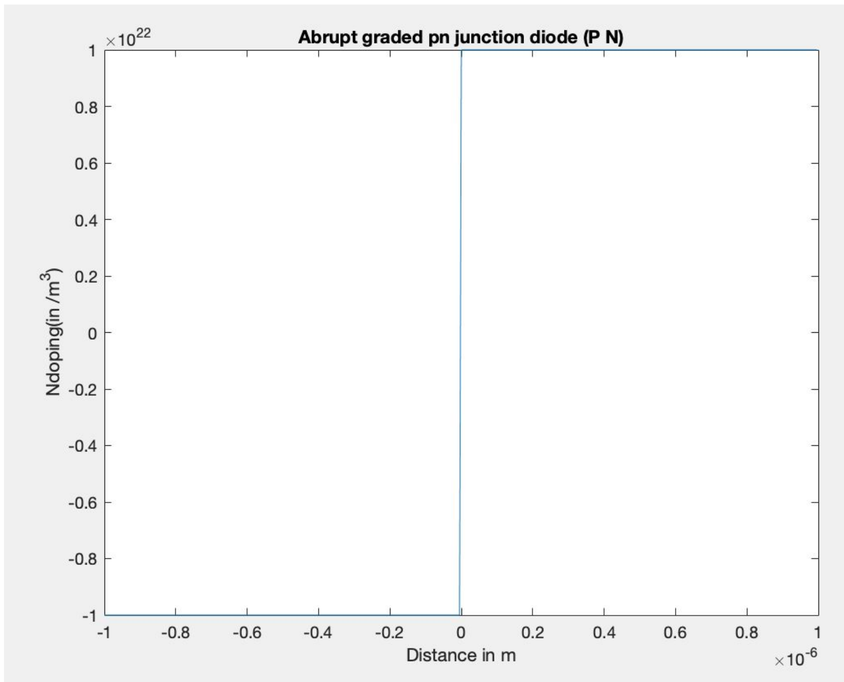
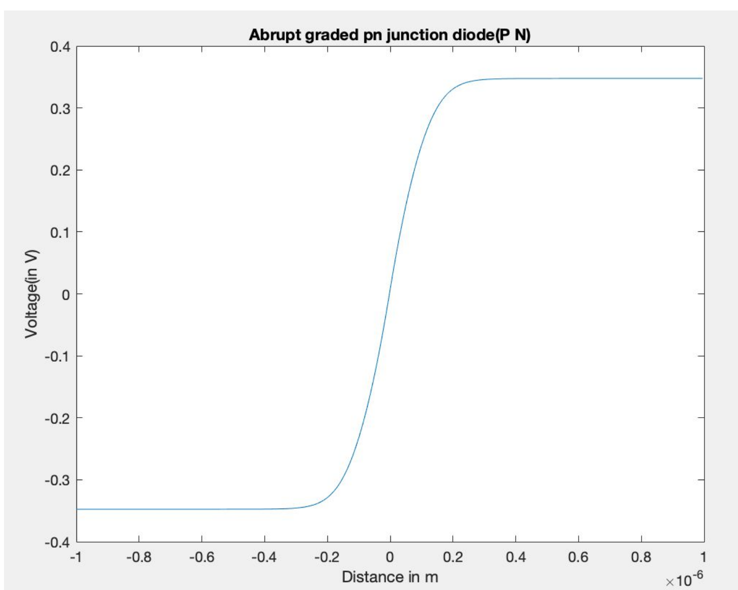
Assignment – 3

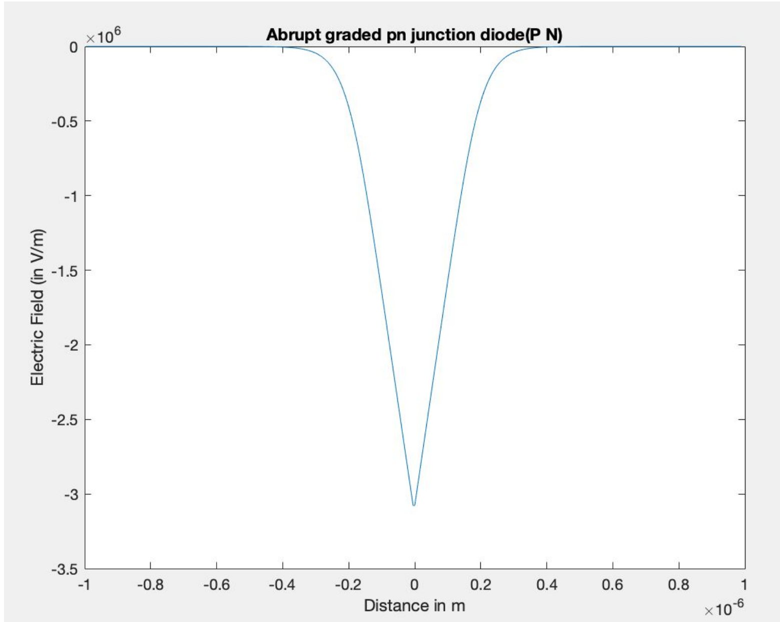
A P-N junction diode with
a) Abrupt junction



