SYLLABUS

SENIOR SECONDARY COURSE IN MATHEMATICS

RATIONALE

The curriculum in Mathematics has been designed to cater to the specific needs of NIOS learners. The thrust is on the applicational aspects of mathematics and relating learning to the daily life and work situation of the learners. The course is modular in nature with – eight compulsory modules forming the core curriculum and four optional modules out of which the learner is to choose one optional module. An attempt has been made to reduce rigour and abstractness.

OBJECTIVES

The course aims at enabling learners to :

- become precise, exact and logical.
- acquire knowledge of mathematical terms, symbols, facts and formulae.
- develop an understanding of mathematical concepts.
- develop problem solving ability.
- acquire skills in applying the learning to situation including reading charts, tables, graphs etc.
- apply the above skills in solving problems related to Science, Commerce and daily life.
- develop a positive attitude towards Mathematics and its application.

COURSE STRUCTURE

The compulsory modules are :

1. Complex Numbers and Quadratic Equations
2. Determinants and Matrices
3. Permutations and Combinations
4. Sequences and Series
5. Trigonometry
6. Coordinate Geometry
7. Differential Calculus
8. Integral Calculus

The optional modules are :

9. Statistics and Probability
10. Vectors and Analytical Solid Geometry
11. Linear Programming

MODULE WISE DISTRIBUTION OF STUDY HOURS AND MARKS

Module No.	Compulsory Modules	Minimum Study Hours	Marks
1.	Complex Numbers & Quadratic Equations	15	10
2.	Determinants & Matrices	15	10
3.	Permutations & Combinations	20	08
4.	Sequences & Series	20	08
5.	Trigonometry	30	10
6.	Coordinate Geometry	30	10
7.	Differential Calculus	45	17
8.	Integral Calculus	45	17
	Optional Modules (The learner have to choose any one module)		
9. **10.** **11.**	Statistics & Probability OR Vectors & Analytical Solid Geometry OR Linear Programming	**20 each**	**10 each**
TOTAL		**240**	**100**

CURRICULUM OF SENIOR SECONDARY MATHEMATICS

COMPULSORY MODULES

Module 1: Complex Numbers and Quadratic Equations

Study Time: 15 hrs. Max. Marks: 10

Pre-requisites: Real numbers and quadratic equations with real coefficients.

Content and Extent of Coverage

- **Complex Numbers**
- Definition in the form $x+iy$
- Real and imaginary parts of a complex number.
- Modulus and argument of a complex number
- Conjugate of a complex number

- **Algebra of Complex number**
- Equality of complex numbers
- Operations on complex numbers (addition, subtraction, multiplication and division)

- Properties of operations (closure, commutativity, associativity, identity, inverse, distributivity)
- Elementary properties of modulus namely

(i) $|z| = 0 \Leftrightarrow z = 0$ *and* $z_1 = z_2 \Leftrightarrow |z_1| = |z_2|$

(ii) $|z_1 + z_2| \leq |z_1| + |z_2|$

(iii) $\left|\frac{z_1}{z_2}\right| = \frac{|z_1|}{|z_2|} (z_2 \neq 0)$

- **Argand Diagram**

- Representation of a complex number by a point in a plane.

- **Quadratic Equations**
- Solution of quadratic equation with real coefficients using the quadratic formula
- Square root of a complex number
- Cube roots of unity

Extended Learning

- **Polar representation of a complex number**
- **Quadratic equations with complex coefficients**

NOTE :

- "Division by zero is not allowed in complex numbers" to be stressed.
- Lack of order in complex numbers to be highlighted.
- The fact that complex roots of a quadratic equation with real coefficients occur in conjugate pairs but the same may not be true if the coefficients are complex numbers is to be verified using different examples.

Module 2: Determinants and Matrices

Study Time: 15 hrs. Max. Marks: 10

Pre-requisites : Knowledge of number systems; solution of system of linear equations.

Content and Extent of Coverage

- **Determinants and their Properties**
- Minors and Cofactors
- Expansion of a determinant
- Properties of determinants

- **Matrices**
- Introduction as a rectangular array of numbers
- Matrices upto order 3×4

- **Types of matrices**
- Square and rectangular matrices
- Unit matrix, zero matrix, diagonal, row and column matrices
- Symmetric and skew symmetric matrices

- **Algebra of matrices**
- Multiplication of a matrix by a number
- Sum and difference of matrices
- Multiplication of matrices

- **Inverse of a square matrix**
- Minor and cofactors of a matrix
- Adjoint of a matrix
- Inverse of a matrix

- **Solution of a system of linear equations**
- Solution by Cramer's Rule
- Solution by matrix method

NOTE:
- The properties of determinants to include the following:
  1. If any two rows or columns of a determinant are interchanged, then

the sign of the determinant is changed.

