ECE 656 Homework (Week 15)
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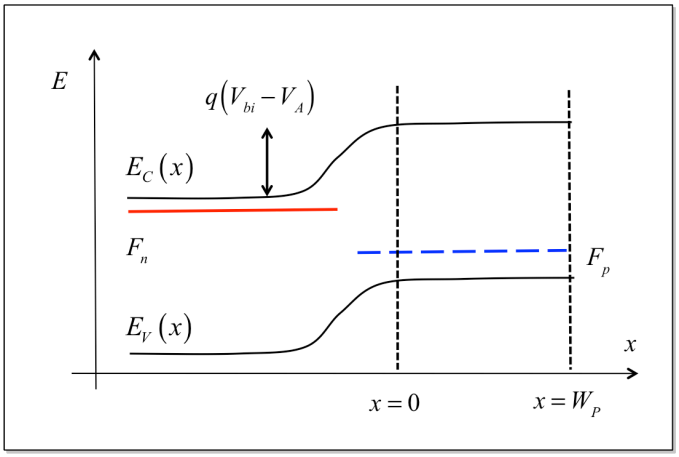
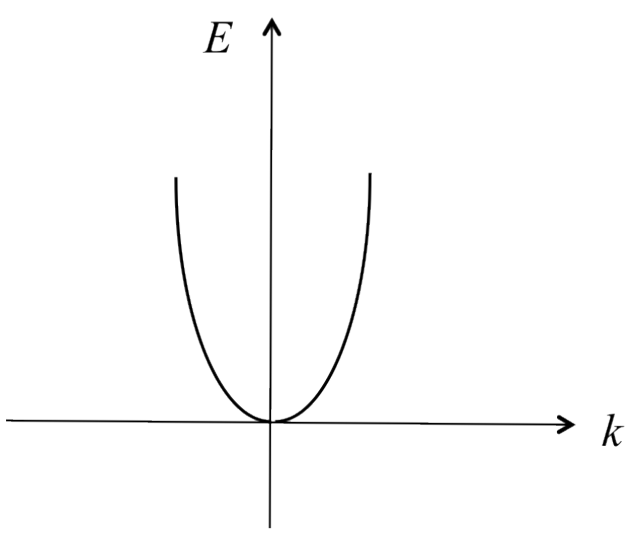
1) Consider the forward biased n⁺p junction sketched below. The classic, short-base theory of the diode gives the current as $I_D = qA\frac{n_i^2}{N_A}\frac{D_n}{W_P}\left(e^{qV_A/k_BT}-1\right)$. (Non-degenerate carrier statistics have been assumed).



1a) Treat the n⁺ region as a Landauer contact and assume that the depletion region is ballistic. Also assume an absorbing contact at $x = W_P$. On the sketch below, which shows the k-states at the beginning of the p-type quasi-neutral region, indicate which k-states are populated from the n⁺ region.



ECE 656 Homework (Week 15) (continued)

1b) Using the results of problem, 1a), present an expression for the magnitude of the electron current injected into the p-type quasi-neutral region, $I_n^+(0)$. (You do not need to solve this expression).

1c) The diode current is all carried by electrons in an n+p diode, so $I_D = \mathcal{T} I_n^+(0)$. Evaluate this expression in the classic, diffusive limit and use it to solve for $I_n^+(0)$. HINT: You could get the same answer by evaluating the expression in 1b), but this approach is easier.

1d) Use the result of 3c) to develop an expression for the diode current, I_D, that is valid from the ballistic to diffusive limit. Compare your answer to the classic, short base result and discuss the differences.