ISC

INDIAN SCHOOL CERTIFICATE EXAMINATION

YEAR 2028



APPLIED MATHEMATICS

(885)

Developed by:
Research, Development and Curriculum Division (RDCD)
CISCE

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Council for the Indian School Certificate Examinations (CISCE)

MISSION STATEMENT

The Council for the Indian School Certificate Examinations is committed to serving the nation's children, through high quality educational endeavours, empowering them to contribute towards a humane, just and pluralistic society, promoting introspective living, by creating exciting learning opportunities, with a commitment to excellence.

ETHOS OF CISCE

- Trust and fair play.
- Minimum monitoring.
- Allowing schools to evolve their own niche.
- Catering to the needs of the children.
- Giving freedom to experiment with new ideas and practices.
- Diversity and plurality - the basic strength for evolution of ideas.
- Schools to motivate pupils towards the cultivation of:
  Excellence - The Indian and Global experience.
  Values - Spiritual and cultural - to be the bedrock of the educational experience.
- Schools to have an 'Indian Ethos', strong roots in the national psyche and be sensitive to national aspirations.

APPLIED MATHEMATICS (885)

This subject may not be taken with Mathematics.

(Note: For candidates who wish to pursue a career in Humanities/ Commerce/ Economics/ Biosciences/ Social Sciences and other related fields.)

Aims

1. To enable candidates to acquire knowledge and to develop an understanding of the terms, concepts, symbols, definitions, principles, processes and formulae of Mathematics at the Senior Secondary stage.
2. To develop the ability to apply the knowledge and understanding of Mathematics to unfamiliar situations or to new problems.
3. To enhance ability of analytical and rational thinking in young minds.
4. To develop mathematical thinking and ability to communicate mathematical ideas logically and precisely.
5. To develop skills of –
   a. Computation.
   b. Logical thinking.
   c. Handling abstractions.
   d. Generalising patterns.
   e. Mathematical modeling to solve real-time problems.
   f. Analysing the data and solving problems using multiple mathematical methods.
   g. Reading and interpreting tables, charts, graphs, etc.
6. To enhance the ability to apply the mathematical skills in interdisciplinary subjects.
7. To develop an appreciation of the role of Mathematics in day-to-day life.
8. To develop a scientific attitude through the study of Mathematics.

CLASS XII

*There will be **two** papers in the subject:*

***Paper I:** Theory (3 hours)…80 marks*

***Paper II:** Project Work……20 marks*

PAPER I (THEORY) : 80 MARKS

Distribution of marks for the theory paper:

S.No.	UNIT	TOTAL WEIGHTAGE
1.	Relations and Functions	6 Marks
2.	Algebra	10 Marks
3.	Calculus	25 Marks
4.	Probability	14 Marks
5.	Linear Programming	5 Marks
6.	Financial Mathematics	14 Marks
7.	Index numbers & Moving averages	6 Marks
	TOTAL	**80 Marks**

1. Relations and Functions

(i) Types of relations: reflexive, symmetric, transitive and equivalence relations. One to one and onto functions, composite function and inverse of a function.

- *Relations as:*
  - *Relation on a set A*
  - *Identity relation, empty relation, universal relation.*
  - *Types of Relations: reflexive, symmetric, transitive and equivalence relation.*
- *Functions:*
  - *As special relations, concept of writing "y is a function of x" as y = f(x).*
  - *Types: one to one, many to one, into, onto.*
  - *Real Valued function.*
  - *Domain and range of a function.*
  - *Conditions of invertibility.*
  - *Sketching of graph of a function and its inverse.*
  - *Composite functions and Invertible functions (algebraic functions only).*

(ii) Inverse Trigonometric Functions

Definition, domain, range, principal value branch. Graphs of inverse trigonometric functions. Elementary properties of inverse trigonometric functions.

- *Principal values.*
- $sin^{-1}x, cos^{-1}x, tan^{-1}x$ *etc.*
- $sin^{-1}x = cos^{-1}\sqrt{1-x^2} = tan^{-1}\frac{x}{\sqrt{1-x^2}}$.

- $sin^{-1}x = \text{cosec}^{-1}\frac{1}{x}$; $sin^{-1}x + cos^{-1}x = \frac{\pi}{2}$ *and similar relations for* $cot^{-1}x$, $tan^{-1}x$, *etc.*

2. Algebra

Matrices and Determinants

(i) Matrices

Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operation on matrices: Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication. Non-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order upto 3). Invertible matrices and proof of the uniqueness of inverse, if it exists (here all matrices will have real entries).

