Syllabus

**Introduction to Superconductivity**

(16 academic hours)

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1. Course Description
   1. Title of a Course

**Introduction to Superconductivity**

* 1. Pre-requisites

**Basic knowledge in solid state physics and electricity. Basics of university-level math: integration, differentiation.**

* 1. Course Type (compulsory, elective, optional)
  2. Abstract

**The course is oriented to engineers, graduate and undergraduate students expecting to work in various fields related to physics, material science and/or electronics. Lectures start from a brief overview of elementary theory of metals. Phenomenological models of superconductivity, Ginzburg-Landau model, BCS model, type-I and type-II superconductors, high-Tc superconductivity, applications of superconductors. The material is presented minimizing unnecessary math emphasizing underlying physics.**

1. Learning Objectives

**The objective of the course is to provide basic knowledge of superconductivity to a broad audience interested in the subject. The emphasis is made on qualitative description, providing basic science background and avoiding unnecessary mathematical formalism.**

1. Learning Outcomes

**The lectures might appear useful for engineers and researchers in natural science disciplines such as physics, electronics, IT, computer and material sciences who wish to advance their knowledge in phenomenon of superconductivity and its applications.**

1. Course Plan

* **Classification of solids. Drude-Lorenz model of conductivity in metals. Mean free path. Ohm's law. Applicability and limitations of Drude-Lorenz model. Wiedemann – Franz law. Joule law.**
* **Basics of quantum solid state theory. Electrons in periodic lattice potential. Bloch theorem. Zone structure. Metals, dielectrics, semiconductors. Basic phenomena in solids. Electric resistivity. Hall effect. Thermionic emission. EM absorption. Cyclotron resonance.**
* **Basic phenomena in superconductors. Zero resistivity. Meissner effect. Themodynamis of superconductors.**
* **Phenomenological model of superconductivity. Superconductors in magnetic field. Current state of a superconductor. London equations.**
* **Free energy. Intermediate state. Type I and II superconductors**
* **Ginzburg-Landau model. Limitations of the phenomenological models.**
* **Fluxoid quantization. Cooper pairs. BCS microscopic model.**
* **Non-equilibrium s/c. High-Tc materials.**
* **Josephson effect. SQUIDs. Superconducting logic elements.**
* **Applications of superconductors. Superconducting magnets. High-Tc superconductors. Open problems in superconductivity.**

1. Reading List
   1. Required

**NA**

* 1. Optional
* **N. W. Ashcroft and N. D. Mermin*,* Solid state physics, Saunders College, 1976. ISBN-13: 978-0030839931. ISBN-10: 0030839939**
* **C. Kittel, Introduction to Solid State Physics, John Wiley&Sons, 2005. ISBN-13: 978-0471415268. ISBN-10: 047141526X**
* **Abrikosov. Fundamentals of the Theory of Metals. North-Holland, Amsterdam (1988).**
* **M. Tinkham. Introduction to Superconductivity, McGraw-Hill Book Co., 1975. ISBN-13: 978-0486435039. ISBN-10: 0486435032**
* **P.G. deGennes ”*Superconductivity of metals and alloys*” Addison-Wesley Publ. Co., 1966**
* **“*Superconductivity*” Edited by R.D. Parks, Marcel Dekker, NY 1969**
* **J. R. Schriefer *”Theory of superconductivity*”, Wiley, NY 1965**

1. Grading System

**The final grade is based on short written exam**

1. Guidelines for Knowledge Assessment
2. Methods of Instruction
3. Special Equipment and Software Support (if required)

**Not required**