PHYSICS OF MATERIALS

PROF. PRATHAP HARIDOSS
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PRE-REQUISITES : First Year under graduate level of physics and mathematics will be beneficial but is not absolutely necessary.

INTENDED AUDIENCE : Any interested Learners

COURSE OUTLINE

Materials display properties. What is the physics behind these properties? Starting from an electronic or atomic level, how can we arrive at the properties of the materials? These are the questions this course will attempt to answer. Focus will be on electronic properties, but other properties will also be looked at.

ABOUT INSTRUCTOR

Prof. Prathap Haridoss is a Professor in the Department of Metallurgical and Materials Engineering at IIT Madras. He works in the areas of Fuel Cell and Carbon nanomaterials. He has a B.Tech in Metallurgical Engineering from IIT Madras, and a PhD in Materials Science and Engineering from the University of Wisconsin-Madison, USA. Before he joined as a faculty at IIT Madras, he served as a Senior Scientist at Plug Power, a Fuel Cell company in New York. He has 3 US patents, several International Journal publications, and has published a book titled “Physics of Materials, Essential Concepts of Solid State Physics.

COURSE PLAN

Week 01 : Properties of materials, thermal expansion
Week 02 : DC and AC techniques to measure electronic conductivity, free electron gas,
Week 03 : Drude model for electronic conductivity and for thermal conductivity; Successes and Limitations of the Drude model –
Week 04 : The Wiedemann Franz Law; Statistical Mechanics, Maxwell-Boltzmann statistics; history of quantum mechanics; Drude
Week 05 : Sommerfeld model, Fermi-Dirac Statistics; Confinement and quantization; calculating density of available states for electrons;
Week 06 : Fermi Energy, Fermi Surface, Fermi Temperature; Reciprocal space ; Wigner seitz cells Brillouin zones;
Week 07 : Calculating allowed and forbidden energy levels; Description of tight binding approximation, impact of inter atomic spacing on band gaps.
Week 08 : Comparison of free electron approximation and tight binding approximation. Efect of pressure on band gaps;
Week 09 : Direct Band gap, indirect Band gap semiconductors; Magnetic properties; Electron compounds/ Hume Rothery phases.
Week 10 : Phonons, Optoelectronic properties;
Week 11 : Superconductivity, Bose-Einstein Statistics;
Week 12 : Physics of nano scale materials.