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

N/A
## LOCATION AND ASSESSMENT METHODS

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