm}^{(2)} = g_{m2} r_{c2}' = 96.5 \times 10^{-3}\ \mho \times 7.20 \times 10^{3}\ \Omega$ ← $4.7k \parallel 10k$

$= 309$



$r_{in}^{(2)} = 1k \parallel \frac{r_{\pi 2}}{1+\beta_0} = 10.2\ \Omega$

$A_{vm}^{(1)} = \frac{g_{m1}(r_{s1}' \leftarrow 2.2k \parallel r_{in}^{(2)} \approx 10.2\ \Omega)}{1 + g_{m1} r_{s1}'}$

$= \frac{0.0724}{1 + 0.0724} = 0.0675$

$r_{in}^{(1)} = r_1 \parallel r_2 = 100k$

$C_F = \frac{r_{in}^{(1)}}{r_{in}^{(1)} + r_t} = \frac{100k}{100k + 10k} = 0.909$

$A_{vm}^{TOTAL} = 0.909 \left(\frac{0.0724}{0.0675}\right)(309) = 190$

7.62

$K' \frac{W}{L} = 2.2\ mA/V^2$

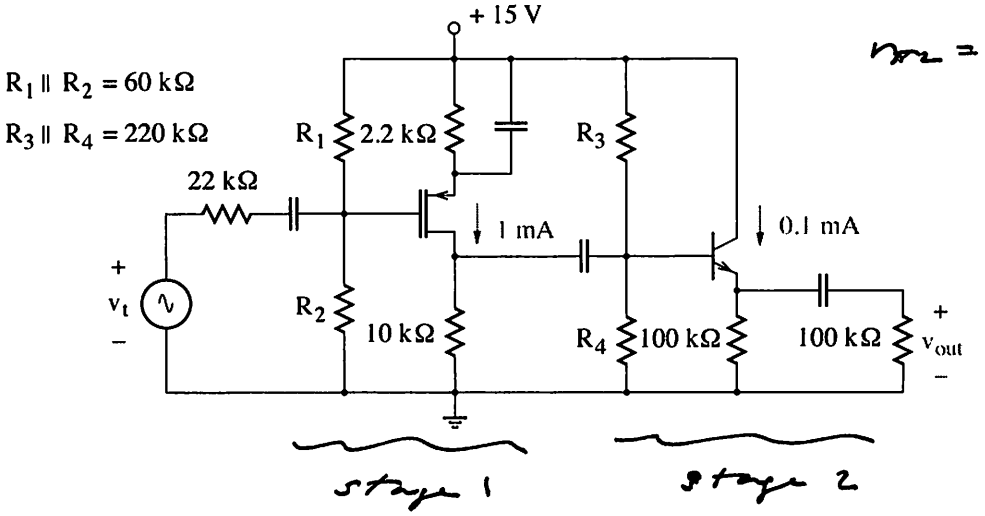
$g_{m1} = \sqrt{2 I_{dq} K' \frac{W}{L}} = 2.10 \times 10^{-3}\ \mho$

$r_{o1} = \infty$

$\beta_0 = 120$

$g_{m2} = \frac{I_{dq}}{kT/q} = \frac{0.1\ mA}{25.8\ mV} = 3.86 \times 10^{-3}\ \mho$

$r_{\pi 2} = \frac{\beta_0}{g_m} = 31.1\ k$



CS $\quad$ 100K // 100K $\quad$ CC

$A_{vm}^{(2)} = \frac{g_{m2} r_{e2}' (1 + 1/\beta_0)}{g_{m2} r_{e2}' (1 + 1/\beta_0) + 1} = \frac{195}{195 + 1} = 0.995$

