The very first idea is to make this document a learning tool for git, latex and, of course, of Electronics. I will be very proud of ourselves if we reach to maintain English as its primary language.

Introduction to Electronics
Formulas and utilities

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1 Semiconductors

Semiconductors are material with an electrical conductivity value falling between that of a conductor and an insulator. An important property of semiconductors is that, during a temperature increment, their resistance decreases. Common semiconductors material are:

- Silicon, Si. Z (i.e. atomic number) = 14. IV (14^{th}) group.
- Germanium, Ge. Atomic number = 32. IV (14^{th}) group
- Gallium Arsenide, GaAs, a compound of Gallium and Arsenic.

1.1 Semiconductors: a nuclear approach

A neutral Silicon atom possesses 14 protons and many electrons.

- the first 10 of them lies in the first energy level: they fit perfectly around the nucleus and are not involved in chemical reactions or anything (because very high energy is necessary to interact with them).

- the remaining 4 electrons are called *valence electrons* and are at higher energy levels. They are involved in the *covalent bond*.

When temperature is near at the absolute zero (-273^oC) the Silicon atoms assume a crystal form in which every *valence electron* is shared with the nearest 4 atoms of Silicon, with a covalent bond: in this circumstance Silicon act as an **insulator**. At higher temperatures, the atoms get energy from the outside: **1 eV** is the energy amount necessary for breaking a covalent bond.

1.1.1 Electrons and Holes

When the break happens, an electron *jumps* to valence band and a hole is generated (note that the semiconductor remains neutral). Remember that the hole is in fact the absence of an electron, and it may be referred to as a **cation**, an atom with positive charge.

1.1.2 Valence and conduction bands

Without the necessary energy, electrons remain under the *Fermi level*, in a zone called *Valence Band*; when the *jump* occurs, electrons step over the *Fermi level* and stay in the *conduction band*. In the conduction band charge carrier have less constraints and can easily move in the crystalline lattice, depending on the intensity of the electro-magnetic field.

1.1.3 Silicon properties

- To complete
- It is compatible with SiO_2 and Al

1.2 Doping

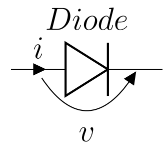
The doping process consists in significantly change the number of *electrons* or *holes* in a semiconductor. This result is achieved inserting atoms of the doping element in the crystalline arrangement of the doped.

1.2.1 Utilities and numbers

- $N_d \approxeq 10^{12} : 10^{20} cm^{-3}$ number of donors
- $p[\frac{electrons}{cm^3}]$ number of holes
- $n[\frac{electrons}{cm^3}]$ number of electrons

TO ADD: the part regarding mobility and resistance.

2 Diodes

Diodes are defined as a p-n junction. 

Is is made by two parts: the left part (according to the figure) is a p-doped semiconductor in which there are holes left. The other part, on the contrary, is n-doped in which there are electrons left.

Problem 6. a) Suppose an entire function f is bounded by M along $|z| = R$. Show that the coefficients C_k in its power series expansion about 0 satisfy

$$|C_k| \leq \frac{M}{R^k}.$$

b) Suppose a polynomial is bounded by 1 in the unit disc. Show that all its coefficients are bounded by 1.

Solution Part a): Since f is an entire function it can be expressed as an infinite power series, i.e.

$$f(z) = \sum_{k=0}^{\infty} \frac{f^{(k)}(0)}{k!} z^k = \sum_{k=0}^{\infty} C_k z^k.$$

If we recall Cauchy's Integral we have

$$f(z) = \frac{1}{2\pi i} \int_\gamma \frac{f(w)}{w - z}\, dw,$$

carefully notice that $\frac{1}{w-z} = \frac{1}{w} \cdot \frac{1}{1-\frac{z}{w}}$ can be written as a geometric series. We have

$$\begin{aligned}
\frac{1}{2\pi i} \int_\gamma \frac{f(w)}{w - z}\, dw &= \frac{1}{2\pi i} \int_\gamma \left\{ \frac{f(w)}{w} \cdot \left(\frac{1}{1 - \frac{z}{w}} \right) \right\}\, dw \\
&= \frac{1}{2\pi i} \int_\gamma \left\{ \frac{f(w)}{w} \cdot \left(1 + \frac{z}{w} + \frac{z^2}{w^2} + \frac{z^3}{w^3} + \cdots \right) \right\}\, dw \\
&= \left(\frac{1}{2\pi i} \int_\gamma \frac{f(w)}{w}\, dw \right) z^0 + \left(\frac{1}{2\pi i} \int_\gamma \frac{f(w)}{w^2}\, dw \right) z^1 + \left(\frac{1}{2\pi i} \int_\gamma \frac{f(w)}{w^3}\, dw \right) z^2 \cdots
\end{aligned}$$

Now take the modulus of C_k to get

$$|C_k| = \left| \frac{1}{2\pi i} \int_\gamma \frac{f(w)}{w^{k+1}}\, dw \right| \leq \frac{1}{2\pi} \int_\gamma \frac{|f(w)|}{|w^{k+1}|}\, |dw| \leq \frac{M}{2\pi} \int_\gamma \frac{|dw|}{|w^{k+1}|}$$

Then integrate along $\gamma(\theta) = Re^{i\theta}$ for $\theta \in [0, 2\pi]$ to get

$$|C_k| \leq \frac{M}{2\pi} \int_0^{2\pi} \frac{|iRe^{i\theta}\, d\theta|}{|R^{k+1} e^{ik\theta}|} = \frac{M}{2\pi \cdot R^k} \int_0^{2\pi}\, d\theta = \frac{M}{R^k}.$$

Hence, $|C_k| \leq \frac{M}{R^k}$.

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