(ii) Determinants

Determinant of a square matrix (up to 3 × 3 matrices), minors, co-factors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix/Cramer's Rule.

- *Types of matrices* ($m \times n$; $m, n \leq 3$), *order; Diagonal matrix, Scalar matrix, Identity matrix, Triangular matrix.*
- *Symmetric, Skew symmetric matrices. Properties of Symmetric, Skew symmetric matrices.*
- *Operation – addition, subtraction, multiplication of a matrix with scalar, multiplication of two matrices (the compatibility).*

  E.g. $\begin{bmatrix} 1 & 1 \\ 0 & 2 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix} = AB(say)$ *but BA is not possible.*

- *Singular and non-singular matrices.*
- *Existence of two non-zero matrices whose product is a zero matrix.*
- *Properties of adjoint of a square matrix.*
- *Inverse* (2×2, 3×3) $A^{-1} = \frac{AdjA}{|A|}$
- *Properties of inverse*

- *Martin's Rule (i.e. using matrices)*

  $a_1x + b_1y + c_1z = d_1$

  $a_2x + b_2y + c_2z = d_2$

  $a_3x + b_3y + c_3z = d_3$

  $$A = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix} \quad B = \begin{bmatrix} d_1 \\ d_2 \\ d_3 \end{bmatrix} \quad X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

  $AX = B \Rightarrow X = A^{-1}B$

  Problems based on above.

NOTE: *The conditions for consistency of equations in two and three variables, using matrices/determinants, are to be covered.*

- *Determinants*
  - *Order.*
  - *Minors.*
  - *Cofactors.*
  - *Expansion.*
  - *Applications of determinants in finding the area of triangle and collinearity.*
  - *Cramer's rule: Solving system of equations of two/three variables.*

3. Calculus

(i) Differentiation, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit functions.

Derivatives of logarithmic and exponential functions. Logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives.

Rate of change, Increasing/ decreasing functions, maxima and minima.

- *Differentiation*
  - *Derivatives of trigonometric and inverse trigonometric functions.*
  - *Derivatives of exponential functions.*
  - *Derivatives of logarithmic functions.*
  - *Derivatives of implicit functions and chain rule.*
  - *Derivatives of Parametric functions.*
  - *Differentiation of a function with respect to another function e.g. differentiation of* $\sin x^3$ *with respect to* x^3.
  - *Logarithmic Differentiation - Finding dy/dx when* $y = x^{x^{x^{\cdots}}}$.
  - *Successive differentiation up to* 2^{nd} *order.*

NOTE: *Derivatives of composite functions using chain rule.*

- *Rate measure.*
- *Increasing and decreasing functions.*
- *Maxima and minima.*
  - *Stationary /turning points,*
  - *First derivatives test and second derivatives test*

(ii) Integrals

Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts, Evaluation of simple integrals of the following types and problems based on them.

Fundamental Theorem of Calculus (without proof). Basic properties of definite integrals and evaluation of definite integrals.

- **Indefinite integral**
  - *Integration as the inverse of differentiation (anti-derivative).*
  - *Anti-derivatives of polynomials and functions* $(ax+b)^n$, $\sin x$, $\cos x$, $\sec^2 x$, $\operatorname{cosec}^2 x$ *etc* .
  - *Integrals of the type* $\sin^2 x$, $\sin^3 x$, $\sin^4 x$, $\cos^2 x$, $\cos^3 x$, $\cos^4 x$.
  - *Integration of* $1/x$, e^x.
  - *Integration by substitution.*
  - *Integrals of the type* $f'(x)[f(x)]^n$, $\dfrac{f'(x)}{f(x)}$.
  - *Integration of tanx, cotx, secx, cosecx.*
  - *Integration by parts.*
  - *Integration using partial fractions.*

    Expressions of the form $\dfrac{f(x)}{g(x)}$ *when degree of f(x) < degree of g(x)*

E.g. $\dfrac{x+2}{(x-3)(x+1)} = \dfrac{A}{x-3} + \dfrac{B}{x+1}$

$$\frac{x+2}{(x-2)(x-1)^2} = \frac{A}{x-1} + \frac{B}{(x-1)^2} + \frac{C}{x-2}$$

$$\frac{x+1}{(x^2+3)(x-1)} = \frac{Ax+B}{x^2+3} + \frac{C}{x-1}$$

When degree of f (x) ≥ degree of g(x), e.g. $\dfrac{x^2+1}{x^2+3x+2} = 1 - \left(\dfrac{3x+1}{x^2+3x+2}\right)$

