Course Type	Course Code	Name of Course	L	T	P	Credit
OE	PHO301	LOW TEMPERATURE PHYSICS & SUPERCONDUCTIVITY	3	0	0	9

Course Objectives
The course has the main objective of making the students familiar with the basic principle of various cooling techniques, basic ideas of superconducting materials and their applications.
Learning Outcomes
After studying this course the students will learn: (i) techniques for liquefaction and storage of air and inert gases, (ii) basics of superconductors, (iii) thermodynamics and electrical properties of superconductors, (iii) High temperature superconductors and (iv) applications of superconducting materials.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Liquefaction of gases, Expansion engines, operation principle and technical realizations, separation of liquefied gases, Inverse Carnot Engine, Joule-Thomson expansion, closed cycle refrigerators and Gifford-McMahon coolers, Pulse tube cooler, Liquid He cryostat. Basics of dilution refrigerator.	13	From this unit one can learn the basic principles of coolers, refrigerators and storages operating near absolute zero temperature.
2	**Basics of superconductivity**: Zero resistance, perfect diamagnetism, type-II super conductor (shubinkov phase), flux quantization, flux pinning, Josephson effects. **Thermodynamics of superconductors**: Condensation energy, entropy, specific heat capacity.	11	In this unit students will be familiar with electrical, magnetic and thermodynamic properties of superconducting materials.
3	**Electrodynamics of super conductors**: Drude model, London theory. BCS theory of superconductivity, properties of fermions and coherent states of fermions. Ginzburg-Landau theory, phase transition, screening, GL coherence length.	11	The learning outcome of this unit is the knowledge about the transport properties and the theory of phase transitions in superconducting materials.
4	**Applications:** Superconducting magnets, Magnetic levitation, application of Josephson junction, SQUID, high Tc superconductors.	7	After studying this unit the students will learn various industrial applications of superconducting materials and basics of high temperature superconductors.
	Total	**42**	

Textbooks:

1. Low-temperature Physics: An introduction for scientists and engineers, PVE McClintock, DJ Meredith, JK Wigmore; Springer Science 1992
2. Low-temperature Physics, C. Enss, S. Hunk linger, Springer-Verlag Berlin Heidelberg 2005
3. Experimental Techniques for Low temperature measurements, J W Ekin, Oxford Univ. Press 2006

Reference Books

1. Matters and Methods at Low-Temperatures, Frank Pobel, Springer-Verlag Berlin Heidelberg 2007
2. Introduction to Superconductivity, Michael Tinkham, Dover Publications; Second Edition; 2004