

GUJARAT TECHNOLOGICAL UNIVERSITY

Mechanical (Cryogenic Engineering)

M.E. Semester: IV

Subject Code: 741001

Subject Name: **Advanced Cryogenics & Applied Super Conductivity**

Sr. No.	Course Content
1.	History of superconductivity: Discovery and early history-Meissner effect and search for understanding the phenomenon, growth and development in the new era.
2.	Understanding the phenomena of Superconductivity: Zero electrical resistance, The superconductor as a thermodynamic phase, perfect diamagnetism, super currents, and penetration depth. Magnetic Phase diagram-Critical field and critical temperature. Intermediate state, Gibbs free energy, Type II superconductivity. Thermodynamic and optical properties (the energy gap). Flux Quantization; Magnetic flux through hollow cylinder and ring. Josephson effect and tunnelling, superconductivity and super fluidity
3.	Superconducting Materials: Materials superconducting at LHe temperature, Structures of the material and composition, High T_c cuprates, composition, structures, properties, and general features of various types of cuprates. Electron super conductors, Oxyhalides, oxycarbonates, ladder cuprates, copper free oxide superconductors, boro carbides, super conducting fullerenes and related materials Preparation of cuprates materials, making of films of superconductor by electron-beam evaporation, High pressure oxygen sputtering system, laser ablation method.
4.	Strange Cuprates: The first Cuprate family, $La_{2-x}M_xCuO_4$, Insular Material-Electrical resistivity of insular material, Graphical presentation(in Plane) of metallic properties, resistivity, The hall effect, single particle spectrum, Fermi surface, magnetic excitations lower energy scale, the superconducting state, basic electronic model for cuprates, future scope of cuprates.
5.	Theories of superconductivity: London Equation, London hypothesis, penetration depth and Meissner effect, rigidity of wave function and flux quantization. Landau theory, order parameter idea, free energy function for superconductor, superconducting phase transition, Coherence length, meissner effect and zero electrical resistance, flux quantization, Type II superconducting, Josephson effect, The BCS theory.

6. **Application of Superconductivity:**

1) **Magnets:**

High-field magnet application, Nuclear magnetic resonance(NMR),medical diagnostics and spectroscopy, Ore refining (magnetic separators),Magnetic levitation, Magnetic shielding, Large physics machines.

2) **Energy-related:**

Production by magnetic fusion and magneto-hydrodynamics, energy storage, Electrical power transmission.

3) **Transportation:**

High-speed trains, Ship-drive systems.

4) **Electronics and small devices:**

SQUIDS, Josephson devices, Bolometer, Electromagnetic shielding

5) **Computers and information processing:**

Semiconductor-superconductor hybrids, Active superconducting elements, Voltage standard, Optoelectronics, Matched filters.

Reference Books:

1. D. Schoneberg, Superconductivity, Cambridge University Press, 1954.
2. F.London, Superfluids, Vol.1,Wiley, New York, 1954
3. M.Tinkham, Introduction to superconductivity, McGraw-Hill, New York, 1975.
4. HTSCs for 21st century Technology, Applied superconductivity,5,1-204(1997)
5. P.W. Anderson, The Theory of superconductivity in High-T_c Cuprates, Princeton University Press,1997