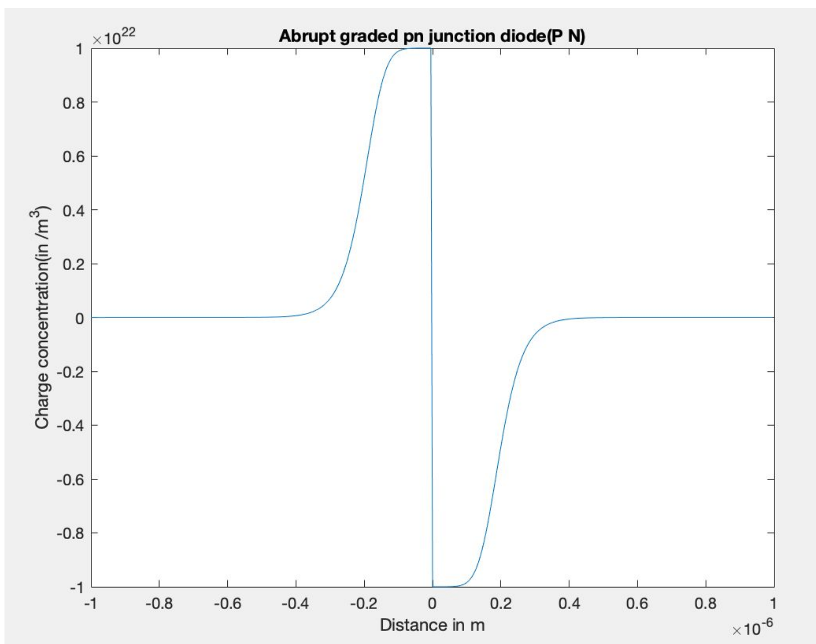
- **Potential (V)**



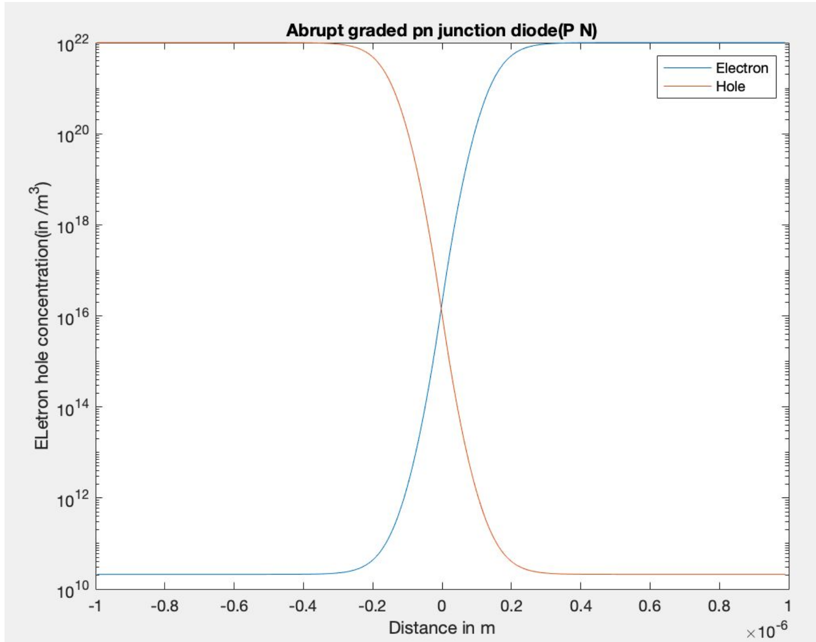
- **Electric field (E)**



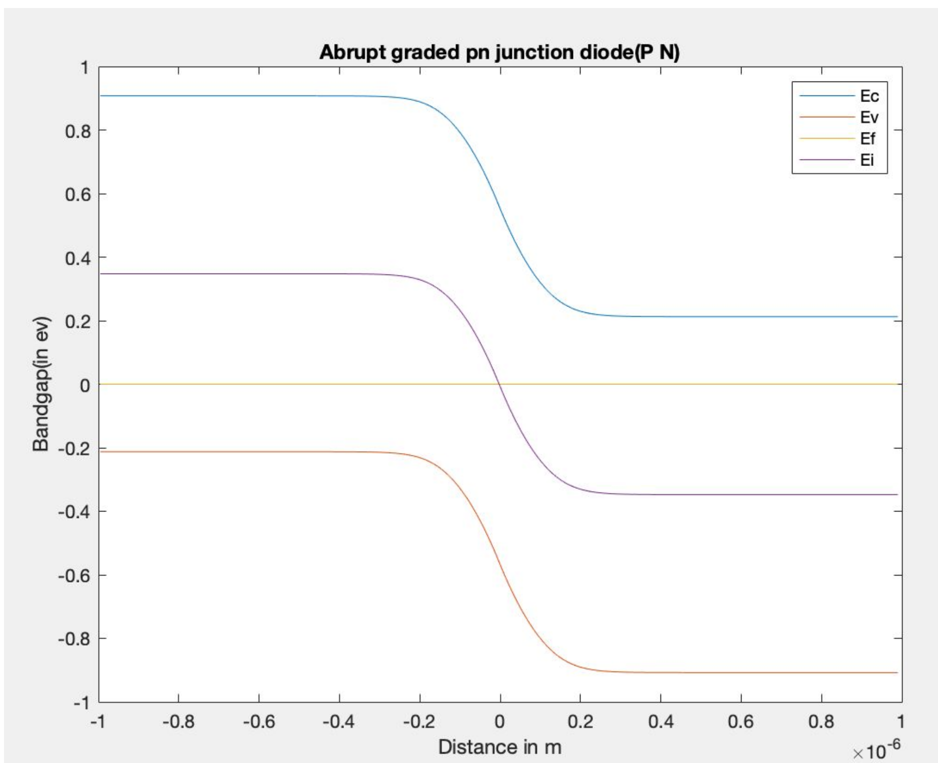
- **Charge concentration (ρ/q)**



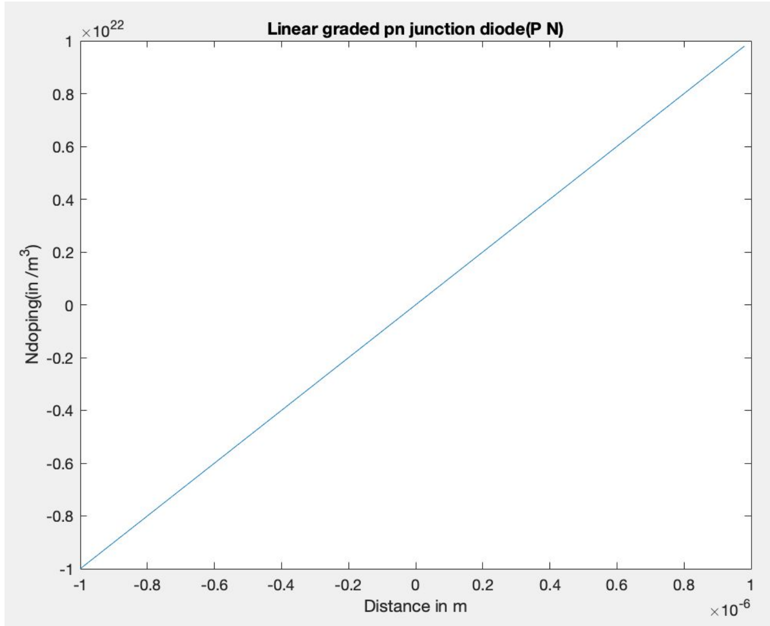
- **Electron (n) and hole (p) concentrations**



