The transistors in the circuit of Fig. P7.72 have $\beta_0 = 100$, $V_A = 100$ V, $C_\mu = 0.2$ pF, At a bias current of 100 μA, $f_T = 400$ MHz. (Note that the bias details are not shown.)

(a) Find R_{in} and the midband gain.

(b) Find an estimate of the upper 3-dB frequency f_H. Which capacitor dominates? Which one is the second most significant?

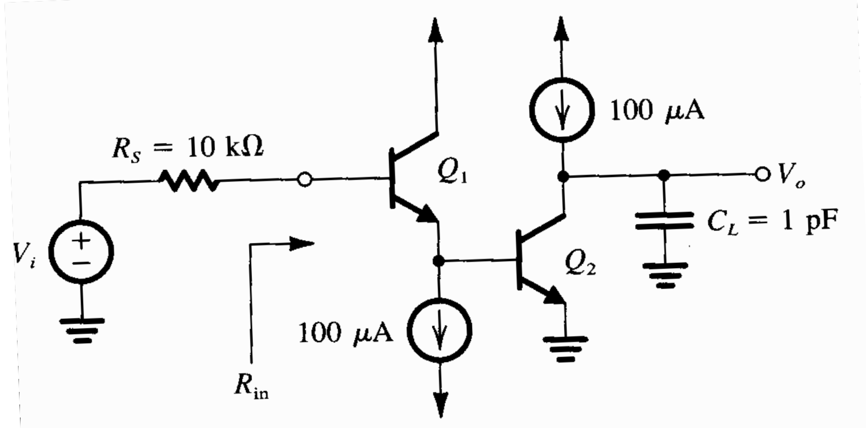


Fig. P7.72

72 Refer to Fig. P 7.72.

Each of the two transistors is operating at a bias current of approx. 100 μA. Then

$r_e = 250\ \Omega$, $g_m = 4$ mA/V, $r_\pi = 25$ kΩ

$r_o = 1$ MΩ, $C_\pi + C_\mu = \dfrac{4 \times 10^{-3}}{2\pi \times 400 \times 10^{6}} = 1.59$ pF

$C_\pi = 1.59 - 0.2 = 1.39$ pF

(a) $R_{in} = (\beta_1 + 1)\left[r_{e1} + (r_{\pi 2} \,//\, r_{o1})\right]$

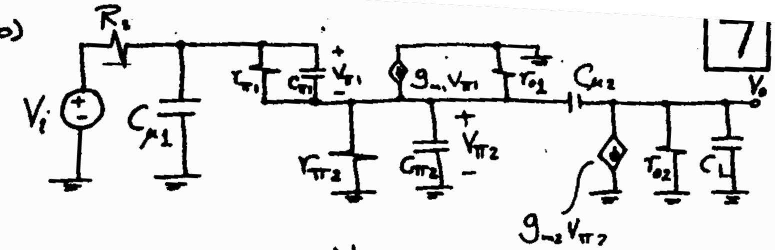
$= 101\left[0.25 + 24.39\right] \simeq \underline{\underline{2.5\ \text{M}\Omega}}$

$$A_M = -\frac{R_{in}}{R_{in} + R_s}\;\frac{(r_{\pi 2} // r_{o1})}{r_{e1} + (r_{\pi 2} // r_{o1})}\; g_{m2}\, r_{o2}$$

$$= -\frac{2.5}{2.5 + 0.01} \times \frac{(25 // 1000)}{0.25 + (25 // 1000)} \times 4 \times 1000$$

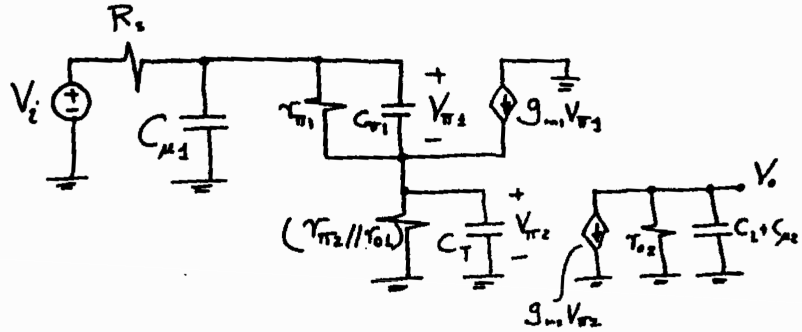
$= \underline{\underline{-3943\ \text{V/V}}}$

(b)



7

$\Downarrow$



$$C_T = C_{\pi 2} + C_{\mu 2}(1 + g_{m2}\, r_{o2})$$

$$= 1.39 + 0.2\,(1 + 4 \times 1000) = 801.6 \text{ pF}$$

$$R_{\mu 1} = R_s // R_{in} = 10 // 2500 \simeq 10 \text{ k}\Omega$$

$$R_{\pi 1} = r_{\pi 1} // \frac{R_s + (r_{\pi 2}//r_{o1})}{1 + g_{m1}(r_{\pi 2}//r_{o1})}$$

$$= 25 // \frac{10 + (25//1000)}{1 + 4\,(25//1000)} = 344\ \Omega$$

$$R_T = r_{\pi 2} // r_{o1} // \frac{r_{\pi 1} + R_s}{\beta_1 + 1}$$

$$= 25 // 1000 // \frac{25 + 10}{101} = 342\ \Omega$$

$$R_{\mu 2} = r_{o2} = 1000 \text{ k}\Omega$$

$$\tau = C_{\mu 1} R_{\mu 1} + C_{\pi 1} R_{\pi 1} + C_T R_T + (C_{\mu 2} + C_L) R_{\mu 2}$$ 7

$$= 0.2 \times 10 + 1.39 \times 0.344 + 801.6 \times 0.342 + 1.2 \times 1000$$

$$= 2 + 0.48 + 274.15 + 1200 \text{ ns}$$ ns

Thus $\underline{(C_L + C_{\mu 2})}$ dominates. The second most significant is C_T or equivalently $C_{\mu 2}$.

$$f_H \simeq \frac{1}{2\pi\tau} = \frac{1}{2\pi \times 1476.6 \times 10^{-9}} = \underline{107.8 \text{ MHz}}$$