MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSH 401: **METHODS OF MATHEMATICAL PHYSICS** (4 Credits)

Objectives: This course introduces the mathematical tools which are very essential for the understanding of Physics of Materials. These mathematical techniques either may be used in one of the courses in the programme to be offered in the ensuing semesters or may be required while practicing materials science either in research or in an industry.

Expected course outcomes: At the end of the course student should be familiar with the mathematical techniques, the concepts involved and should be able to apply the concepts to solve at least some simple problems.

Unit I

Complex Variables: Analytic functions. Series expansion- Laurent's Theorem. Residue Theorem and evaluation of simple contour integrals. Evaluation of Improper integrals and Integrals involving trigonometric functions by the method of residues. Group Theory: Basic concepts - multiplication tables - subgroups - direct product. Properties of groups. Representations of finite group - reducible and irreducible representations and example of C_{4v} group. 18 hours

Unit II

Matrices: Matrices as operators. Symmetric, Orthogonal, Hermitian and Unitary matrices. Eigen values and eigen vectors of a matrix. Simiarity, Orthogonal, Unitary and Congruent transformations. Diagonalisation of a real symmetric matrix. General Curvilinear Co-ordinates: Expressions for line, surface and volume elements in general curvilinear co-ordinates. Gradient, Curl, Divergence and Laplacian - Orthogonal curvilinear co-ordinates.

Tensors: Definition - Contravariant, Covariant and Mixed tensors.Sum, inner and outer products - Contraction - Quotient law. The line element and the metric tensor. Length of a vector. Raising and lowering of indices. Christoffel symbols and covariant differentiation of tensor. Stress and strain tensors. 18 hours

Unit III

Special Functions: Bessel functions of the first kind -derivation of the basic form- Recurrence relations - Fraunhofer diffraction and vibrations of bars and membranes. Legendre and Associated Legendre functions - Recurrence relations and differential equations. Legurre and Associated Legurre functions – differential equations. Hermite functions - Recurrence relations – differential equations. 18 hours

References

1. Mathematical Methods for Physicists – G Arfken (Academic Press, 1968)
2. Elements of Group Theory for Physicists – A W Joshi (Wiley Eastern, 1975)
3. Symmetry Groups and their applications – W. Miller

4. Mathematics of Physics and Chemistry – H Margenau and G M Murphy (Affiliated East West Press, 1966)
5. Matrices and Tensors in Physics – A W Joshi (Wiley Eastern, 1975)
6. Tensor Analysis – I S Sokolnikoff (John Wiley, 1974)