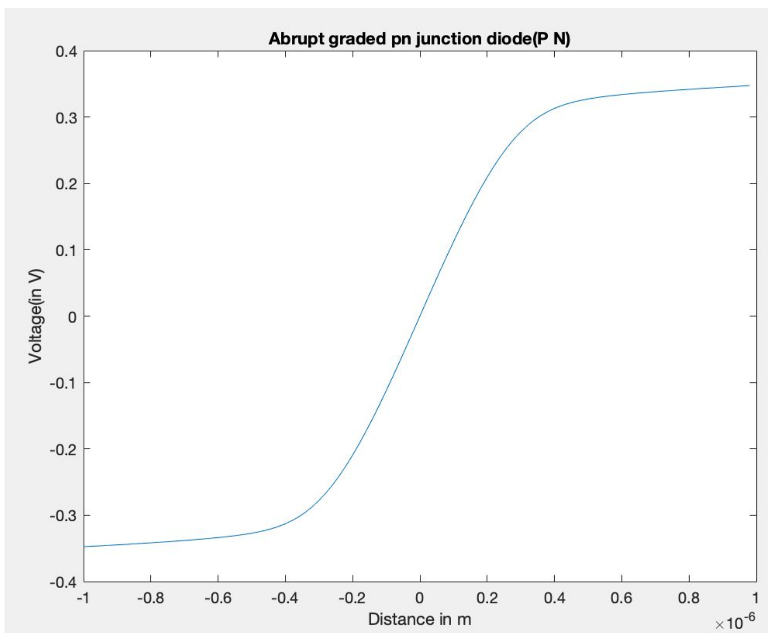
- **Energy band diagram depicting conduction band minimum (EC), valence band maximum (EV),mid gap energy level (Emid), fermi energy level EF .**



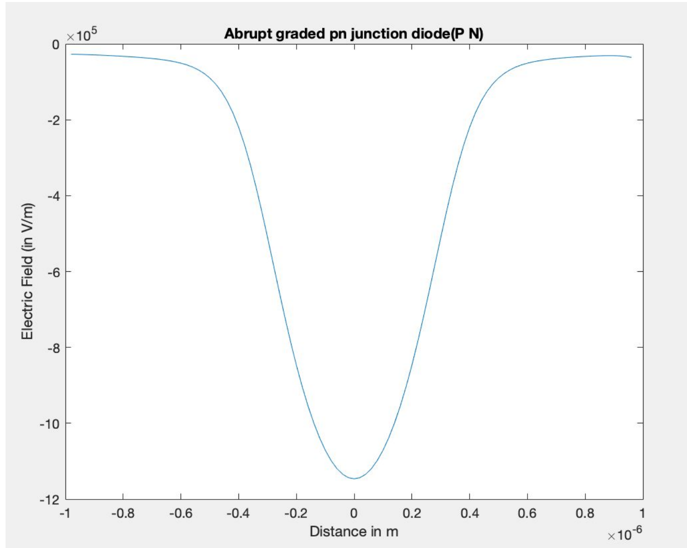
b) linearly graded junction.



