B29SS Solid State Physics

COURSE DETAILS
Course Code: B29SS
Full Course Title: Solid State Physics
SCQF Level: 9
SCAF Credits: 15
Available as Elective: Yes

DELIVERY LEVEL
Undergraduate: Yes
Postgraduate Taught: No
Postgraduate Research: No
Additional Information:

COURSE AIMS
This module aims to:

- Provide an introduction to solid state physics.
- Develop connections between solid state physics and other introductory parts of the course.
- Provide a foundation for subsequent modules (e.g. year four modules: quantum theory and solid state B20QS, semiconductor optoelectronics, B20SO).
- Develop the skills and techniques to solve problems relating to Solid State physics.

LEARNING OUTCOMES – SUBJECT MASTERY
On completion of this course the student should be able to:

- understand basic principles of crystallography
- understand basic electronic properties of metals and semiconductors
- apply this knowledge to the understanding of simple solid state devices

LEARNING OUTCOMES – PERSONAL ABILITIES
This module aims to develop the students abilities in a number of ways:

- Develop the ability to critically analyse a problem or situation;
- Applying knowledge and understanding of topics in a problem-solving context;
- Develop the ability to work with numerical and graphical problems;
- Develop an awareness, and ability, of time management.

This module aims to develop a general awareness of the significance of solid state physics:
B29SS Solid State Physics

- An interest in current developments in, and applications of, physics (e.g. in semiconductor circuits);
- A willingness to make critical and evaluative comment;
- An acceptance that physics is a changing subject.

**SYLLABUS**

**Crystal Structures**

- Periodicity and lattices
- Structure of crystals (unit cells, close packed structures, directions and planes, miller indices, Bravais lattices)
- Simple X-ray diffraction, reciprocal space
- Defects and dislocations in crystals
- Elasticity and thermal expansion
- Bonding in Crystals (van der Waals, Ionic, Covalent, Metallic)
- Tight binding model
- Crystal structure, band structure, effective mass, donors and acceptors.
- Brillouin Zones

**Vibrations in Crystals**

- Lattice vibrations (phonons), thermal properties, Debye specific heat
- Cyclotron resonance.

**Electronic Properties of metals**

- Free electron theory of metals, density of states, Fermi-Dirac distribution, electronic specific heat
- Drude model for conductivity
- Phonons in solids – ball & spring model diatomic chains.

**Band Theory and Semiconductors**

- Semiconductors and energy bands – Brillouin zones, energy bands, Fermi level
- Electrical and optical behaviour of semiconductors – energy gap, optical absorption, doping, Hall effect
- Doping & pn junctions
- Fundamental optical absorption, exciton absorption, recombination processes, luminescence
- Solid state devices (qualitative models of p-n junction, light emitting diode, field effect transistor)
- Semiconductors: applications in photonics as light sources (LEDs, lasers) and detectors

**COURSE RELATIONSHIPS**

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