

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

Semester II
Mathematics-II
(Integration, Differential Equations and Analytic Geometry)

CODE: MM 1231.2

Instructional hours per week: 4
No. of Credits: 3

Overview of the course:

The complementary course in the second semester continues the trend indicated in the first, namely, laying emphasis on applications of integral calculus to problems in Chemistry. Module 1 consists of a review of basic integration techniques and the applications of integration. It also covers multiple integrals. Module 2 deals with differential equations, while Module 3 covers analytic geometry.

Module 1: Integration (with applications to Chemistry)

- Indefinite integrals (Review only), integral curves, integration from the view point of differential equations, direction fields
Exercise set 5.2; Questions 43 and 44
- (Review only) Definite integral and Fundamental Theorem of Calculus.
- Rectilinear motion: finding position and velocity by integration. Uniformly accelerated motion. The free-fall model. Integrating rates of change. Displacement in rectilinear motion. Distance travelled in rectilinear motion. Analysing the velocity versus time curve. Average value of a continuous function. Average velocity revisited.
Exercise set 5.7; Questions 3, 4, 5, 6, 29 and 55
- Review of integration techniques.
- Use of definite integrals in finding area under curves, area between two curves, volume of revolution, arc length and surface area of a solid of revolution.
- The idea of approximating the volume under a bounded surface in 3-space by volumes of boxes, leading to the definition of double integrals of functions of two variables over bounded regions. Evaluation of double integrals by iterated integrals. Evaluation by changing to polar co-ordinates and by suitably changing order of integration in the iterated integral. Applications to finding the volume of solids under bounded surfaces.
- Triple integrals over bounded regions in three space. Evaluation by iterated integrals. Cylindrical coordinates and spherical coordinates and their relation to Cartesian coordinates. Use of cylindrical and spherical co-ordinates in evaluating triple integrals. Applications of triple integrals to finding volumes of solid objects.

Module 2: Differential Equations

- Review of basic concepts about differential equations and their solutions. Method of solving special types of first order ODEs such as variable separable, exact, homogeneous, and linear. Finding the family of curves orthogonal to a given family.
- Second order linear differential equations. Nature of the general solution of homogeneous and non-homogeneous linear ODEs. Extension to higher order ODEs.
- Second order linear homogeneous ODEs with constant coefficients. The characteristic equation and its use in finding the general solution. Extension of the results to higher order ODEs.
- Second order linear non-homogeneous ODEs with constant coefficients. General solution as the sum of complementary function and particular integral. Second order linear differential operator and its properties. The inverse operator and its properties. Operator method for finding the particular integral of simple functions. Extension of the results to higher order equations. Cauchy and Legendre equations and their solutions by reducing to equations with constant coefficients by suitable change of variable.

Module 3: Analytic Geometry

- Geometric definition of a conic—the focus, directrix and eccentricity of a conic. Classification of conics into ellipse, parabola and hyperbola based on the value of eccentricity. Sketch of the graphs of conics. Reflection properties of conic sections.
Exercise set 11.4; Questions 39 – 43.
- Equations of the conics in standard positions. Equations of the conics which are translated from standard positions vertically or horizontally. Parametric representation of conics in standard form. Condition for a given straight line to be a tangent to a conic. Equation of the tangent and normal to a conic at a point.
- Asymptotes of a hyperbola. Equation of the asymptotes. Rectangular hyperbola and its parametric representation. Equation of tangent and normal to a rectangular hyperbola at a given point.
- Rotation of co-ordinate axes. Equation connecting the co-ordinates in the original and rotated axes. Elimination of the cross product term in a general second degree equation by suitable rotation. Identifying conics in non-standard positions represented by general second degree equation by suitable rotation of axes. The discriminant of a general second degree equation and its invariance under rotation of co-ordinate axes. The conditions on the discriminant for the general second degree equation to represent a conic, a pair of straight lines or a circle.
- Conic sections in polar coordinates. Eccentricity of an ellipse as a measure of flatness. Polar equations of conics. Sketching conics in polar coordinates. Kepler's Laws. Example 4 of section 11.6.

TEXT FOR MODULES 1 AND 3 : Howard Anton, et al, *Calculus*. Seventh Edition, John Wiley

Text for Module 2: Kreyzig, *Advanced Engineering Mathematics*, 8th 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.
5. George F Simmons, *Differential equations with applications and historical notes*, Tata McGraw Hill, 2003

DISTRIBUTION OF INSTRUCTIONAL HOURS:

Module 1: 24 hours; Module 2: 24 hours; Module 3: 24 hours