- *Integrals of the type:*

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

- *Definite Integral*
  - *Fundamental theorem of calculus (without proof)*
  - *Properties of definite integrals.*
  - *Problems based on the following properties of definite integrals are to be covered.*

$$\int_a^b f(x)dx = \int_a^b f(t)dt$$

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

$$\int_a^b f(x)dx = \int_a^c f(x)dx + \int_c^b f(x)dx \qquad \text{where } a < c < b$$

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

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

$$\int_0^{2a} f(x)dx = \begin{cases} 2\int_0^a f(x)dx, if \quad f(2a-x) = f(x) \\ 0, \qquad\quad f(2a-x) = -f(x) \end{cases}$$

$$\int_{-a}^a f(x)dx = \begin{cases} 2\int_0^a f(x)dx, \text{if } f \text{ is an even function} \\ 0, \text{if } f \text{ is an odd function} \end{cases}$$

(iii) Application of Calculus in Commerce and Economics in the following:

- Cost function,
- average cost,
- marginal cost and its interpretation
- demand function,
- revenue function,
- marginal revenue function and its interpretation,
- Profit function and breakeven point.
- Rough sketching of the following curves: AR, MR, R, C, AC, MC and their mathematical interpretation using the concept of maxima & minima and increasing- decreasing functions.
- Identify the region representing C.S. and P.S. graphically. Apply the definite integral to find consumer surplus-producer surplus, etc.
- Problems based on finding -Total cost when Marginal Cost is given - Total Revenue when Marginal Revenue is given -Equilibrium price and equilibrium quantity and hence consumer and producer surplus etc.

Self-explanatory

NOTE: Application involving differentiation, increasing and decreasing function and maxima and minima to be covered.

Application involving integration, definite integration to be covered.

(iv) Differential Equations

Definition, order and degree, general and particular solutions of a differential equation. Solution of differential equations by method of separation of variables.

- *Differential equations, order and degree.*
- *Formation of differential equation by eliminating arbitrary constant(s).*
- *Solution of differential equations.*
- *Variable separable.*
- *Homogeneous equations.*

- *Linear form* $\frac{dy}{dx} + Py = Q$, *where P and Q are functions of x/constant. Similarly, for dx/dy.*

NOTE 1: *Equations reducible to variable separable type are included.*

NOTE 2: *The second order differential equations are excluded.*

4. Probability

Conditional probability, multiplication theorem on probability, independent events, total probability, Bayes' theorem, Random variable and its probability distribution, mean and variance of random variable. Binomial, Poisson and Normal distributions and its application in real life situation. Advantages & disadvantages of each type of distributions.

- *Independent and dependent events conditional events.*
- *Laws of Probability, addition theorem, multiplication theorem, conditional probability.*
- *Theorem of Total Probability.*
- *Bayes' theorem.*
- *Theoretical probability distribution, probability distribution function; mean and variance of random variable.*
- *Binomial distribution*
  - *Bernoulli's trials.*
  - *Binomial distribution*
  - *Mean and variance*
- *Poisson Distribution*
  - *Definition of Poisson distribution*
  - *Characteristics*
  - *Mean and variance*
- *Normal distribution*
  - *Concept of continuous of distribution*
  - *Understanding the normal distribution is a Continuous distribution.*
  - *Standard normal variate*
  - *Mean and Standard deviation.*
  - *Total area under the curve*
  - *Area relationship between Mean and Standard deviation.*

5. Linear Programming

Introduction, related terminology such as constraints, objective function, optimization, different types of linear programming (L.P.) problems, mathematical formulation of L.P. problems, graphical method of solution for problems in two variables, feasible (bounded and unbounded) and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (up to three non-trivial constraints).

- *Introduction, definition of related terminology such as constraints, objective function, optimization, advantages of linear programming; limitations of linear programming; application areas of linear programming; different types of linear programming (L.P.) problems, mathematical formulation of L.P problems, graphical method of solution for problems in two variables, feasible (bounded/ unbounded) and infeasible regions, feasible and infeasible solutions, optimum feasible solution(may/may not exists).*

6. Financial Mathematics

- Perpetuity, Sinking Funds (Meaning). Real life examples of sinking fund. Advantages of sinking fund. Sinking fund vs. Savings account.
- EMI (Methods to calculate EMI (Flat rate method, Reducing balance method). Real life examples to calculate EMI of various types of loans, purchase of assets etc.
- Rate of Return, Nominal rate of return (meaning and use) and their formula.
- Compound Annual Growth Rate (Meaning and use) and their formula.
- Linear Method of Depreciation (Meaning) and its formula. Advantages and disadvantages of Linear Method.