2. If each element of a row (or column) of a determinant is multiplied by a constant, the value of the determinant gets multiplied by.
3. If k times a row (or column) is added to another row (or column) the value of the determinant remains unchanged.

- The number of equations and variables to be restricted to three only.

Extended Learning

- **Cramer's Rule** for four or more equations
- **Determinant as a function**
- **Matrix as a function**
- **Matrices over complex numbers**
- **Hermitian and Skew Hermitian**
- **Rank of a Matrix**
- **Inverse by elementary row transformations**
- **Solution of 4 or more than 4 linear equations in 4 more than 4 variables**

Module 3: Permutations, Combinations and Binomial Theorem

Study Time: 20 hrs. Max. Marks: 8

Pre-requisites : Number Systems

Content and Extent of coverage

- **Mathematical Induction**
- Principle of mathematical induction
- Application of the principle in solving problems

- **Permutations**
- Fundamental Principle of Counting
- Meaning of ${}^{n}P_{r}$
- Expression for ${}^{n}P_{r}$

- **Combinations**
- Meaning of ${}^{n}C_{r}$
- Expression for ${}^{n}C_{r}$
- Properties of ${}^{n}C_{r}$ namely

(i) $${}^{n}C_{r} = \frac{{}^{n}P_{r}}{n!}$$

(ii) $${}^{n}C_{r} = {}^{n}C_{n-r}$$

(iii) $${}^{n}C_{r-1} + {}^{n}C_{r} = {}^{n+1}C_{r}$$

- **Binomial Theorem**
- Binomial theorem for a positive index with proof.

Extended Learning

- **Circular permutations**
- **Pascal's triangle**
- **Binomial theorem for negative index and rational indices (without proof)**

Module 4: Sequences and Series

Study Time: 20 hrs. Max. Marks: 8

Pre-requisites : Permutation, Combination and concept of a function, Exponential functions, Logarithmic functions and their properties, and graphs.

Content and Extent of coverage

- **Arithmetic Progression**
- Concept of a sequence
- A.P as a sequence
- General term of an A.P
- Sum upto 'n' terms of an A.P.

- **Geometric Progression**
- G.P as a sequence
- General term of a G.P
- Sum upto 'n' terms of a G.P.
- Sum upto infinite terms of a G.P.

- **Series**
- Concept of a series
- Some important series, etc. using method of differences and mathematical induction

- **Exponential and Logarithmic Series**
- Representation of e^x and $\log(1+x)$ as series.
- Properties of e^x and $\log(1+x)$

Extended Learning

- **Arithmetic Mean, Geometric Mean**
- **Harmonic Progression, Arithmetico-Geometric Progression and their relationships**
- **Logarithms on any base**

Module 5 : Trigonometry

Study Time: 30 hrs. Max. Marks: 10

Pre-requisites : Trigonometric ratios of an acute angle.

Content and Extent of coverage

- **Functions**
- Concept of a function
- Domain, codomain and range of a function
- Graphs of functions
- Odd and even functions
- Some important functions

- **Composition of Functions**
- Composition of two or more functions
- Inverse of a Function

- **Trigonometric Ratios**
- Radian measure of angles
- Trigonometric ratios as functions
- Graphs of T-ratios
- Periodicity
- T-ratios of allied angles
- Inverse Trigonometric ratios

- **Addition and Multiplication formulae**
- Addition and subtraction formulae for trigonometric functions
- Sines, Cosines and Tangents of multiples and submultiples
- Solution of simple trigonometric equations

Extended Learning

- **Properties of triangles**
- **Solution of triangles**
- **Properties of inverse functions**
- **Trigonometric equations and their solutions**
- **General solution of Trigonometric equations**

Module 6 : Coordinate Geometry

Study Time: 30 hrs. Max. Marks: 10

Pre-requisites: Number systems and plotting of points on a graph.

