The One-Dimensional Minority Carrier Diffusion Equations Lesson

Lesson Topic: The One-Dimensional Minority Carrier Diffusion Equations

Objective of Lesson: To discuss the derivation of the one-dimensional minority carrier diffusion equations (MCDEs).

Reading Assignment: Section 3.4.2

Discussion Questions:

1. What assumptions are needed to derive the 1-D MCDE?
2. Why are these ONLY for minority carriers?
3. How does the requirement for low level injection impact the MCDE derivation?

Homework: None

What do you need to know for the exam?

1. What assumptions are needed to derive the MCDEs?
2. How do those assumptions impact the derivation?

Summary
The One-Dimensional minority carrier diffusion equations (MCDEs) are very powerful tools for modeling and understanding semiconductor devices. This section describes how they are derived.

The One-Dimensional Minority Carrier Diffusion Equations
The One-Dimensional minority carrier diffusion equations (MCDEs) are very powerful tools for modeling and understanding semiconductor devices. They are derived in the text with plenty of explanation so refer to the text for basic understanding. The equations themselves are shown below:

$$\frac{\partial \Delta p_n}{\partial t} = D_p \frac{\partial^2 \Delta p_n}{\partial x^2} - \frac{\Delta p_n}{\tau_p} + G_L$$

for holes in an n-type semiconductor and $\frac{\partial \Delta n_p}{\partial t} = D_n \frac{\partial^2 \Delta n_p}{\partial x^2} - \frac{\Delta n_p}{\tau_n} + G_L$

for electrons in a p-type semiconductor. Please note the subscripts so you understand what they mean and how to write them yourselves. Even these equations, as they are, are too complicated to solve problems on paper because there are partial derivatives both in time and in space. In the problems you will soon be learning to solve, one of those must always be eliminated.

The key at this point is to see where the MCDEs came from and to remember the assumptions—why do we need to worry about the assumptions? We need to worry about the assumptions because they place limitations on the situations where the MCDEs can be applied. Once a problem has been solved, the solution must be checked against the assumptions and against the conditions of application to be sure the solution is valid. We can get an answer on paper that makes sense until we notice that the solution violates one of our assumptions or one of our requirements for the application of the solution technique.

Continue on to the next lesson in which we learn how to use the MCDEs.

Useful other links
Look at the continuity equations

Definitions:
Assumption: Something taken for granted or accepted as true without proof—until later!