New Subject for M. Tech 2nd Semester (3-0-0)

Cryogenics and Superconductivity for Particle Accelerator

A. Introduction: 6 hours

1. Introduction of Particle Accelerator and its application.
2. Types of Accelerator/ Collider
3. Relevance of Particle Energy with magnetic field strength and accelerating field gradient
4. Present trend of High Power Accelerator
5. Role of Cryogenics and Superconductivity for Accelerator
6. Superconducting Cavity and Magnet for Accelerator
7. Few Important Accelerator (LHC, ILC etc.) with Superconductivity

B. RF Superconductivity and Superconducting Cavity: 10 hours

1. Introduction on RF Superconductivity
2. Materials suited for RF Superconductivity
3. Surface Resistance, BCS resistance and Residual Resistance
4. Accelerating Gradient and its limitation on SC cavity
5. Surface preparation by different techniques.
6. Variation of BCS resistance with RF frequency and temperature
7. Quality factor with Surface resistance with Geometry factor
8. Comparison with Normal Conducting and Superconducting Cavity

C. Superconducting Magnet for Accelerator: 2 hours

1. Types of Magnet used in Accelerator
2. Solenoid, Quadrupole, Dipole Magnet for focussing and Guiding high energy beams

D. Cryogenics for Accelerator: 10 hours

1. Refrigeration load with particle accelerator
2. Power comparison
3. High capacity (> 1 kW) Helium Refrigerator
4. Process Cycle for large capacity helium refrigerator
5. Limitation on Inverse COP for high capacity refrigerator

6. Modes of operation (Liquefaction, Refrigeration and Mixed mode of operation)
7. Cryogen Distribution line and Valve Box for accelerator

E. Cryomodule for Accelerator : 8 hours

1. Concept of Cryomodule
2. Dynamic load from SC Cavity and Magnet
3. Static load at 2K, 4.2 K and 80/60 K
4. Modes of Heat transfer in brief applicable to Cryomodule
5. Concept of thermal shield and Radiation Load
6. Conduction Load through Support Structure
7. Load through Current lead and RF Drive Coupler
8. Conceptual design of Cryomodule
9. Cool down Methodology of Cryomodule from 300 K to 2 K
10. Thermal contraction in complex structure and Centre of Beam line

F. 2 K Helium System : 4 hours

1. Why 2 K is essential for Accelerator
2. Phase Diagram of Normal and Superfluid of Liquid Helium
3. Possible Cycle option to have 2 K from 4.2 K
4. 2 K heat exchanger, cold compressor
5. Thermodynamic Efficiency of 2 K system for Accelerator

G. Other Application: 2 hours

1. Bubble Chamber with liquid hydrogen
2. Liquid Argon Detector for neutrino and muon particle