# Solid State Physics

## Introduction

Matter is any substance that has mass and takes up space by having volume. It generally includes atoms and anything made up of them (molecules), and any particles (or combination of particles) that act as if they have both rest mass and volume. So matter can be in a form of condensed state (solid state & liquid state) and gaseous state. Here, we shall define “solid” as any materials in which atoms, ions or molecules are fixed in position, except for thermal vibration.

In this course, Solid state physics will be focused on rigid matter, or solids, by understanding quantum mechanics, crystallography, and electromagnetism. However, classical mechanics will be introduced in early section to link with quantum mechanics. Even though “physics” is in the name of this course, we are not going to derive the equations and not going to test your ability of memorizing the equations. Instead, fundamental concepts, principles, laws and theories will be studied to understand the structure and properties of solid materials and to engineer those solid materials.

Study of this subject will arise from the atomic-scale to the electromagnetic properties of solid materials and applications of those materials at the end. Actually, this course is about what we had learned in high school but more deeply in the way of “how” and “why”. For example, we’d already known about atoms (proton, electron and neutron) and formation of bonds between atoms, but here we will study how and why electrons behave around the nucleus, the energy states of those electrons, and how those energy states influence formation of bonds between atoms. More deeply, we will study crystal structure of solid materials depend on the how those bonds are formed and effect of bonding and crystal structure on the properties of solid materials. On the requirement of this course, you will be learned the general physic, general chemistry and also related engineering fields.

There are several reasons why we choose to focus only solid state. Solid is one of the four fundamental states (solid, liquid, gas, and plasma) of matter and also most of

the elements in periodic table are in the form of solid at standard temperature and pressure. Besides, solid state physics is the largest branch of condensed matter physics and also a theoretical basis of materials science. Since I design this course as a integrated subject, I have to say this course is most important course for materials science and also important for physic, chemistry, and electrical engineering. And you will see how beauty of this subject all along you are taking this course and also the basic concepts of all solid materials will help you to understand characteristic and properties of solid materials and how to engineer those solid materials in your related fields.

## Structure of the Course

- There will be two semesters for this course, which means you will study this course for the whole year.
- You will have quizzes and assignments for this course and two exams will be conducted for this course. Detail of about this will be provided in the “study guide of the course”.
- For the first semester, you have to study following sections:
  Introduction to solid state physics
  Atomic and electronic structure
  Atomic bonding
  Crystal structure
  X-rays diffraction
  Crystal imperfection
  Atomic diffusion
  Atomic vibration
  Thermal properties of materials

- For the second semester, you have to study following sections:
  Free electrons in crystals
  Band theory
  Semiconducting properties of materials

Dielectric properties of materials

Optical properties of materials

Magnetic properties of materials

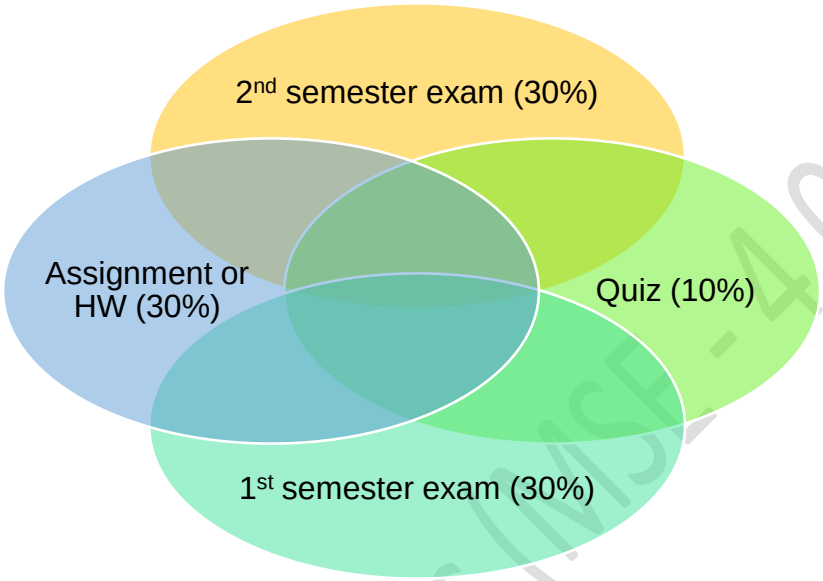
Superconductivity

Modern researches of solid materials

## Study Guide of the Course

- Every student has to present in all the lectures and you can email me in advance in case of you have emergency for absence.
- Every student has to prepare for the coming lecture and you will be provided lecture note in the form of soft or hard copy, two days before that lecture.
- Every student will have 10 to 15 minutes quiz in every lecture, and it can be the first or last 15 minutes of the lecture. You will be announced which lecture will be going to ask for coming quiz. More importantly, these quizzes will count as 10% of total scores.
- Every student has to submit assignment or homework in case of if lecture asks for specific topic or questions. You are not allowed to copy directly from the references and you need to provide the references that you are going to use. Model solution of homework will be provided after one week later of your submission. This assignment and homework will also count as 30% of total score.
- Every student will have two exams; $1^{st}$ semester exam and $2^{nd}$ semester exam. Both will equally count for the rest of total score. So $1^{st}$ semester exam will count as 30% of total scores and $2^{nd}$ semester exam will count as the rest of 30% of total score.
- There will be no re-grade assignments or homework or test or exam. The total score will announce according to the system of the university and the minimum score of passing the course is also according to the system of university.
- A list of reference books will be provided for the whole course, and required list of reference books will also be provided for specific lecture in case of requirement.

- Every student will have right to come and discuss with lecturer in case of requirement related with course and lecture. It should be in office hour of that lecturer.




**Keywords:** Condensed Matter Physics, Solid State Physics, Quantum Mechanics, Solid State Chemistry, Materials Science and Engineering, Semiconductors, Electronic Materials, Magnetic Materials, and Superconductivity.

## Text Books

## References

1. Simon SH. The Oxford Solid State Basics: OUP Oxford; 2013.
2. Wahab MA. Solid State Physics: Structure and Properties of Materials: Alpha Science International, Limited; 2017.
3. Myers HP. Introductory Solid State Physics: CRC Press; 1997.
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5. Askeland DR, Wright WJ. Science and Engineering of Materials, SI Edition: Cengage Learning; 2015.