**Semester wise Syllabus of Minor Courses in Mathematics:**

**(For the students who have taken Chemistry/ Physics/ Computer Science as a Major Subject)**

**First Year, Semester – 1, Course: Minor – 1**
**Paper Name: Differential Calculus and Integral Calculus**
**Paper Code: MATMIN - 1**
**Full Marks: 100 (75 = Written, 10 = Project, 10 = Internal, 5 = Attendance)**
**Total Credit: 6, Total Hours: 90**

**Program Objectives:**

Through this course, the students will understand the various aspects of limit, continuity, differentiability and partial differentiation. Additionally, they will study Rolle's Theorem, Mean Value Theorems, maxima and minima, indeterminate forms and many other applications of calculus. As a part of this course, students will learn how to integrate a solid, calculate the volume and surface area of various solids in the form of revolutions, and calculate the surface area of a solid as a function of integration.

**Program Outcomes:**

This course will enable the students to:

- learn the fundamentals of the calculus,
- enhance the application skills of the students and prepare them to pursue higher analytical mathematics,
- analyze the relationships between quantities such as rates of changes, area, volume, properties of curves and their mathematical equivalents,
- equip with the tools of calculus to measure various quantities such as curvature, torsion, point motion in space etc.

**Differential Calculus (50 Hours)**

**Unit-1: Limit and Continuity**

Limit and Continuity ($\epsilon$ and $\delta$ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, L'Hospital's rule and it's applications, Partial differentiation, Euler's theorem on homogeneous functions.

**(17 Hours)**

**Unit-2: Tangents and Normal**

Tangents and normals, Pedal equation, Curvature, Asymptotes, Envelope, Singular points, Tracing of curves, Parametric representation of curves and tracing of

parametric curves, Polar coordinates and tracing of curves in polar coordinates.

**(17 Hours)**

**Unit-3: Mean Value theorems**

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $sinx, cosx, e^x, \log(1+x), (1+x)^m$, Maxima and Minima, Indeterminate forms.

**(16 Hours)**

## Integral Calculus (40 Hours)

**Unit-1: Integration**

Integration by Partial fractions, integration of rational and irrational functions, Properties of definite integrals, Reduction formulae for integrals of rational, trigonometric, exponential and Logarithmic functions, and their combinations, Working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelation (without proof).

**(22 Hours)**

**Unit-2: Applications of Integration theory**

Arc length of a curve, arc length of parametric curves, area enclosed by a curve, area between two curves, volume and surface areas of solids of revolution, Double and Triple integrals.

**(18 Hours)**

**Reference Books:**

1. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
2. G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson education, Delhi, 2005.
3. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
4.T. Apostol, Calculus, Volumes I and II.
5. S. Goldberg, Calculus and mathematical analysis.
6. Shanti Narayan: Integral Calculus
7. B.C. Das & B.N. Mukherjee (U.N. Dhur & Sons): Integral Calculus
8. Shanti Narayan: Differential Calculus
9. B.C. Das & B.N. Mukherjee (U.N. Dhur & Sons): Differential Calculus

**First Year, Semester – 2, Course: Minor – 2**
**Paper Name: Ordinary Differential Equation and Partial Differential Equation**
**Paper Code: MATMIN - 2**
**Full Marks: 100 (75 = Written, 10 = Project, 10 = Internal, 5 = Attendance)**
**Total Credit: 6, Total Hours: 90**

**Program Objectives:**

- To familiarize the students with the various methods for solving second and higher order linear ODEs,
- To form mathematical model for various real world problems with their solution.
- To form the PDEs in different manners,
- To study the various methods for solving PDEs like Lagrange method, Charpit's method etc. ,
- To study the classification of second order PDE and their simple solutions.

**Program Outcomes:**

This course will enable student to:

- learn the basics of differential equations and mathematical modeling,
- formulate the ordinary differential equations for various mathematical models,
- solve first order non-linear differential equations and linear differential equations of higher order using various techniques,
- formulate, classify and transform first order PDEs into canonical form,
- learn about method of characteristics and separation of variables to solve first order PDEs,
- classify and solve the second order linear PDEs,
- learn about Cauchy problem for second order PDE and homogeneous & non-homogeneous wave equations,
- apply the method of separation of variables for solving many well known second order PDEs.

## Ordinary Differential Equation (50 Hours)

**Unit-1: Equation of first order and first degree**: Picard's Existence theorem (statement only). Lipschitz condition. Separable, Homogeneous and Exact equations, Condition of exactness, Integrating factor, Rules of finding integrating factor, Equation reducible to linear equation (Bernouli's equation).

**Equation of first order but not of first degree:** Clairaut's equation, Singular solution.

**Applications:** Geometrical applications, Orthogonal trajectories.

**(20 Hours)**

**Unit-2: Higher order linear equation with constant coefficients:** Complementary Function, Particular Integral. Method of undetermined coefficients, Wronskian - Its properties and applications, Method of variation of parameters. Cauchy-Euler's homogeneous equation and reduction to an equation with constant coefficients.
Simple eigen value problem.

**(15 Hours)**

**Unit -3: Second order linear equations with variable coefficients:** Reduction of order when one solution is known. Complete solution. Reduction to Normal form. Change of independent variable.

Simultaneous linear differential equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$.

Total differential equations. System of linear ordinary differential equation in two variables.

**(15 Hours)**

**Partial Differential Equation (40 Hours)**

**Unit-1:** Partial Differential Equations – Basic concepts and definitions, Formation of PDE, Order and Degree of PDE, Types of PDE (Linear, Semi-linear, Quasi-linear). Solution of linear PDE by Lagrange's Method. Cauchy's problem for first order partial differential equations.

**(20 Hours)**

**Unit-2:** Solution of Non-linear partial differential equation by Charpit's method. Classification of second order PDE equations as hyperbolic, parabolic and elliptic. Reduce the equation to its corresponding canonical form. Method of Separation of variables.

**(20 Hours)**

**References Books:**

(1) Differential Equations, S.L. Ross ,John Wiley & Sons, New York, 1980.
(2) Differential Equations with Historical Notes, G.F.Simmons, McGraw Hill Education.
(3) Linear Partial Differential Equations for Scientists and Engineers, TynMyint-U and Lokenath Debnath, Birkhäuser, Boston.
(4) Differential Equations with MATHEMATICA, Martha L Abell, James P Braselton, Elsevier.

(5) Difference equations: An Introduction with Applications, Walter Kelley & Allan Peterson, Academic Press, 2000.
(6) Fundamentals of Differential Equations, R. Kent Nagle, Edward B. Saff, Arthur David Snider , Pearson.
(7) Differential Equations, D. A. Murray, Orient Longmann.
(8) An Introduction to Differential Equations, R. K . Ghosh and K. C. Maity, New Central Book Agency.
(9) Ordinary and Partial differential Equation - Dr. M.D. Raisinghania, S. Chand.
(10) Differential Equation , J. G. Chakravorty and P. R. Ghosh, U.N. Dhar and Sons.
(11) Differential Equation, G. F. Simmons , Tata McGraw Hill.