Solid state fundamentals for engineering

Academic Year: (2022 / 2023) **Review date: 20-06-2022**

Department assigned to the subject: Department of Physics

Coordinating teacher: MUÑOZ CASTELLANOS, ANGEL

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is expected the students have taken the following courses in Engineering Physics: Physics I and II, Calculus I and II, Linear Algebra, Chemistry I and II, Probability and Statistic, Materials science and engineering, Differential equations, Quantum Physics, Mechanics and relativity, Complex variables and transforms.

DESCRIPTION OF CONTENTS: PROGRAMME

1.BONDING IN SOLIDS
1.1 General considerations
1.2 Ionic bonds
1.3 Covalent bonds
1.4 Van der Waals bonds
1.5 Metallic bonds
1.6 Hydrogen bonds

2. LATTICE VIBRATIONS. PHONONS- HEAT CAPACITY
2 1 Introduction
2.2 Interaction of atoms in the crystal
2.3 Vibrations of an one dimensional monoatomic chain
2.4 Vibration of an one dimensional diatomic chain
2.5 Three-dimensional lattice
2.6 Phonons
2.7 Heat capacity

3.THE THEORY OF FREE ELECTRONS IN METALS
3.1 Classical theory of metals: The Drude model
3.2 Electrical and thermal conductivity in metals
3.3 Quantum theory of metals: The Sommerfeld model
3.4 Work function
3.5 Thermionic emission
3.6 Photoelectric effect

4.THE BAND THEORY OF SOLIDS
4.1 Introduction: Band theory
4.2 Bloch theorem
4.3 The Kronig-Penny model
4.4 Some remarks about the Bloch theorem
4.5 Electrons affective mass
4.6 Metals and insulators
4.7 Holes and electrons

5.SEMICONDUCTORS
5.1 Introduction
5.2 Band Gap
5.3 Pure or intrinsic semiconductors
5.4 Extrinsic semiconductors
5.5 P-n junctions
5.6 Diodes, Transistors: Bipolar junctions transistor

6. DIELECTRIC MATERIALS

6.1 Introduction
6.2 Dielectric materials
6.3 Mechanisms of polarization
6.4 The complex dielectric constant. Frequency response
6.5 Piezoelectricity
6.6 Ferroelectricity

7.MAGNETIC MATERIALS
7.1 Introduction
7.2 Microscopic overview
7.3 Diamagnetism
7.4 Paramagnetism
7.5 Ferromagnetism and antiferromagnetism
7.6 Magnetic resonance

8.OPTICAL PROPERTIES OF MATERIALS
8,1 Basic concepts
8.2 Optical properties of metals
8.3 Optical properties of non-metals
8.4 Applications of optical phenomena

9. SUPERCONDUCTIVITY
9.1 Overview
9.2 Electrical rsistivity
9.3 The effects of a magnetic field
9.4 Microscopic theory
9.5 High Tc superconductors
9.6 Applications

LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students must acquire. Receive course notes and will have basic reference texts. Students partake in exercises to resolve practical problems
AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher. Subjects with 6 credits have 4 hours of tutoring/ 100% on- site attendance.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK. Subjects with 6 credits have 98 hours/0% on-site.
AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.
AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site
AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction (4 laboratory sessions).
MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning
MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group
MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.
MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

Throughout the course there will be continuous assessment tests. These tests will consist of several exams. They will allow to evaluate the degree of understanding of the different theoretical concepts explained in the lectures. The result of this evaluation will be the 25% of the final grade.
Laboratory practical sessions of the course will be structured in 4 sessions of 1.5 hours. Assistance and preparation of reports for each of the practices is compulsory. The laboratory final grade will be evaluated on the following two aspects of each of the practical sessions:
a) Student participation. It will be checked by questions made to the students by the teacher after the delivery of each report.
b) Correction of the report prepared for each practical session.

The lab grade will be 15% of the final grade.

It is compulsory to deliver the lab reports in order to pass the course.

There will be a final exam, which may consist of theoretical and practical (problems solving) questions. Its score will represent 60% of the final grade. In order to pass the course, a minimum grade of 3 (out of 10) must be obtained in the final exam.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- Charles Kittel Introduction to solid state physics, 8th ed. Hoboken, NJ : John Wiley & Sons , 2005
- L. Solymar, D. Walsh Electrical properties of materials, Oxford Universitary Press, 2010
- Neil W. Ashcroft Solid state physics, [International ed.]. Fort Worth etc. : Sanders College Publishing , 1976
- Steven H. Simon The oxford solid state basics, Ed: Oxford : Oxford University Press , 2013

ADDITIONAL BIBLIOGRAPHY

- H. P. Myers , Introductory solid state physics, 2nd ed. London : Taylor & Franci.
- John R. Hook H.E Hall Solid State Physics, 2nd ed. Chichester : John Wiley & Sons.
- Manijeh Razeghi Fundamentals of solid state engineering, Kluver Acacemidc Publishers 2002.
- R. K. Puri, V.K. Babbar Solid state physics, , S. Chand&Company, LTD, Ramnagar New Delhi.