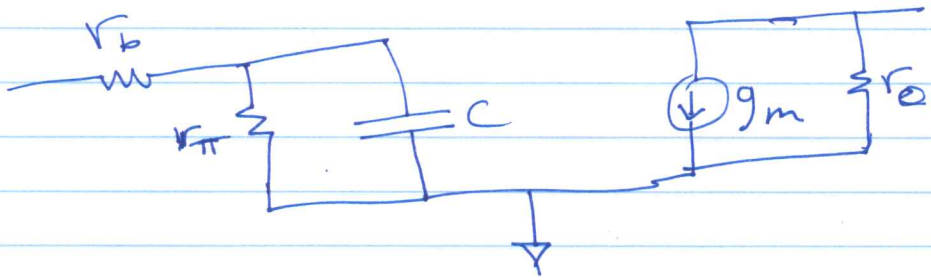


$$y_{22} = \frac{1}{r_o} \qquad y_{21} = g_m \qquad y_{12} = 0$$

$$y_{11} = \frac{1}{r_b + r_\pi \| C}$$

$$r_\pi \| C = \frac{r_\pi \frac{1}{i\omega C}}{r_\pi + \frac{1}{i\omega C}} = \frac{r_\pi}{1 + r_\pi i\omega C}$$

$$h_{21} = \frac{y_{21}}{y_{11}} = g_m (r_b + r_\pi \| C)$$

$$= g_m \left(r_b + \frac{r_\pi}{1 + i\omega r_\pi C} \right)$$

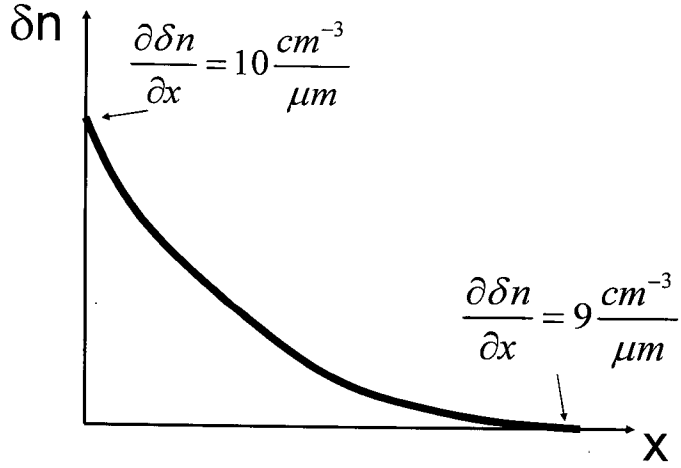
$$r_b \to 0 \Rightarrow h_{21} = g_m \frac{r_\pi}{1 + i\omega r_\pi C}$$

$$\omega \to \infty \Rightarrow h_{21} = \frac{g_m}{i\omega C}$$

$$\Rightarrow f_T \approx \frac{g_m}{2\pi C}$$

$$U = \frac{g_m^2}{4\, \mathrm{Re}\left(\frac{1}{r_o} \times \frac{1}{r_b + r_\pi \| C} \right)} = \frac{g_m^2}{4} r_o \, \mathrm{Re}(r_b + r_\pi \| C)$$

3) For the hypothetical density of electrons in the p region of an npn transistor biased in active mode, find the value of β.



$$I_E \propto \left.\frac{\partial \delta n}{\partial x}\right|_{x=0}$$

$$I_C \propto \left.\frac{\partial \delta n}{\partial x}\right|_{x=W_B}$$

$$\Rightarrow \frac{I_E}{I_C} = \frac{10}{9} \Rightarrow I_E = \frac{1}{0.9} I_C$$

$$I_E = I_B + I_C$$

$$\Rightarrow I_C \frac{1}{0.9} = I_B + I_C$$

$$\Rightarrow \frac{I_C}{I_B} = \frac{1}{\frac{1}{0.9} - 1} = \boxed{9 = \beta}$$