$r_{in}^{(2)} = r_3 // r_4 // [r_{\pi 2} + (\beta_0 + 1) r_{e2}'] = 212\ K$

6.08 MEG $\quad$ 50K

$A_{vm}^{(1)} = -g_{m1} r_{c1}' = -20.0$

$r_{c1}' = 10K // r_{in}^{(2)} = 9.57\ K$

$r_{in}^{(1)} = r_1 // r_2 = 60\ k$

$LF = \frac{r_{in}^{(1)}}{r_{in}^{(1)} + r_t} = \frac{60}{60 + 22} = 0.732$

$A_{vm}^{\text{overall}} = LF \times A_{vm}^{(1)} \times A_{vm}^{(2)} = -15$

7.63 $\beta_F = \beta_0 = 140$

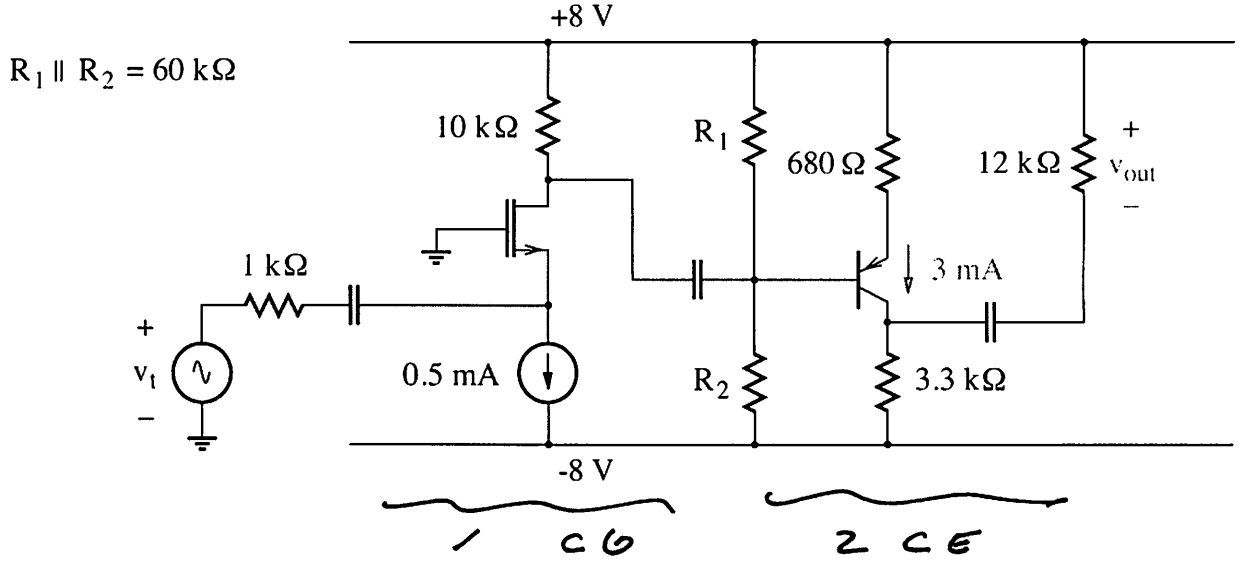
$K'\frac{W}{L} = 1.8\ mA/V^2$, $V_T = 0.7\ V$

$$g_{m1} = \sqrt{2 \times 1.8\ mA/V^2 \times 0.5\ mA} = 1.34 \times 10^{-3}\ \Omega$$

$$g_{m2} = \frac{3\ mA}{25.9\ mV} = 116 \times 10^{-3}\ \Omega$$

$$r_{\pi 2} = \frac{\beta_0}{g_{m2}} = 1.21\ k$$

$$A_{vm}^{(2)} = \frac{-g_{m2} r_{c2}'}{1 + g_{m2} r_{e2}' (1 + 1/\beta_0)}$$



$r_{c2}' = 3.3\ k \| 12\ k = 2.59\ k$

$r_{e2}' = 680\ \Omega$

$$A_{vm}^{(2)} = \frac{-116 \times 10^{-3}\ \Omega \times 2.59 \times 10^{3}\ \Omega}{1 + 116 \times 10^{-3}\ \Omega \times 0.68 \times 10^{3}\ \Omega \left(1 + \frac{1}{140}\right)}$$

$$= -3.74$$

60K

$$r_{in}^{(2)} = (R_1 \| R_2) \| [r_{\pi 2} + (1+\beta_0) R_{e2}']$$

$\rightarrow 1.21K + 141 \times 0.68K = 97.1K$

$$= 37.1\,K$$

$$A_{vm}^{(1)} = g_{m1} R_{d1}'$$

$\uparrow$ $10K \| r_{in}^{(2)} = 7.88K$

$$= 1.34 \times 10^{-3}\,\mho \times 7.88 \times 10^{3}\,\Omega = 10.6$$

$$r_{in}^{(1)} = \frac{1}{g_{m1}} = 746\,\Omega$$

$$LF = \frac{r_{in}^{(2)}}{r_{in}^{(2)} + R_L} = \frac{0.746}{0.746 + 1} = 0.427$$

$$A_{vm}^{TOTAL} = 0.427 \times 10.6 \times (-7.74)$$

$$= \underline{-16.9}$$