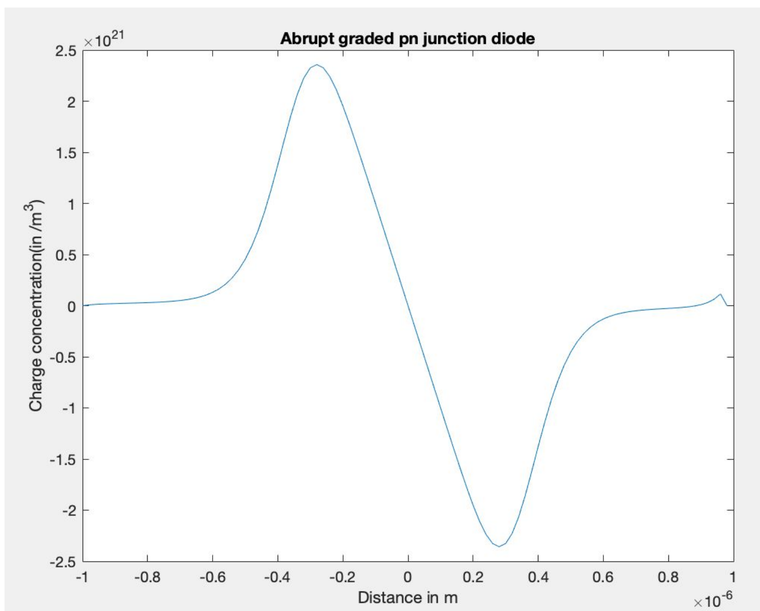
- **Potential (V)**



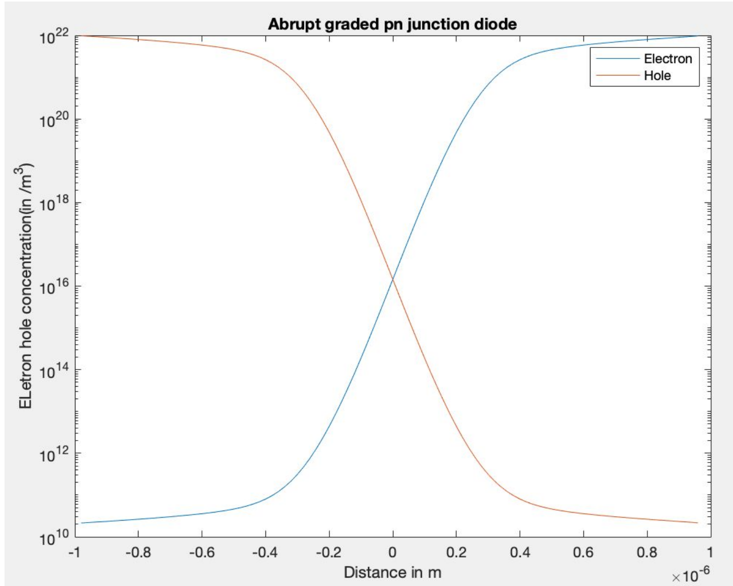
- **Electric field (E)**



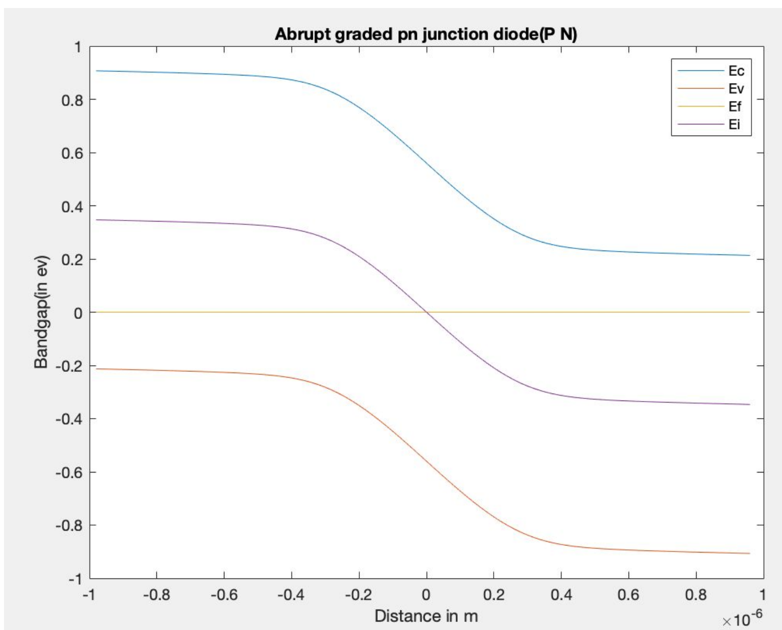
- **Charge concentration (ρ/q)**



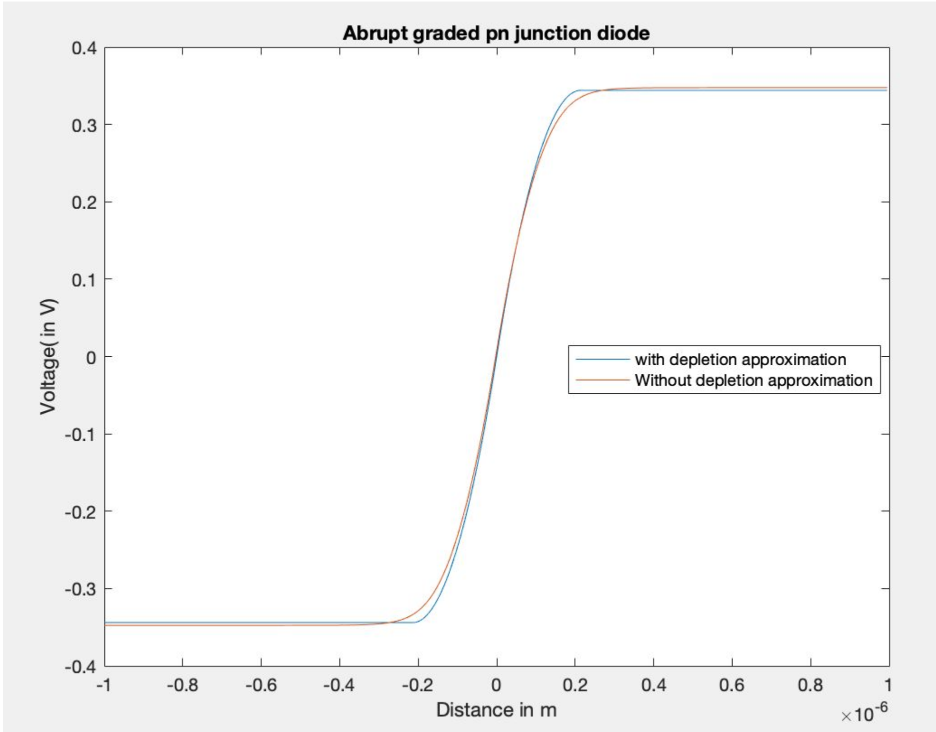
- **Electron (n) and hole (p) concentrations**

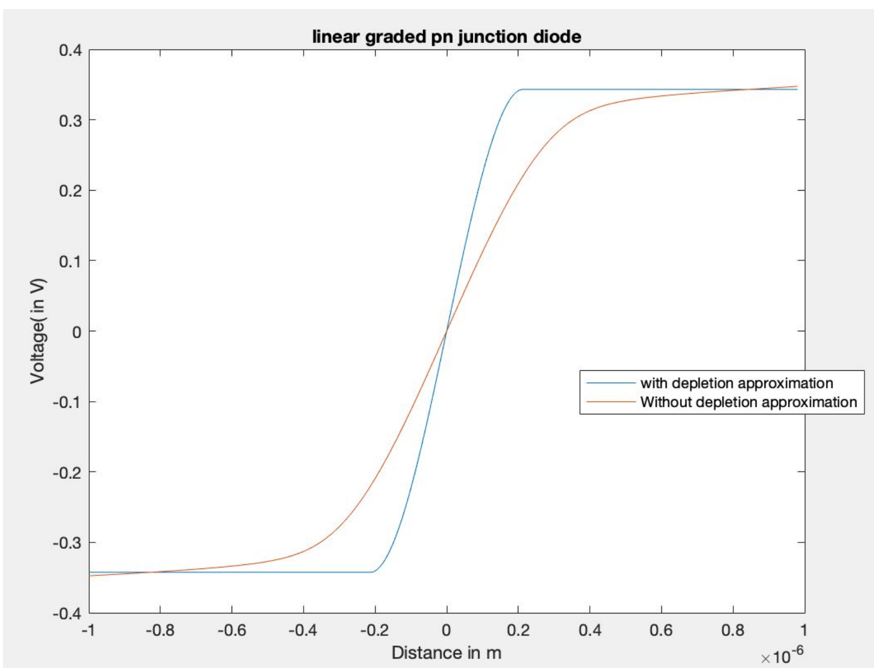


- **Energy band diagram depicting conduction band minimum (EC), valence band maximum (EV),mid gap energy level (Emid), fermi energy level EF .**



Compare the V vs X graph with the one obtained in Assignment 2 using depletion approximation.





Give a qualitative description of your observation.

