ECE 305 EXAM 5.

part I 1. e 2. c 3. c 4. d 5. a

part II.

(6 points) a. $\gamma_F = \dfrac{1}{1+\dfrac{D_{PE} W_B N_{AB}}{D_{nB} W_E N_{DE}}} = \dfrac{1}{1+\dfrac{2\,cm^2/s \cdot 0.25\,um \cdot 10^{17}\,cm^{-3}}{20\,cm^2/s \cdot 0.5\,um \cdot 10^{18}\,cm^{-3}}} = 0.995.$

(6 points) b. $\alpha_T = \dfrac{1}{1+\frac{1}{2}\left(\frac{W_B}{L_B}\right)^2} = \dfrac{1}{1+\frac{1}{2}\left(\frac{0.25\,um}{1\,um}\right)^2} = 0.9697$

(6 points) c. $\alpha_{dc} = \alpha_F = \gamma_F \cdot \alpha_T = 0.995 \times 0.9697 = 0.9649$

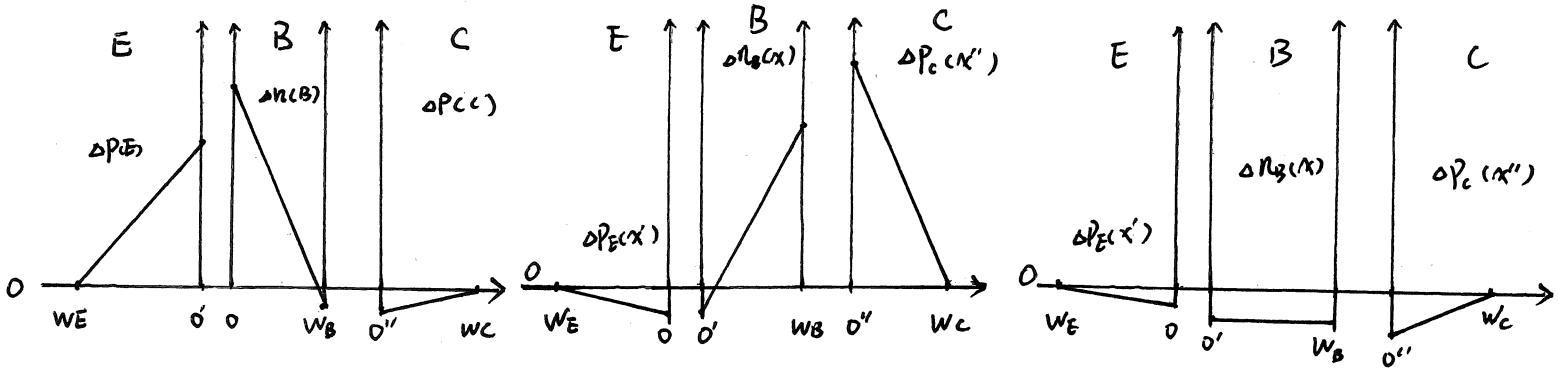
(6 points) d. $\beta_{dc} = \beta_F = \dfrac{\alpha_F}{1-\alpha_F} = \dfrac{0.9649}{1-0.9649} = 27.5$

(6 points) e. $I_{F0} = qA\left(\dfrac{D_{nB}}{W_B}\dfrac{n_i^2}{N_{AB}} + \dfrac{D_{pE}}{W_E}\dfrac{n_i^2}{N_{DE}}\right) = 1.6\times10^{-19} C \cdot 1\,um^2 \cdot \left[\dfrac{20\,cm^2/s}{0.25\,um}\cdot\dfrac{(10^{10}\,cm^{-3})^2}{10^{17}\,cm^{-3}} + \dfrac{2\,cm^2/s}{0.5\,um}\cdot\dfrac{(10^{10}\,cm^{-3})^2}{10^{18}\,cm^{-3}}\right]$

$= 1.286\times10^{-18} A.$

part III.

(6 points) a. Forward active. (6 points) b. Inverted active (6 points) C. Cut-off



(6 points) d.

① C-B junction is forward biased, or $V_{CB} > 0$

② E-B junction is reverse biased, or $V_{EB} < 0$

③ Inverted

(6 points) e. At the edge of C-B depletion region: $\Delta p_B(W_B) = p_{B0}\left(e^{\frac{qV_{CB}}{kT}} - 1\right)$

So $\dfrac{\Delta p_B(W_B)}{p_{B0}} = e^{\frac{qV_{CB}}{kT}} - 1 = 10 \Rightarrow V_{CB} = \dfrac{kT}{q}\ln(11) = 0.062\,V.$