Content and Extent of coverage

- **Introduction (Basic concepts)**
- Distance Formula
- Section Formula
- Area of a Triangle

- **Straight Line**
- Equation of a straight line in
- Slope-intercept form
- Two point form
- Point-slope form
- Parametric form
- Intercepts form

- **General equation of first degree and its relationship with straight line**

- **Parallel and Perpendicular Lines**
- Angle between two lines
- Parallel lines
- Perpendicular lines
- Distance of a point from a line
- Distance between two parallel lines
- Family of lines

- **Circle**

- Equation of a circle whose radius and centre are given.

- Equation of a circle in terms of extremities of its diameter.
- General equation of a circle
- Equations of tangents and normals
- Parametric representation of a circle.

- **Conic Sections**

- Acquaintance with equation of parabola and ellipse in standard form
- Eccentricity, directrix and focus

NOTE:

- Problems on lines to include questions of the type $l + \lambda\, l' = 0$
- Conic sections to be introduced through examples of loci and not as a section of a cone.

Extended Learning

- **Locus**
- Advanced examples of loci

- **System of Circles**

- Equation of a family of circles passing through the intersection of two circles
- Condition for orthogonality of circles
- Radical axis of two circles

- **Sections of a cone (Conic sections)**

- Derivation of equations of parabola, ellipse and hyperbola in standard form
- Condition for $y = mx + c$ to be a tangent to these conics
- Point of tangency

- **General second degree equation in two variables**

Condition for it to represent :
- A pair of straight lines
- A circle
- Different conic sections

MODULES 7: Differential Calculus

Study Time: 45 hrs. Max. Marks: 17

Pre-requisites: Trigonometry and Exponential and Logarithmic series

Content and Extent of Coverage

- **Limit and Coverage**

- Notion of limit (left hand and right hand limits)
- Continuity of functions at a point
- Continuity of functions in an interval

- **Differentiation**

- Derivatives from the first principle
- Derivative as instantaneous rate of change
- Geometrical meaning of derivative
- Derivative of sum, difference, product and quotient of functions and chain rule
- Derivatives of algebraic, trigonometric, exponential and logarithmic functions.

- **Monotonicity of functions**

- Monotonicity and sign of the derivative
- Second derivative of a function
- Maxima and Minima

NOTE:

- The concept of monotonic function will be introduced at the appropriate stage.

Extended Learning

- **Differentials and errors**
- **Approximation**
- **Rolle's theorem**
- **Lagrange's mean value theorem**
- **Derivatives of higher orders**
- **Points of inflexion**
- **Concavity and convexity of functions**

MODULE 8 : INTEGRAL CLACULUS

Study Time: 45 hrs. Max. Marks: 17

Pre-requisite : Differential Calculus

Content and Extent of Coverage

- **Introduction to Integral Calculus**
  - Integration as inverse of differentiation
  - Properties of integrals

- **Techniques of Integration**
  - Integration by Substitution
  - Integration by parts
  - Integration using partial fractions

- **Definite Integrals**
  - Idea of definite integral as limit of a sum
  - Geometrical interpretation of definite integrals in simple cases.
  - Properties of definite integrals

(i) $\int_a^b f(x)dx = -\int_b^a f(x)dx$

(ii) $\int_a^b f(x)dx = \int_a^c f(x)dx + \int_c^b f(x)dx$

(iii) $\int_0^{2a} f(x)dx = \int_0^a f(x)dx + \int_0^a f(2a-x)dx$

(iv) $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$

(v) $\int_0^a f(x)dx = \int_0^a f(a-x)dx$

(vi) $\int_0^{2a} f(x)dx = 2\int_0^a f(x)dx$ if $f(2a-x) = f(x)$

$= 0$ if $f(2a-x) = -f(x)$

(vii) $\int_{-a}^a f(x)dx = 2\int_0^a f(x)dx$ if f is an even function of x

$= 0$ if f is an odd function of x

  - Fundamental theorem of Integral Calculus (statement only)
  - Application of definite integrals in finding area under a curve

- **Differential Equations**

  - Notion of differential equation, its order and degree
  - Solution of first order, first degree differential equations

NOTE:

The fact that integral is called primitive, anti-derivative to be specified.