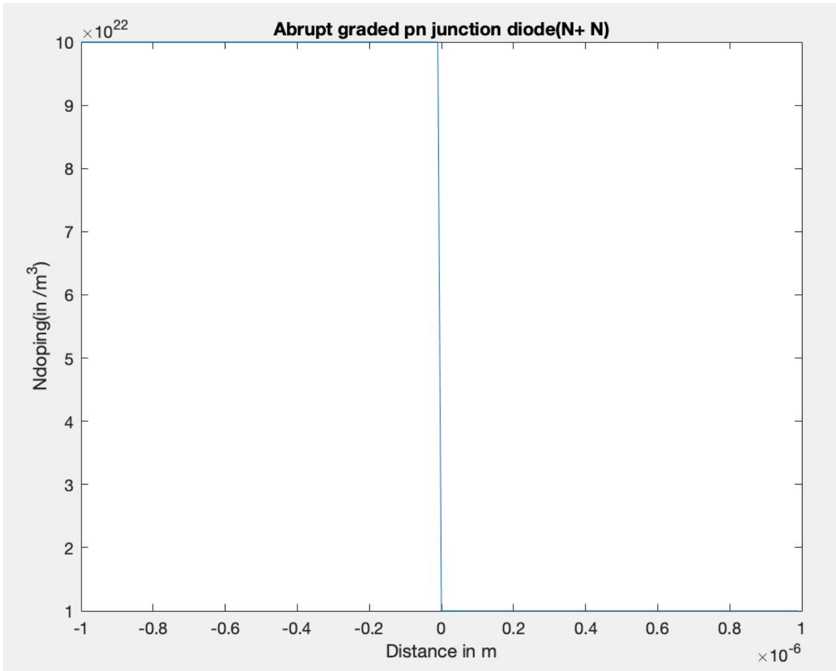
Both the graph coincide very well in case of abrupt junction.

We observe that the graph is not smooth when depletion approximation is considered as depletion region assumes that the charge suddenly vanishes after depletion region.

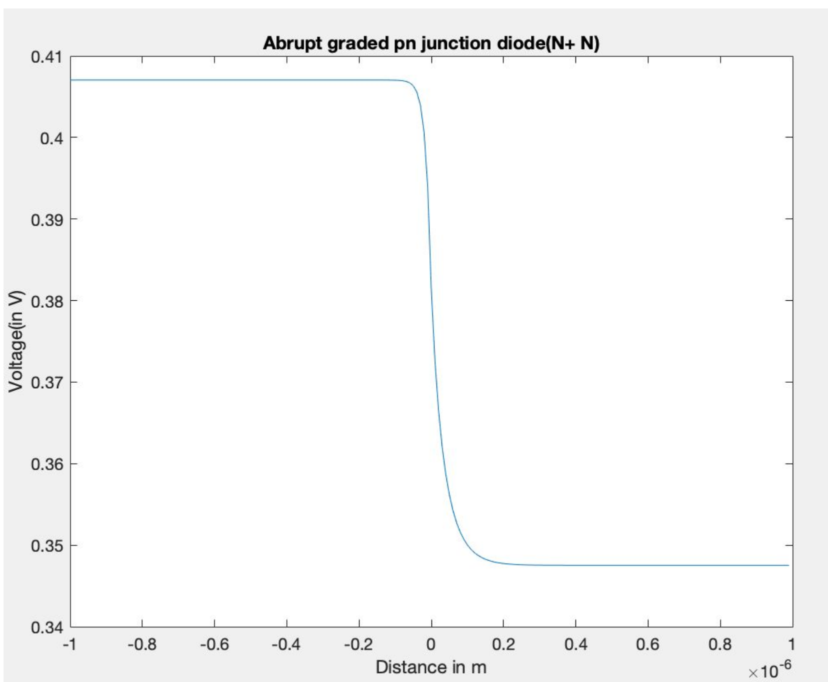
Depletion approximation gives close to Newton-Raphson method. But it differs a lot when we do it for linearly graded which clearly highlights the limitations of the depletion approximation method. The linearly doped channel has a lot of rho outside depletion region which can be seen from the graph

Q2.

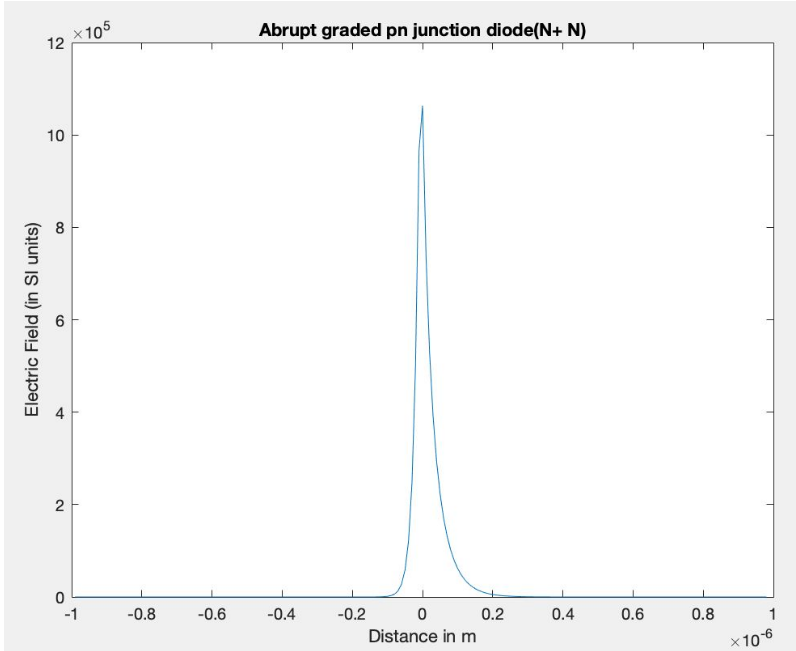
An N+-N abrupt junction with doping concentrations 1017 /cm3 and 1016 /cm3 on the respective sides. Dimensions are same as in Q1 with P region replaced by N+ region.



