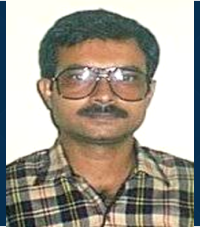

ELECTRONIC THEORY OF SOLIDS

PROF. ARGHYA TARAPHDER
Department of Physics
IIT Kharagpur

TYPE OF COURSE : Rerun | Elective | UG/PG
COURSE DURATION : 12 weeks (24 Jan' 22 - 15 Apr' 22)
EXAM DATE : 23 Apr 2022

INTENDED AUDIENCE : Physics, Chemistry, Material Science,Electronics, Electrical Engineering,Nano-science and Nano-Technology
PREREQUISITES : Elementary quantum mechanics.
INDUSTRY SUPPORT : Physics, Chemistry, Material Science, Electronics, Electrical engineering, Nano-science and Nano-Technology

COURSE OUTLINE :
The course aims to introduce electronic properties of solids starting from a very simple example: the two-atom solid. Building on this, it develops the theory of electrons in an N-atom solid – the band concept and its application to electrical and thermal properties in solids. The novel electronic concepts related to graphene and carbon nano tubes are discussed. Concept of symmetries and their relevance in emergent electronic properties are also outlined.

ABOUT INSTRUCTOR :
Prof. Taraphder former HoD, Dept of Physics and Centre for Theoretical Studies, IIT Kharagpur. He completed his PhD from IISc Bangalore in 1991. PhD guidance: 7 completed ; 1 submitted Postdoctoral Associate in the Condensed Matter Physics Group, Rutgers University, USA Aug.1991 - Jan. 1993

COURSE PLAN :

Week 1: Free electron theory of metals, Fermi-Dirac distribution

Week 2: Independent electron systems, degenerate fermi gas: Specific heat, semiclassical theory of transport, Drude theory and Hall effect.

Week 3 : Periodic potential, Bloch's theorem, tight binding approximation.

Week 4: Fermi surface in several cases. Novel electronic structures:graphene and carbon nanotubes.

Week 5: Elementary concepts of low dimensional electron gas, quantum dot, 1D and 2D electron gas introduced.

Week 6: Magnetism and its origin, magnetization and susceptibility, dia-, para- and ferro-magnetism. Larmour diamagnetism.

Week 7: Hund's rule and paramagnetism, Van Vleck paramagnetism, Curie's law. Thermal properties of magnetic insulators, Pauli paramagnetism.

Week 8: Magnetic interactions, two-electron system, spin-spin interactions – exchange interaction direct, super and itinerant exchange.

Week 9: Magnetic order, Ising, XY and Heisenberg spin models, mean-field theory, ground states and thermodynamics.

Week 10: Phenomenology of Superconductors

Week 11: BCS theory, tunneling, SC gap and transition temperature

Week 12 : Quantum interference, Josephson effect, SC junctions, squid and its application. Novel superconductors.