University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Chemistry

Semester III
Mathematics-III
(Theory of Equations and Vector Analysis)

CODE: MM 1331.2 | Instructional hours per week: 5
No. of Credits: 4

Module 1: Theory of equations

- Polynomial equations and fundamental theorem of algebra (without proof). Applications of the fundamental theorem to equations having one or more complex roots, rational roots or multiple roots.
- Relations between roots and coefficients of a polynomial equation and computation of symmetric functions of roots. Finding equations whose roots are functions of the roots of a given equation. Reciprocal equation and method of finding its roots.
- Analytical methods for solving polynomial equations of order up to four-quadratic formula, Cardano's method for solving cubic equations, Ferrari's method (for quartic equations). Remarks about the insolvability of equations of degree five or more. Finding the nature of roots without solving-Des Cartes' rule of signs.

Module 2: Vector Differentiation

- (Review only) Vectors in 3-space. Addition of two vectors, multiplication of a vector by a scalar and basic properties of these operations. Representation in Cartesian coordinates using standard basis. Dot, cross and triple product of vectors, their significance and properties.
- Vector function of a single variable and representation in terms of standard basis. Limit of a vector function and evaluation of limit in Cartesian representation. Continuous vector functions and the idea that such functions represent oriented space curves. Examples.
- Derivative of a vector function and its geometric significance. Derivative in terms of Cartesian components. Tangent vector to a curve, smooth and piecewise smooth curves. Applications to finding the length and curvature of space curves, velocity and acceleration of motion along a curve etc.
- Scalar field and level surfaces. The gradient vector of a scalar field (Cartesian form) at a point and its geometric significance. Gradient as an operator and its properties. Directional derivative of a scalar field and its significance. Use of gradient vector in computing directional derivative.
- Vector fields and their Cartesian representation. Sketching of simple vector fields in the plane. The curl and divergence of a vector field(Cartesian form) and their physical significance. The curl and divergence as operators, their properties. Irrotational and solenoidal vector fields. Various combinations of gradient, curl and divergence operators.

Module 3: Vector Integration

- The method of computing the work done by a force field in moving a particle along a curve leading to the definition of line integral of a vector field along a smooth curve. Scalar representation of line integral. Evaluation as a definite integral. Properties. Line integral over piecewise smooth curves. Green's theorem in the plane (without proof) for a region bounded by a simple closed piecewise smooth curve.
- Oriented surfaces. The idea of flux of a vetor field over a surface in 3-space. The surface integral of a vector field over a bounded oriented surface. Evaluation by reducing to a double integral. Use of cylindrical and spherical co-ordinates in computing surface integral over cylindrical and spherical surfaces.
- Stokes' theorem (without proof) for an open surface with boundary a piecwise smooth closed curve. Gauss' divergence theorem (without proof). Verification of the theorems in simple cases and their use in computing line integrals or surface integrals which are difficult to evaluate directly. Physical intrepretation of divergence and curl in terms of the velocity field of a fluid flow.
- Conservative fields and potential functions. Relation of conservative vector fields to their irrotational nature and the path- independence of line integrals in the field (without proof). Significance of these results in the case of conservative force fields such as gravitational, magnetic and electric fields. Method of finding the potential function of a conservative field.

Text for Module 1: Barnard and Child, *Higher Algebra*, Macmillan

Text for Modules 2 and 3: Howard Anton, et al, *Calculus*. Seventh Edition, John Wiley

References:

1. James Stewart, *Essential Calculus*, Thompson Publications, 2007.
2. Thomas and Finney, *Calculus and Analytic Geometry*, Ninth Edition, Addison-Wesley.
3. Peter V. O' Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007
4. Michael D. Greenberg, *Advanced Engineering Mathematics*, Pearson Education, 2002.

Distribution of instructional hours:

Module 1: 30 hours; Module 2: 30 hours; Module 3: 30 hours