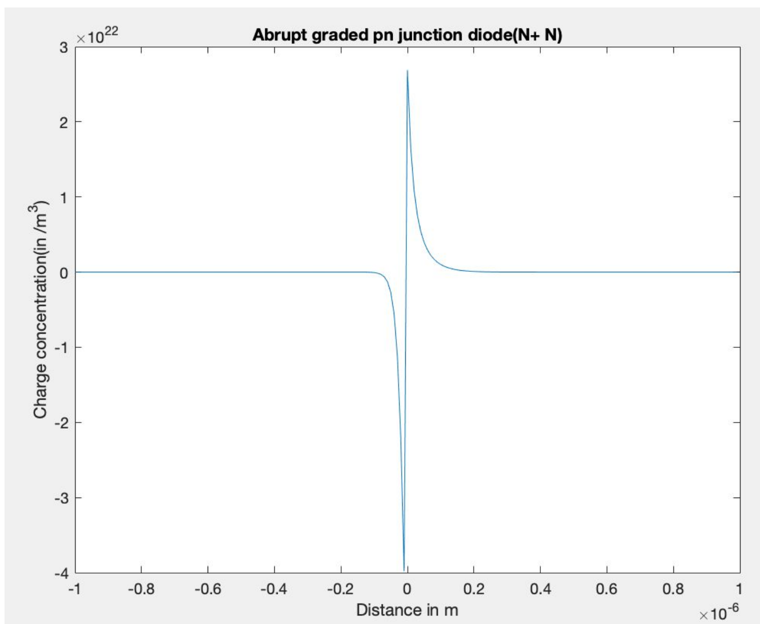
- **Potential (V)**



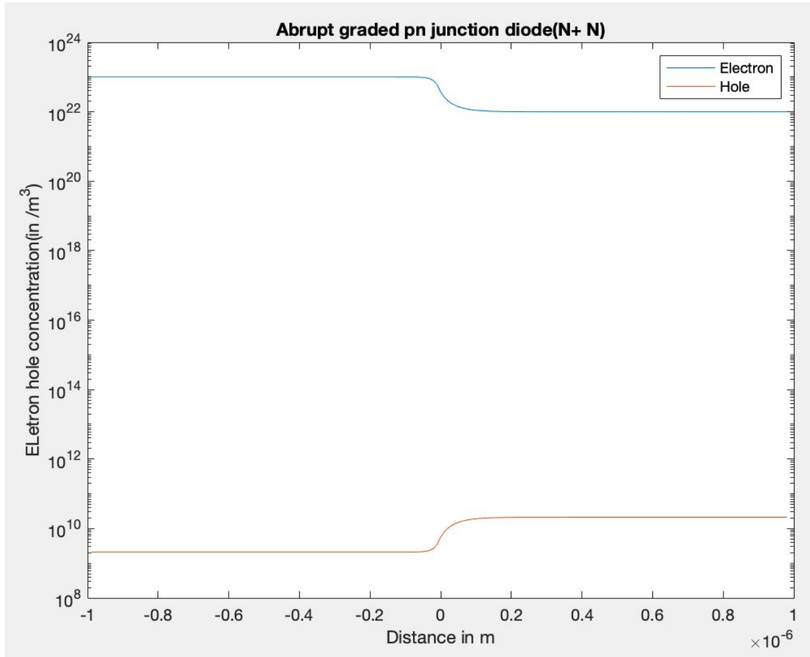
- **Electric field (E)**



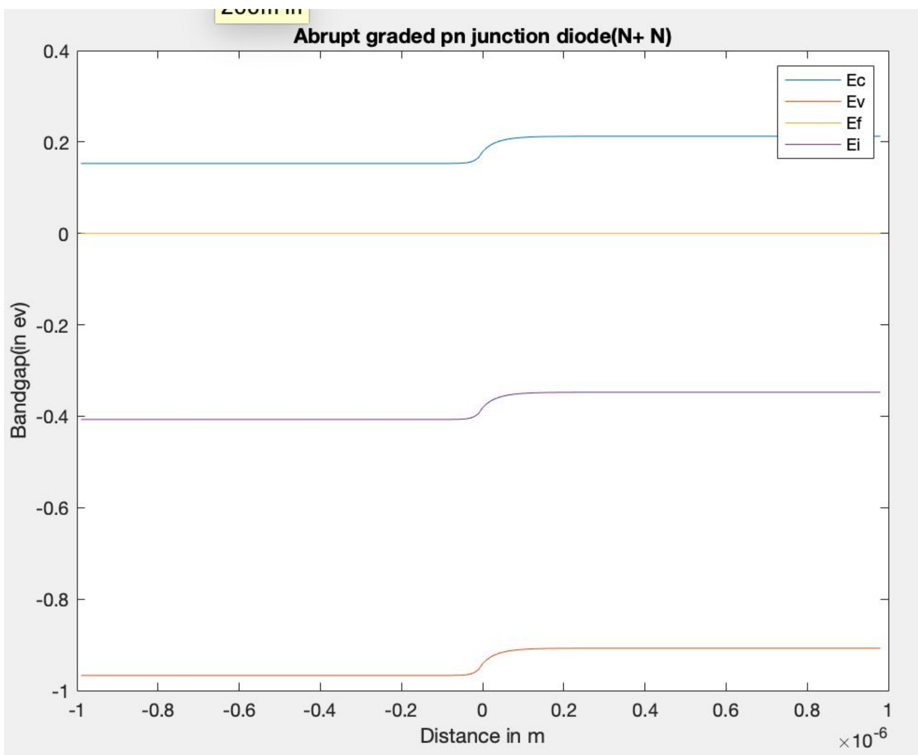
- **Charge concentration (ρ/q)**



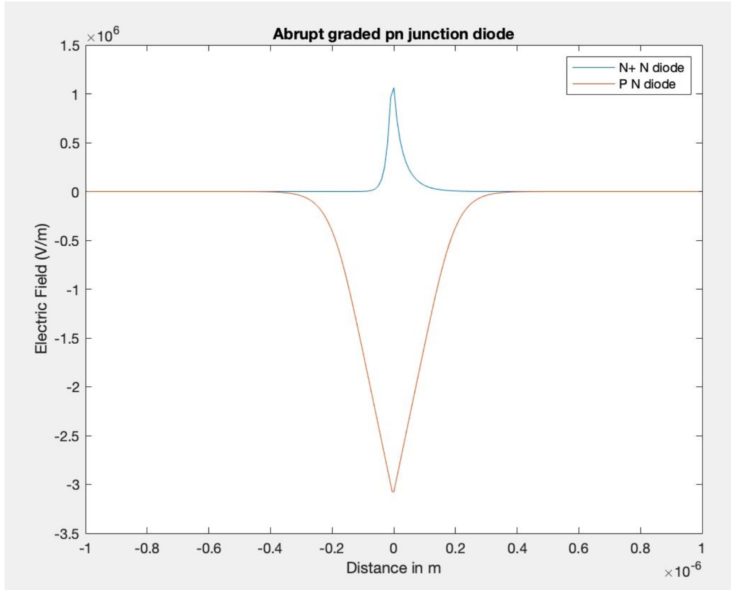
- **Electron (n) and hole (p) concentrations**

