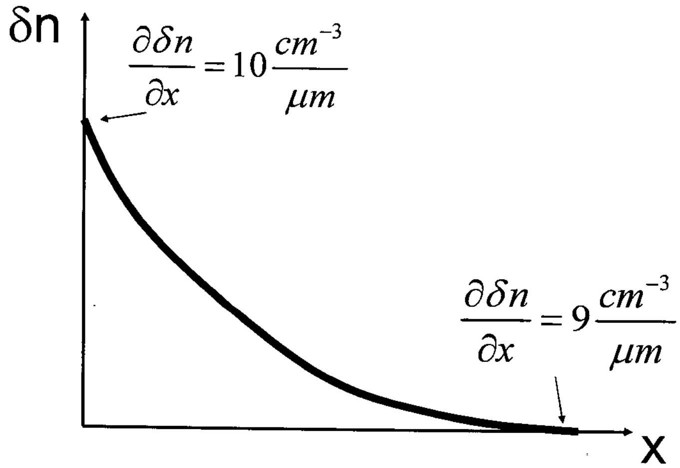
3) For the hypothetical density of electrons in the p region of an npn transistor biased in active mode, find the value of β.



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

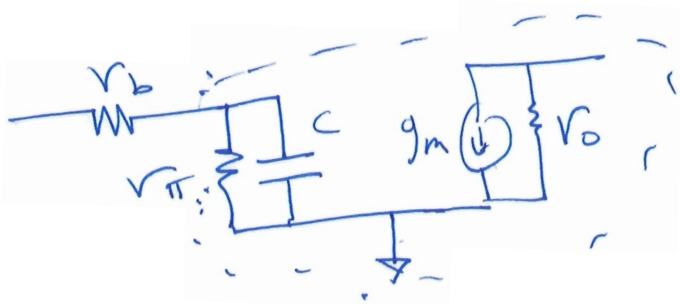
$$I_C \propto \left.\frac{\partial \delta n}{\partial x}\right|_{x=W_B}$$

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

$$I_E = I_B + I_C$$

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

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



For circuit in dotted line:

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

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

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

IF $r_b = 0$

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

$$w \to \infty \Rightarrow h_{21} = \frac{g_m}{iwC} \Rightarrow f_T = \frac{g_m}{2\pi C}$$

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

If $r_b \neq 0$, need to concatenate ABCD matrices:

1) Find ABCD matrix for circuit in dotted lines.
2) Find ABCD matrix for r_b.
3) Find resultant ABCD ie $(ABCD)_{total} = (ABCD)_1 (ABCD)_2$
4) Convert ~~total~~ ABCD back to total y-matrix, then find f_T, f_{MAX} from y_{21}, etc.

This level of effort will not be required for midterm.