The following types of integrals may be taken up giving appropriate details.

$$\int \frac{dx}{x^2 \pm a^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{a^2 - x^2}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2 + bx + c},$$

$$\int \frac{dx}{\sqrt{ax^2 + bx + c}}, \int \frac{(px+q)dx}{ax^2 + bx + c}, \int \frac{(px+q)dx}{\sqrt{ax^2 + bx + c}},$$

$$\int \sqrt{x^2 \pm a^2}\,dx, \int \sqrt{a^2 - x^2}\,dx, \int e^{ax} \sin bx\,dx,$$

$$\int (px + q)\sqrt{ax^2 + bx + c}\,dx, \int \sin^{-1} x\,dx,$$

$$\int \sin^n x \cos^m x\,dx, \int \frac{dx}{a + b\sin x}, \int \frac{dx}{a + b\cos x}$$

Extended Learning

- **Application of definite integrals in finding the area under a curve**
- **Formation of a differential equation**
- **Higher order differential equations reducible to variable separable cases**

OPTIONAL MODULES
(The learner have to choose any one out three modules)

Module 9 : Statistics and Probability

Study Time: 20 hrs. Max. Marks: 10

Pre-requisites : Mean, median and mode of ungrouped and grouped data.

Content and Extent of coverage

- **Measures of dispersion**
- Range
- Mean deviation
- Variance and standard deviation

- **Random Experiments and Events**
- Ramdom experiments
- Sample space, events
- Types of events, viz. mutually exclusive events and equally likely events

- **Probability**
- Concept of probability
- Use of permutation and combination in probability
- Probability as a function
- Conditional Probability and independent events
- Random variable as a function on sample space.

- **Probability Distribution**
- Introduction to probability distribution
- Binomial distribution
- Expected value of a random variable
- Mean and variance of a Binomial distribution.

NOTE:

- Probability to be explained as the ratio of number of cases favourable to an event and the total number of cases.
- Venn diagrams to be used as frequently as possible to give a pictorial representation of the concepts
- Use of addition theorem when product of event is easily identifiable.

Extended Learning

- **Correlation and regression**
- **Curve fitting (fitting a line)**
- **Mean and variance of Poisson distribution**
- **Bivariate probability distributions.**

Module 10: Vectors & Analytical Solid Geometry

Study hrs. : 20 Max. Marks: 10

Pre-requisites: Knowledge of Two-Dimensional Geometry ,Coordinate Geometry and Trigonometry.

Content and extent of Coverage

- **Vectors**
- Scalars and vectors
- Vectors as directed line segments
- Magnitude and direction of a vector
- Null vector and Unit vector
- Equality of vectors
- Position vector of a point

- **Algebra of vectors**
- Addition and subtraction of vectors and their properties
- Multiplication of a vector by a scalar and their properties

- **Resolution of a vector**
- Resolution of a vector in two dimensions.
- Resolution of a vector in three dimensions
- Section formula

- **Co-ordinates of a point**
- Co-ordinates of a point in space.
- Distance between two points
- Co-ordinates of a division point.
- Direction cosines and projection.
- Condition of parallelism and perpendicularity of two lines.

- **The Plane**

- General equation of a plane.
- Equation of a plane passing through three points.
- Equation of a plane in the normal and intercept form.
- Angle between two planes.
- Plane bisecting angles between two planes.
- Homogeneous Equations of second degree representing two planes.
- Projection and Area of a triangle.
- Volume of tetrahedron.

- **The Straight Line**

- Equation of a line in symmetrical form.
- Deduction of the general equation into symmetrical form.
- Perpendicular distance of a point from a straight line.
- Angle between a line and a plane.
- Condition of coplanarity of two lines.

- **The Sphere**

- Equation of a sphere : Centre-radius form.
- Equation of a sphere through four non coplanar points.
- Diameter form of the equation of a sphere.
- Plane section of a sphere and sphere through a given circle.
- Intersection of a sphere and a line.

Extended Learning

- **Skew lines**
- **Intersection of three planes.**
- **Pole and polar plane in a sphere.**
- **Equation of a cylinder and its properties.**
- **Equation of a cone and its properties.**

Module 11: Linear Programming

Study Time: 20 hrs. Max. Marks: 10

Pre-requisites : Matrices

Content and Extent of coverage

- **Introduction**

- Introduction through a real life problem.
- Solution by graphical method
- General terms used in linear programming (inequation, objective function, convex polygon, feasible solution, optimal solution, etc.)
- Constraints in a linear programming problem
- Feasible and optimal solutions.
- Simplex method.

- **Applications**

- Dual problem
- Assignment problem
- Transportation problem

Extended Learning

- **Product-mix problem**
- **Duality**
- **Simplex method.**