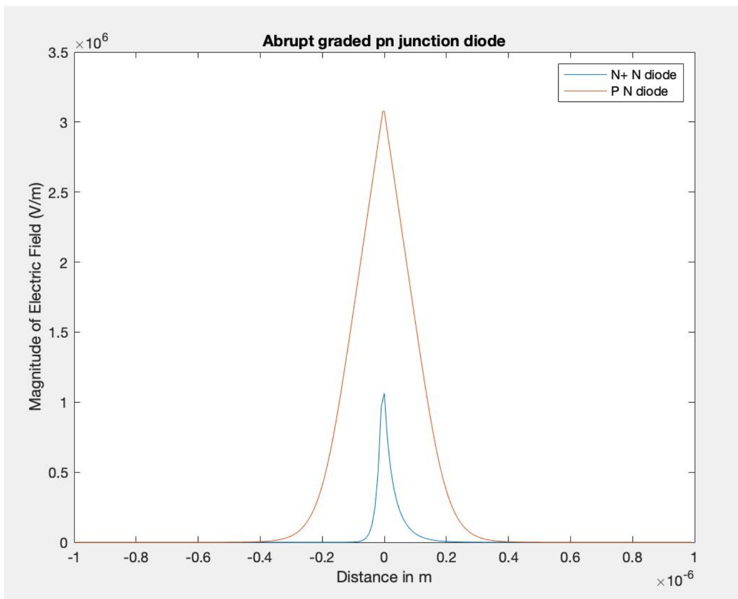


- **Energy band diagram depicting conduction band minimum (EC), valence band maximum (EV),mid gap energy level (Emid), fermi energy level EF .**



Compare the E vs X profile with the one in Q1.





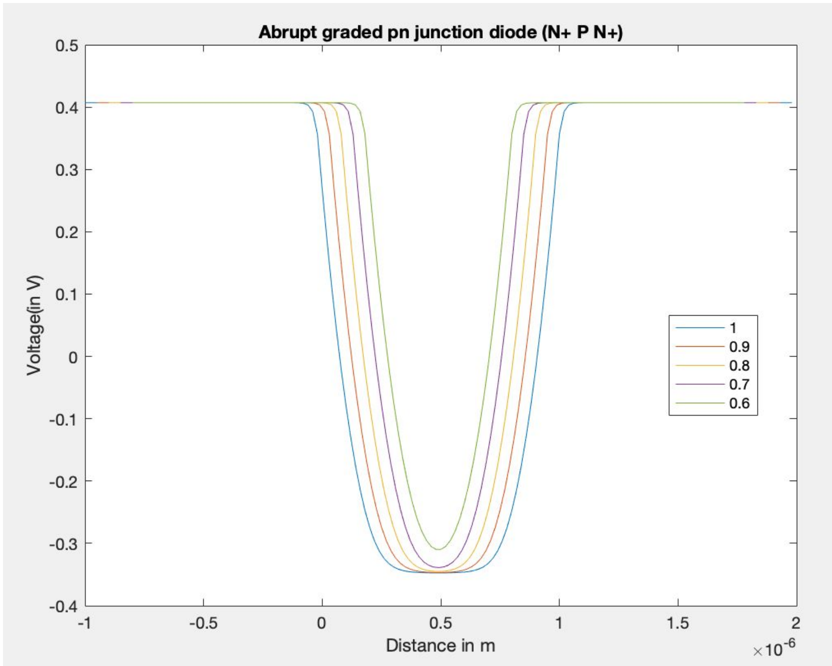
Explain your observation.

Pn diode has greater magnitude of electric field. To generate the electric field we need charge separation, we need both positive and negative charge. There is no majority carrier in N+ N to supply positive charge(minority carrier supply less charge)
Direction change: N+ is in right while in pn p was on right.
Steep electric field: N+ p does not have a symmetric field around 0 as it has N+ has less depletion width so steeper electric field

Q3

An N+-P-N+ structure with abrupt junctions. Doping in N+ regions is *ND* = 1017 /*cm*3 and that in P region is *NA* = 1016/*cm*3. Length of N+ regions is 10-6 m each and that of P region is varied over the following range: (1, 0.9, 0.8, 0.7, 0.6) x 10-6 m.

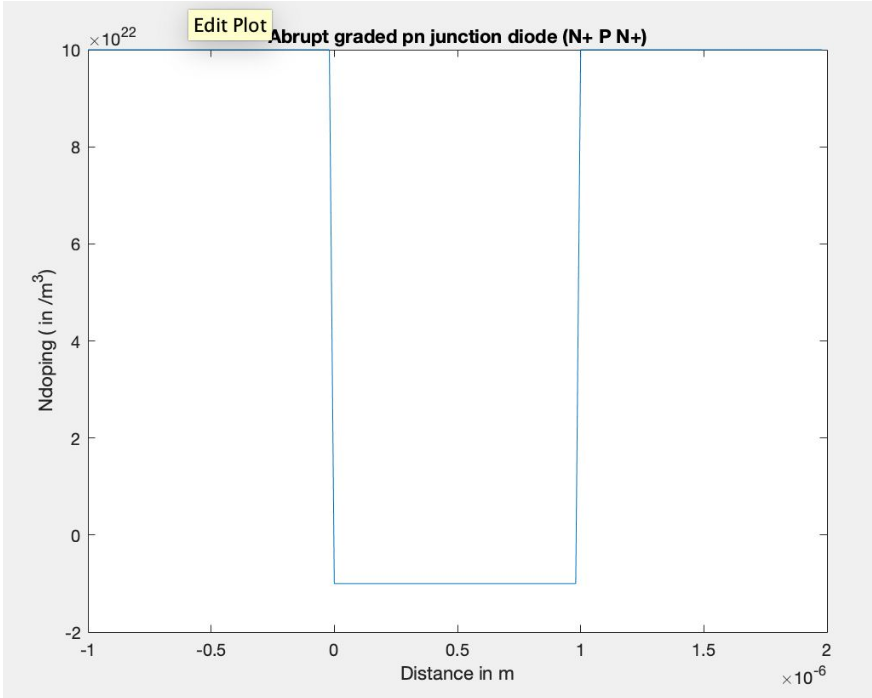
Show the variation of (V vs X) as function of P region length (LP).



