MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSH 452: **CLASSICAL MECHANICS AND STATISTICAL PHYSICS** (4 Credits)

Objectives: This course is designed to introduce the student to the basics of Classical Mechanics and Statistical Physics - both of which are mathematical tools helpful in solving physical problems involving the motion of objects under the influence of forces or microscopic systems with large populations. It first familiarizes the student with very simple concepts of classical mechanics and then illustrates how these principles can be used to solve complex problems of rigid and deformable bodies. In the same vein, the statistical mechanics introduces the student to the fundamentals of classical and quantum statistics.

Expected course outcomes: This course prepares the student with the basic skills required to compute mathematical problems at both the macroscopic and microscopic level. With the theoretical background acquired, the student should be capable to understand and tackle more complex problems that he/she may encounter in the career.

Unit I

Analytical Mechanics: Mechanics of a system of material particles, constraints, degrees of freedom. D'Alembert's principle and Lagrange's equations. Simple applications of Lagrange's equations. Hamilton's principle - derivation of Lagrange's equations. Hamilton's equations - cyclic co-ordinates- Principle of least action - canonical transformation. Poisson brackets and equations of motion. Hamilton - Jacobi equations - solution of harmonic oscillator.
18 hours

Unit II

Mechanics of Rigid and Deformable Bodies: The independent co-ordinates of a rigid body - orthogonal transformations - Eulerian angles. Infinitesimal rotations, rate of change of a vector. Euler's equations of motion - motion of a symmetric rigid body with one point fixed and force free motion. Analysis of strain tensor of an elastic medium - Navier's conditions of equilibrium. Symmetric stress tensor. generalised Hooke's law - elastic constants of an isotropic homogeneous media - equations of motion - elastic waves –velocity of longitudinal and transverse waves. 18 hours

Unit III

Statistical Mechanics: Phase space - Ensembles - Thermodynamic probability - Maxwell - Boltzmann distribution - Partition functions - translational, vibrational and rotational partition functions - applications to specific heats.

Quantum Statistics: Inadequacy of classical statistics - spectra of black - body radiation. Indistinguishability of identical particles. Bosons and Fermions - Bose - Einstein statistics - black - body radiation and Bose condensation. Fermi - Dirac Statistics-degenerate electron gas.
18 hours

References

1. Classical Mechanics - H Goldstein (Addison Wesley, 1960)
2. Classical Mechanics - H C Corben and P Stehle (John Wiley, 1960)
3. Mechanics - A Sommerfeld (Academic Press, 1964)
4. Mathematical Theory of Elasticity - I S Sokolnikoff (McGraw Hill, 1956)
5. Statistical Physics – L D Landau and E M Lifshitz (Pergamon, 1968)
6. Statistical Mechanics and Properties of Matter – E S R Gopal (McMillan India, 1976)
7. Statistical Physics: Berkeley Physics(5) – F Reif (McGraw Hill,1967)
8. The Feynman Lectures on Physics – R P Feynman, R B Leighton and M Sands (Addison Wesley/Narosa, 1986)