

ECE 3040 Microelectronic Circuits Quiz 1

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Professor Leach

Name _____

Instructions. Print your name in the space above. The quiz is closed-book, closed-notes, and closed calculator. **Honor Code Statement:** *I have neither given nor received help on this quiz.*
Initials _____

1. What determines whether a material is a conductor, a semiconductor, or an insulator? – The number of valence electrons in the outer shell. Conductors have the fewest. Insulators have the most. Semiconductors fall in the middle.
2. Give a brief description of current flow in a metal. – Under the influence of an applied electric field, the free electrons have a force exerted on them which causes them to flow. Collisions cause the average velocity of the electrons to approach a constant, which is called the drift velocity. Thus a constant current flows under the influence of a constant electric field.
3. Why is there no diffusion current in an intrinsic semiconductor? – Because the mobile charge carriers are uniformly distributed.
4. For a conduction current in a conductor, what is meant by “mean free path?” How does it affect the temperature and the electrical resistance of a conductor? – The mean free path is the average distance a mobile charge carrier travels under the influence of an electric field before it collides with a bound atom. The shorter the mean free path, the more collisions charge carriers undergo. This causes the temperature of a conductor to increase and its resistance to increase.
5. What is the direction of the electric field that forms across an open-circuited p-n junction? What is the voltage called that this electric field generates? – It points from the n side to the p side. The voltage is called the built-in voltage.
6. If $N_A = N_D$ and the mass-action law $np = n_i^2$ holds, it follows that a doped semiconductor behaves as an intrinsic semiconductor. What fundamental concept is responsible for this conclusion? – The concept of electrical or charge neutrality. That is, if $N_A = N_D$ and electrical or charge neutrality holds ($n + N_A = p + N_D$), it follows that $p = n$. This is the condition for a semiconductor to be intrinsic.
7. In a semiconductor, it is known that $n = n_i^2 / (n + N_A)$. What type semiconductor is it and why? – Electrical or charge neutrality requires $n + N_A = p + N_D$. By the mass-action law, $np = n_i^2$. It follows that $N_D = 0$, so the semiconductor is a p-type.
8. What is the basic difference between a conduction or drift current and a diffusion current? – A conduction current consists of the flow of mobile charges (electrons or holes) under the influence of an electric field. A diffusion current is the result of a non-uniform concentration of mobile charges.