



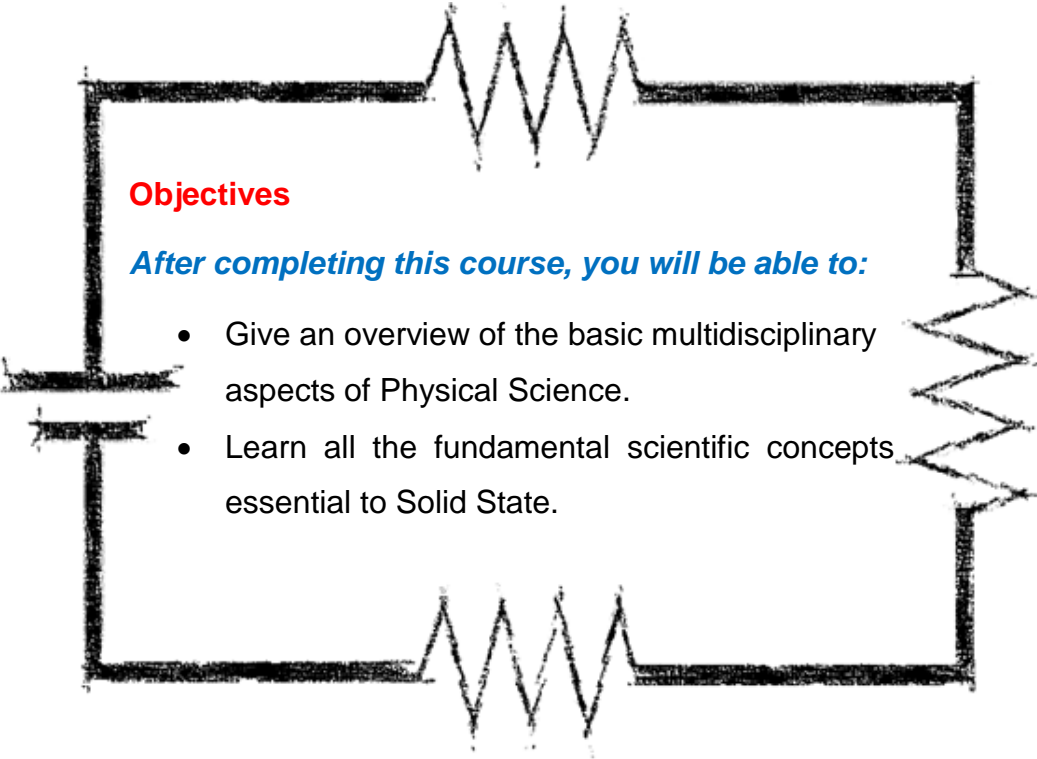
CHAPTER 2

SOLID STATE FUNDAMENTALS

Objectives

After completing this course, you will be able to:

- Give an overview of the basic multidisciplinary aspects of Physical Science.
- Learn all the fundamental scientific concepts essential to Solid State.



Solid-state electronics

- means semiconductor electronics; electronic equipment using semiconductor devices such as transistors, diodes and integrated circuits (ICs).
- The term is also used for devices in which semiconductor electronics which have no moving parts replace devices with moving parts, such as the solid-state relay in which transistor switches are used in place of a moving-arm electromechanical relay, or the solid-state drive (SSD) a type of semiconductor memory used in computers to replace hard disk drives, which store data on a rotating disk.
- The term "solid state" became popular in the beginning of the semiconductor era in the 1960s to distinguish this new technology based on the transistor, in which the electronic action of devices occurred in a solid state, from previous electronic equipment that used vacuum tubes, in which the electronic action occurred in a gaseous state.
- A semiconductor device works by controlling an electric current consisting of electrons or holes moving within a solid crystalline piece of semiconducting material such as silicon, while the thermionic vacuum tubes it replaced worked by controlling current conducted by a gas of particles, electrons or ions, moving in a vacuum within a sealed tube.
- Although the first solid state electronic device was the cat's whisker detector, a crude semiconductor diode invented around 1904, solid state electronics really started with the invention of the first working transistor in 1947.
- The first working transistor was a point-contact transistor invented by John Bardeen and Walter Houser Brattain while working under William Shockley at Bell Laboratories in 1947.
- Before that, all electronic equipment used vacuum tubes, because vacuum tubes were the only electronic components that could *amplify*—an essential capability in all electronics.
- The MOSFET (metal-oxide-silicon field-effect transistor), also known as the MOS transistor, was invented by Mohamed M. Atalla and Dawon Kahng at Bell Labs in 1959.
- The MOS transistor's advantages include high scalability, affordability, low power consumption, and high density.
- The MOS transistor revolutionized the electronics industry, and is the most common semiconductor device in the world.
- The replacement of bulky, fragile, energy-hungry vacuum tubes by transistors in the 1960s and 1970s created a revolution not just in technology but in people's habits, making possible the first truly portable consumer electronics such as the transistor radio, cassette tape player, walkie-talkie and quartz watch, as well as the first practical computers and mobile phones.

- Examples of solid state electronic devices are the microprocessor chip, LED lamp, solar cell, charge coupled device (CCD) image sensor used in cameras, and semiconductor laser.

Condensed matter physics

- is the field of physics that deals with the macroscopic and microscopic physical properties of matter.
- A laser diode, (LD), injection laser diode (ILD), or diode laser is a semiconductor device similar to a light-emitting diode in which a diode pumped directly with electrical current can create lasing conditions at the diode's junction.
- Laser diodes can directly convert electrical energy into light. Driven by voltage, the doped p-n-transition allows for recombination of an electron with a hole. Due to the drop of the electron from a higher energy level to a lower one, radiation, in the form of an emitted photon is generated. This is spontaneous emission. Stimulated emission can be produced when the process is continued and further generate light with the same phase, coherence and wavelength.
- Interdisciplinary field of materials science, also commonly termed materials science and engineering, is the design and discovery of new materials, particularly solids. The intellectual origins of materials science stem from the Enlightenment, when researchers began to use analytical thinking from chemistry, physics, and engineering to understand ancient, phenomenological observations in metallurgy and mineralogy

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as solar panels.

The common single junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 to 0.6 volts. Solid-state physics is the study of rigid matter, or solids, through methods such as quantum mechanics, crystallography, electromagnetism, and metallurgy. It is the largest branch of condensed matter physics. Solid-state physics studies how the large-scale properties of solid materials result from their atomic-scale properties. Thus, solid-state physics forms a theoretical basis of materials science. It also has direct applications, for example in the technology of transistors and semiconductors.

Video links:

Solid State Electronics

- <https://www.youtube.com/watch?v=aPrh0mrkko0>

What is SOLID-STATE ELECTRONICS? What does SOLID-STATE ELECTRONICS mean?

- <https://www.youtube.com/watch?v=bFzTeV139x0>

Introduction to Solid State Electronics

- <https://www.youtube.com/watch?v=LqeTfMWRRQA>

Reference:

- Murty, B.S.; Shankar, P.; Raj, Baldev; et al. (2013). *Textbook of Nanoscience and Nanotechnology*. Springer Science and Business Media. pp. 108–109. ISBN 3642280307. Archived from the original on 2017-12-29.
- ^ Papadopoulos, Christo (2013). *Solid-State Electronic Devices: An Introduction*. Springer Science and Business Media. pp. 5–6. ISBN 1461488362. Archived from the original on 2017-12-29.
- ^ Vaughan, Francis (February 22, 2012). "Why the expression "solid state" instead of simply "solid"?". *StraightDope* message board (Mailing list). Archived from the original on December 7, 2017. Retrieved December 5, 2017.