NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES
ENGINEERING PHYSICS PROGRAM

CF531 – SOLID STATE PHYSICS

I. GENERAL INFORMATION

CODE	**:**	CF531 Solid State Physics
SEMESTER	**:**	9
CREDITS	**:**	6
HOURS PER WEEK	**:**	8 (Theory – Practice)
PREREQUISITES	**:**	IF411 Quantum Mechanics IF482 Introduction to Materials Sciences and Engineering
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

Matter states. Solids. Types of binding. Fundamentals of crystallography. Structure of solids. Experiments of Modern Physics: photoelectric, electron diffraction. Spectrum. Bohr atom. Wave-particle dualism. Postulates of quantum mechanics: Schrödinger equation. Applications of Quantum Mechanics. Tunnel effect. Hydrogen atom. Electrical and magnetic properties of solids. Solid metals: quantum model of free electron, function of Fermi-Dirac distribution, Fermi energy, electrical conductivity. Semiconductors: energy bands, electronic and vacancy concentration, mass action law, electrical conductivity in intrinsic semiconductors. Extrinsic semiconductor: Types of doping. Operation of PN junction, PNP, diodes, photovoltaic cells, solar panels. The solid state laser, photosensitive semiconductor sensors.

III. PHYSICS SKILLS

1. Understand the concept of network, recognizes and classifies crystalline structures.
2. Analyze and interpret the interaction radiation-glass, based on Bragg's Law.
3. Understand and apply the photon concept in problems related to the photoelectric effect and the electronic transition between energy levels of the hydrogen atom.
4. Understand and apply the electric and magnetic properties of solids. Study the unpaired electron model.
5. Classify solids according to their electrical conductivity.
6. Analyze solids through Theory of Bands model, and classify solids as conductors, semiconductors and insulators.
7. Understand the general characteristics of semiconductors. Calculate the conductivity of intrinsic and extrinsic semiconductors.

IV. LEARNING UNITS

1. CRYSTALLOGRAPHY

Solids: amorphous, crystalline / unit cell / crystalline Systems / Symmetries / Maps / Directions in a crystal / Split packaging / bonding forces.

2. MODERN PHYSICS AND QUANTUM MECHANICS

X-ray diffraction / De Broglie relation / Bragg Law/ photoelectric effect. Einstein explanation / The photon / Probability / spectroscopy. Spectral Series / Bohr Atom / Ground state Radiation / Postulates of Quantum Mechanics / Schrödinger equation / function of wave/particle in a potential well / Tunnel effect / quantum treatment of the hydrogen atom / wave functions. Quantum numbers / angular and magnetic momentum / spin / Exclusion Principle / The periodic table.

3. ELECTRIC AND MAGNETIC PROPERTYS OF SOLIDS

Resistance: Resistivity and Conductivity / resistance and temperature / thermal coefficient of resistance / Classification of solids according to their resistivity and magnetic properties: Paramagnetism, diamagnetism, ferromagnetism / Superconductivity: Meissner Effect / ceramic superconductors.

4. METALS

Classical theory of free electrons / electrical conductivity / Limitations of the classical theory / quantum theory of free electrons / electron in a potential well / states and energy levels / Density of states / Statistics of Fermi - Dirac / The ground state / power of Fermi / electrical conductivity and its relationship with temperature and impurities / applications.

5. SEMICONDUCTORS

Bands theory / conduction Band / Band of valence / forbidden band / concentration of electrons and vacancies at different temperatures / semiconductor elements. Binary SC / SC ternary SC organic / SC intrinsic. Concentration of electrons and vacancies / Law of mass action / SC doped. Donors and acceptors / The Fermi level / Ionization Energies / conductivity / temperature / Applications: unions, solar cell / transistor, LDR / solid-state lasers / sensors / rectifiers.

V. LABORATORY AND PRACTICE EXPERIENCES

Lab 1: Simple crystal structures.
Lab 2: Diffraction.
Lab 3: Spectroscopy.
Lab 4: Forbidden band
Lab 5: Photovoltaic effect
Lab 6: NP junction

VI. METHODOLOGY

The course takes place in theory, practice and laboratory sessions. In theory sessions, faculty presents concepts, principles and methods. In practice sessions, students solve diverse problems related to crystal structures, spectroscopy, electric properties of solids and semiconductors. In laboratory sessions, students carry out experiments to verify the principles and concepts presented in theory. At the end of each laboratory session, students present a report containing results analysis and conclusions. In every session active student participation is promoted.

VII. EVALUATION FORMULA

The final grade (PF) is the result of the following formula:

PF = 0.25 EA + 0.25 EB + 0.25 PPC + 0.25 PPL

EA: Partial Exam
EB: Final Exam
PPC: Average of practice work
PPL: Average laboratory work

VIII. BIBLIOGRAPHY

1. **Asmat, Humberto**
   Introduction to Solid State Physics, TecniGraf Editions, 2012
2. **McKelvey, John**
   Solid State Physics and Semiconductors, Limusa Editorial, 2008
3. **SEARS, Francis y ZEMANSKY W**
   Physics, Vol. 2, Addison Wesley, 2006