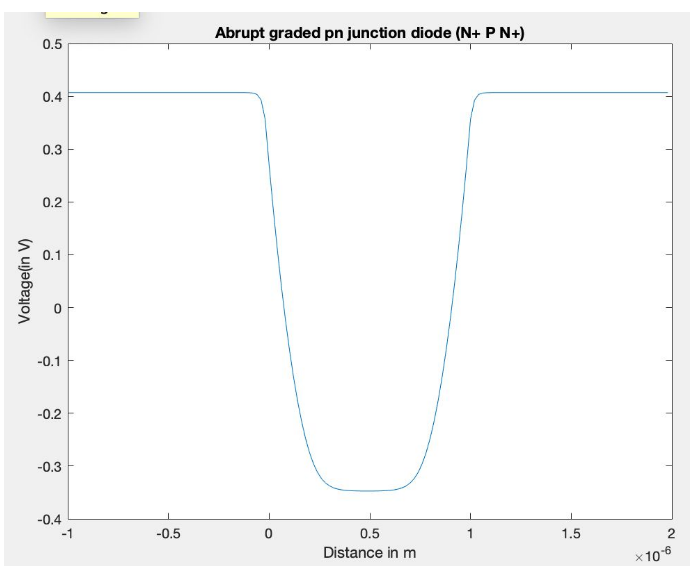
Give a qualitative description of your observation.

As X decreases min voltage also decreases. As we are decreasing X, the rho in the P region also decreases. And we know V will be proportional to the integral of rho.

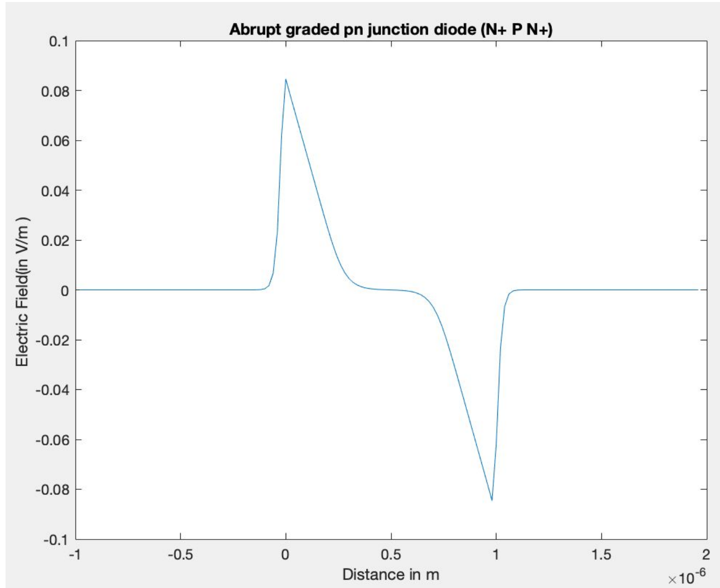
As we decrease the width of the depletion region of both np diodes come closer and V starts to fall.



- **Potential (V)**



- **Electric field (E)**



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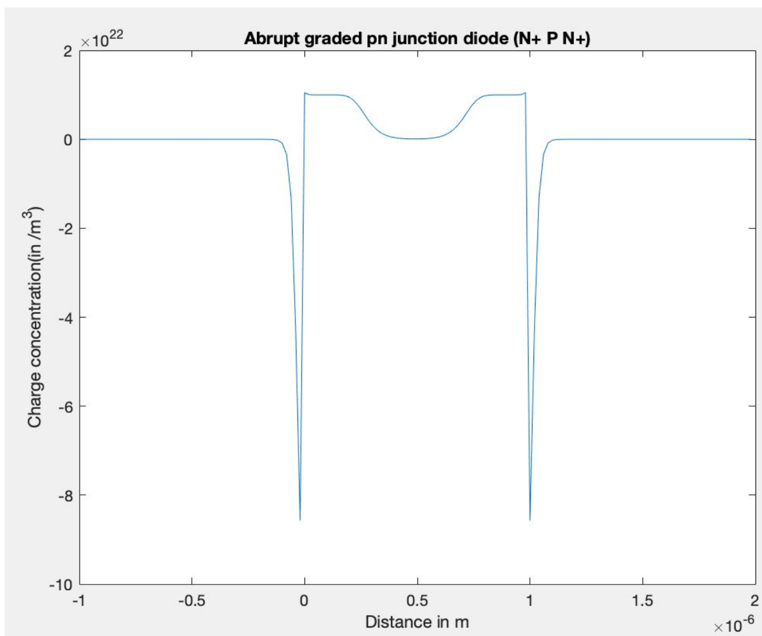

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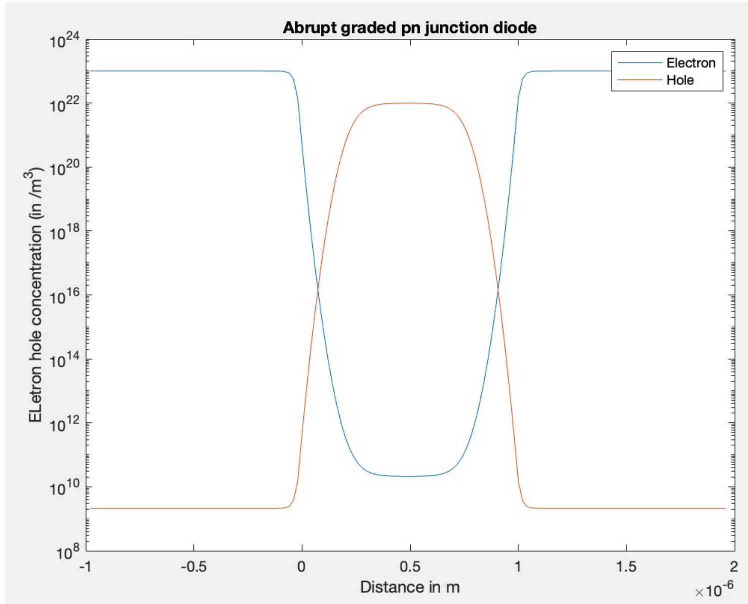

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