DEBRE MARKOS UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

DEPARTMENT OF PHYSICS

Module Code: Phys-M2061 EtCTS of Course: 5

Course Status:Compulsory Course Title : Solid State Physics I

Course Code:Phys2061 Credits Hours: 3

Mode of delivery:Full Semester

Prerequisite(s): none Co-requisite(s):none

Academic Year:2012E.C Year/Semester: II/ II

Students’ College/Faculty:NCS Department:Physics

Program:Undergraduate Enrollment**:** Regular

**Course Rationale :**This module is intended to introduce students to the basic ideas that underlie solid state physics, with emphasis on the behaviour of electrons in crystalline structures, particularly in materials that are metallic. This will enable the students to learn the subject matter in order to explain and account for the physical, thermal, electrical and optical properties of solids. Students will appreciate solid state physics as one branch of physics which plays a fundamental role in the electronic industry.

**Learning Outcomes**

Upon completion of this module students students will have demonstrated the ability to:

• examine the behavior of solid state systems and, through the application of physical laws, make quantitative predictions of future behaviour based upon their properties

• describe crystal structure of solids in terms of a space lattice + unit cell, and relate structures in real space to those in reciprocal space,

• explain the concepts of the reciprocal lattice and the Brillouin zone,

• describe the various atomic bonds in crystals,

• discuss the electrical, thermal and optical properties in terms of the free electron model,

• apply knowledge of how crystalline structures vibrate and the associated theories of heat capacity,

• discuss the factors that control the electrical conductivity of metals,

• elaborate how the diffraction of X rays are related to the properties of the reciprocal lattice.

• be familiar with and understand the magnetic, and dielectric properties of solids for practical applications.

**Course Description**

This module describes phenomena associated with the solid state: Topics to be treated include the classification of solids and crystal structure, X-ray diffraction, classification of crystals, binding energy, and an introduction to their electronic, vibrational, thermal, optical, magnetic, dielectric properties and the quantum mechanical description of electrons in crystals

COURSE CONTENT

1. **Crystal Structure**

• Introduction- atomic models

• Lattice points and space lattice

• Fundamental types of lattices

• Index system for crystal planes

• Classification of crystals

**2. X-Ray Diffraction**

•Reciprocal lattices

• Diffraction of waves by crystals: Bragg’s law

• Brillouin zones in one and two dimensions

**3. Binding Energy in Crystals**

• Bonding in solids

• Ionic bonding

• Covalent bonding

• Metallic bond

• Properties of metallic crystals

• Calculation of cohesive energy

**4. Thermal properties of solids**

• Crystal vibration

• Lattice Specific heat

• Classical theory (Dulong and Petit law)

• Einstein’s theory of specific heat

• Debye’s theory Thermal conductivity

**5. Dielectric properties of solid**

• Review of basic formulae

• The microscopic concept of polarization

• Langevin’s theory of polarization in polar dielectrics

• Clausius-mosotti relation

• The static dielectric constant of solids and liquids (Elemental dielectrics,

Polarization of ionic crystals)

• Ferroelectricity

• Piezoelectricity

**6.Magnetic properties of solids**

• Magnetic permeability

• Magnetization

• Diamagnetism

• Paramagnetism

• Ferromagnetism

• Quantum theory of paramagnetism and ferromagnetism

• The domain model

**7.The free electron Fermi gas**

• Energy levels in one dimension

• Effect of temperature on the Fermi-dirac distribution

• Free electron gas in three dimensions

• Heat capacity of the electron gas

**Assessment**

* **From chapter 1-4**
* Quiz and test ……..30%
* Assignment………. 20%
* **From chapter 5-7**
* Final exam ……50%

**Recommended References**

1. C. Kittel, *Introduction to Solid State Physics*,Wiley, 8th ed., (2004).

2. M. Ali Omar, *Elementary Solid state Physics: Principles and Applications*, AddisonWesley, (1993).

3. S. O. Pillai, *Solid State Physics*, New Age Int. 6th ed., (2008).

4. Ashcroft N.W. and Mermin N.D., *Solid State Physics*, Holt-Saunders, (1976).

5. Burns G., *Solid State Physics*, Academic Press, (1985).

6. Hook J.R. and Hall H.E., *Solid State Physics* 2nd ed.,,Wiley, (1991).

7. L. Mihly and M.C. Martin, *Solid State Physics; Problems and Solutions*, Wiley-VCH, (2009).