7. Index Numbers and Moving Averages

(i) Index Numbers

- *Price index or price relative.*
- *Simple average of price relatives.*
- *Weighted average of price relatives (cost of living index, consumer price index).*
- *Simple aggregate method.*
- *All types of weighted aggregate index number methods and their advantages/disadvantages with reference to real life situation.*

(ii) Moving Averages

- *Meaning and purpose of the moving averages.*
- *Calculation of moving averages with the given periodicity and plotting them on a graph.*

If the period is even, then the centered moving average is to be found out and plotted.

PAPER II (PROJECT WORK) : 20 MARKS

Candidates will be expected to have completed **two** projects. **The project work will be assessed by the subject teacher and a Visiting Examiner appointed locally and approved by the Council.**

Mark allocation for **each** Project [10 marks]:

Overall format	1 mark
Content	4 marks
Findings	2 marks
Viva-voce based on the Project	3 marks
Total	**10 marks**

List of suggested assignments for Project Work:

1. Using a graph, demonstrate a function which is one-one but not onto.
2. Using a graph demonstrate a function which is invertible.
3. Draw the graph of $y = \sin^{-1} x$ (or any other inverse trigonometric function), using the graph of $y = \sin x$ (or any other relevant trigonometric function). Demonstrate the concept of mirror line (about $y = x$) and find its domain and range.
4. Explore the principal value of the function $\sin^{-1} x$ (or any other inverse trigonometric function) using a unit circle.
5. Find the derivatives of a determinant of the order of 3×3 and verify the same by other methods.
6. Verify the consistency of the system of three linear equations of two variables and verify the same graphically. Give its geometrical interpretation.
7. For a dependent system (non-homogeneous) of three linear equations of three variables, identify infinite number of solutions.
8. Explain the concepts of increasing and decreasing functions, using geometrical significance of dy/dx. Illustrate with proper examples.
9. Explain and illustrate (with suitable examples) the concept of local maxima and local minima using graph.
10. Explain the conditional probability, the theorem of total probability and the concept of Bayes' theorem with suitable examples.
11. Explain the types of probability distributions and derive mean and variance of binomial probability distribution for a given function.
12. Using any suitable data, find the minimum cost by applying the concept of Transportation problem.
13. Using any suitable data, find the minimum cost and maximum nutritional value by applying the concept of Diet problem.
14. Using any suitable data, find the Optimum cost in the manufacturing problem by formulating a linear programming problem (LPP).
15. Draw a rough sketch of Cost (C), Average Cost (AC) and Marginal Cost (MC)

    Or

    Revenue (R), Average Revenue (AR) and Marginal Revenue (MR).

    Give their mathematical interpretation using the concept of increasing - decreasing functions and maxima-

minima.

16. Different methods to calculate depreciation. Main inputs to calculate depreciation. Linear or straight line method to find depreciation with a suitable real life example.
17. Stock price movement.
18. Predicting stock market crash.
19. Risk assessment of insurance farm from data.
20. Identify the purchasing power using the concept of cost of living index number.
21. Identify the purchasing power using the concept of weighted aggregate price index number.
22. Calculate moving averages with the given even Periodicity. Plot them and as well as the original data on the same graph.
23. Real life application of Binomial distribution, Poisson and Normal distribution in the field of medical, games, banking, election result etc.
24. Applications of Sequence and series in Banking and Finance.

NOTE: No question paper for Project Work will be set by the CISCE.

SAMPLE TABLE FOR PROJECT WORK

S. No.	Unique Identification Number (Unique ID) of the candidate	PROJECT 1					PROJECT 2					TOTAL MARKS
		A	B	C	D	E	F	G	H	I	J	
		Teacher	Visiting Examiner	Average Marks (A + B ÷ 2)	Viva-Voce by Visiting Examiner	Total Marks (C + D)	Teacher	Visiting Examiner	Average Marks (F + G ÷ 2)	Viva-Voce by Visiting Examiner	Total Marks (H + I)	(E + J)
		7 Marks*	7 Marks*	7 Marks	3 Marks	10 Marks	7 Marks*	7 Marks*	7 Marks	3 Marks	10 Marks	20 Marks
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

*Breakup of 7 Marks to be awarded separately by the Teacher and the Visiting Examiner is as follows:		Name of Teacher: Signature: Date
Overall Format	1 Mark	
Content	4 Marks	Name of Visiting Examiner Signature: Date
Findings	2 Marks	

NOTE: VIVA-VOCE (3 Marks) for each Project is to be conducted only by the Visiting Examiner, and should be based on the Project only.