

## List of Value-Added Courses in Mathematics

VAC-1            Basic Mathematics

### Unit I: Differential Calculus

Limits and differentiation-Derivative of functions- Derivative interactive graphs-Differential Equations in Physics

### Unit II: Integral Calculus

Finite sums- Limits of finite sums-Definite integrals-Integration of functions-Fundamental theorem of calculus

### Unit III: Determinant and Matrix

Basics of determinants and matrices-Types of matrices- Simultaneous linear equations- Eigenvalue and eigenvectors-Matrices in Physics

### Unit IV: Vector Calculus

Differentiation of vectors-Gradient, divergence, curl-Integration of vectors-line, surface and volume integral

VAC-2            Advanced Mathematics

### Unit I: Few Basic Functions in Physics

Plotting of functions-Beta and Gamma Function-Riemann Zeta Function-Dirac Delta Function

### Unit II: Statistics

Mean, Mode, Median, Correlation and Regression

### Unit III: Probability

Probability, Multiplicity, Combinatorics-Bernoulli Distribution-Poisson and Gaussian Distribution

Unit IV:

VAC-3            Introduction to SCILAB

**Unit I: INTRODUCTION TO SCILAB** Introduction to Numerical Computing Various Software Alternatives History Installation Workspace Command Prompt Variable Browser SciNotes

**Unit II: Working with Scilab** Files Formatting Command Prompt Display Operator Precedence Variable Browser Window Clearing Variables Comments Predefined Constants Common Mathematical Functions Variable Assignment Operator = Naming Conventions for Variables Global and Local Variables List of Variables Data Types Numerical Data How to Store Floating Point Numbers Formatted Display of Numbers Boolean Data Strings

**Unit III: ARRAYS and Loops** Introduction Arrays and Vectors Operations on Arrays and Vectors Elementwise Operations Matrix Multiplication Inverse of Matrices det() rank() trace() meshgrid, ndgrid Magnitude of a Vector Random Matrix, Using Indices to Make New Vectors Slicing Appending Rows and Columns Deleting a Row and/or Column of a Matrix Concatenation along a Dimension Logical Operations on Arrays Automatic Generation of Vectors Linearly Spaced Vectors Logarithmically Spaced Vectors Matrix Manipulations Scaling a Matrix Reshaping a Matrix Special Matrices Upper and Lower Triangular Matrices.

Introduction Loops while Infinite Loops for if-else, if-else

**Unit IV: PLOTTING** Introduction 2D Plotting plot(x, y) plot2d(), plot2d2(), plot2d3(), and plot2d4() polarplot() Plotting Multiple Plots in the Same Graph Plotting Multiple Plots Separately 3D Plots

Course outcome

1. Evaluate, analyse and plot results.
2. Develop programs in SciLab
3. Understanding of linear algebra and numerical methods
4. Analyse various SciLab commands
5. Implement and illustrate 2-D graphs and 3-D graphs.

VAC-4 Mathematical Modelling

Unit I: Role of Mathematics in problem-solving, characteristics of Mathematical Modelling, Problem definitions,

Unit II: System Characterizations: System vs Variable vs Parameter, System vs Environment, Relationship between variables, Static vs Dynamic, Continuous Time vs Discrete Time, Mathematical formulations, Analysis of Mathematical formulations.

Unit III: Simple population growth model, Simple Epidemics model, Prey-predator model, Linear growth and decay model, Non-Linear growth and decay model

Unit IV: Deterministic models and Stochastic models

VAC-5 Basic Algebra

**Unit I: The Integers**

Properties of Integers, Greatest common divisor, Unique Factorization, Mathematical Induction, Equivalence Relations and Congruences.

**Unit II: Groups**

Definition and examples of Groups, Finite groups, Subgroups, Cyclic groups, Permutation groups.

**Unit III: Group Homomorphisms**

Definition and Examples, Properties of Homomorphism.

**Unit IV: Ring Theory**

Rings, Ideals, Ring Homomorphisms, Polynomial Rings.

## VAC-6 Numerical Methods

### **Unit I: Roots of Algebraic and Transcendental Equations**

Introduction to significant digits and errors, Bisection method, Regula-Falsi method, Newton-Raphson method and convergence criteria

### **Unit II: Solution of system of linear Equations**

Direct methods, Iterative methods, Ill-conditioned systems

### **Unit III: Interpolation**

Finite difference operators, difference tables, Newton's Forward/Backward difference, Divided differences, Lagrange interpolation and Newton's divided difference interpolation

### **Unit IV: Numerical Differentiation and Integration**

Numerical Differentiation using Forward/Backward formula, Trapezoidal and Simpson's rules for integration

### **Unit V: Solution of ordinary differential equations**

Picards method, Euler method, Euler modified method and Runge-Kutta methods