ITL PUBLIC SCHOOL

Active Engagement of Young Minds during Summer Vacations 2026-27

Class :XII **Subject: MATHEMATICS**

(I) Project Title: Statistical Study on Childhood Obesity and BMI ,along with suggestive measures through AI.

Introduction

Childhood obesity is a growing concern in urban areas like Delhi due to sedentary lifestyles and unhealthy diets. One of the most widely used measures to assess obesity is the Body Mass Index (BMI). In this project, we will perform a statistical analysis of BMI data collected from school children in Delhi to explore trends and insights related to obesity.

Objectives

- Understand BMI and its calculation
- Analyze BMI data of 50 children.
- Categorize students into weight groups using BMI
- Use statistical tools: **mean, median, mode, range, pie chart, bar graph, histogram**
- Use the concept of **Matrices** and interpret the data
- Draw conclusions based on data trends

Section 1: Understanding BMI

BMI = Weight (kg) / [Height (m)]^2

BMI Categories for Children (approximate for ages 5–15)

BMI Range	Category
< 18.5	Underweight
18.5–24.9	Normal Weight
25–29.9	Overweight
≥ 30	Obese

Section 2: Sample Data of 20 Students

Student	Height (m)	Weight (kg)	BMI	Category
1	1.52	40	17.3	Underweight
2	1.60	52	20.3	Normal
3	1.55	63	26.2	Overweight
4	1.50	68	30.2	Obese
5	1.48	45	20.5	Normal

Section 3: Categorization Summary

Category	Number of Students
Underweight	4
Normal Weight	8
Overweight	4
Obese	4

Section 4: Statistical Measures (BMI values)

BMI List (rounded):
17.3, 20.3, 26.2, 30.2, 20.5, 24.0, 26.4, 30.5, 19.2, 22.9, 15.6, 16.2, 20.5, 30.7, 25.8, 18.4, 20.9, 30.8, 19.8, 25.2

1. Mean (Average) - Sum of all BMI values/20
2. Median
3. Mode - Most frequent BMI
4. Range – Difference of the highest and lowest value
5. Collate the data in **Matrix Form**

Section 5: Graphical Representation

1. Pie Chart – Weight Categories

Use % values:

- Underweight: 4/20 = 20%
- Normal: 8/20 = 40%
- Overweight: 4/20 = 20%
- Obese: 4/20 = 20%

2. Bar Graph – BMI Category Distribution

X-axis: Category
Y-axis: Number of Students
3. Histogram – BMI Values

- Group BMI values into intervals:
  - 15–17, 17–19, 19–21, 21–23, 23–25, 25–27, 27–29, 29–31
- Count how many values fall in each interval and draw the histogram.

Section 6: Interpretation &Conclusion

- The **average BMI** was **______**, which borders on the _______ category.
- **______% of students** are of normal weight, while **______% are overweight or obese**.
- The **most common BMI** was _______
- The study shows that:____
- Comment on the health implications of your findings.
- Include personal reflections and suggestions on promoting a healthy lifestyle

Mathematical Concepts Used

- Statistics (Mean, Median, Mode, Range)
- Graphs: Pie chart, Bar graph, Histogram
- BMI formula and analysis
- Data interpretation
- Concept of Matrices

AI-Based Fitness Applications

Many fitness apps use AI to:

- Count calories
- Track exercise
- Monitor sleep
  Suggest healthy diets Examples include:
- Smart watches
- Fitness bands
- Mobile health apps

(II) Complete the given 10 activities in the Maths Activity File

(III) Practice the assignment given below:

Chapter – 2 Inverse Trigonometric Functions

1 MARK MCQ

1) The value of $\cos^{-1}\left(\cos\frac{5\pi}{3}\right)+\sin^{-1}\left(\sin\frac{5\pi}{3}\right)$ is

(a) $\frac{\pi}{2}$ (b) $\frac{5\pi}{3}$ (c) $\frac{10\pi}{3}$ (d) 0

2) $\sin\left\{2\cos^{-1}\left(\frac{-3}{5}\right)\right\}$ is equal to

(a) $\frac{6}{25}$ (b) $\frac{24}{25}$ (c) $\frac{4}{5}$ (d) $-\frac{24}{25}$

1/2 Marks Questions

1) Evaluate: $\sin\left[\frac{\pi}{3}-\sin^{-1}\left(-\frac{1}{2}\right)\right]$

2) Using principal value, evaluate the following: $\cos^{-1}\left(\cos\frac{2\pi}{3}\right)+\sin^{-1}\left(\sin\frac{2\pi}{3}\right)$.

3) Find the principal value of $\operatorname{cosec}^{-1}\left(-\sqrt{2}\right)$.

4) Find the value of $\tan^{-1}\left(\tan\frac{3\pi}{4}\right)$.

5) Find the value of $\cos^{-1}\left(\cos\frac{7\pi}{6}\right)$.

Chapter – 3 Matrices

1 MARK MCQ

1) If $A=\begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$, $n \in N$, then A^{4n} equals

(a) $\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$

2) If $A=\begin{bmatrix} \alpha & \beta \\ \gamma & -\alpha \end{bmatrix}$ is such that $A^2 = I$, then

(a) $1 + \alpha^2 + \beta\gamma = 0$ (b) $1 - \alpha^2 + \beta\gamma = 0$ (c) $1 - \alpha^2 - \beta\gamma = 0$ (d) $1 + \alpha^2 - \beta\gamma = 0$

3) If $A=\begin{bmatrix} n & 0 & 0 \\ 0 & n & 0 \\ 0 & 0 & n \end{bmatrix}$ and $B=\begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}$, then AB is equal to

(a) B (b) nB (c) B^n (d) A + B

4) If $A = \begin{bmatrix} 1 & a \\ 0 & 1 \end{bmatrix}$, then A^n (where $n \in N$) equals

(a) $\begin{bmatrix} 1 & na \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & n^2a \\ 0 & 1 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & na \\ 0 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} n & na \\ 0 & n \end{bmatrix}$

5) If A is a 3 × 4 matrix and B is a matrix such that A’B and B’A are both defined. Then, B is of the type

(a) 3 × 4 (b) 3 × 3 (c) 4 × 4 (d) 4 × 3

<u>1/2 Marks Questions</u>

1. If $\begin{bmatrix} x+3 & 4 \\ y-4 & x+y \end{bmatrix} = \begin{bmatrix} 5 & 4 \\ 3 & 9 \end{bmatrix}$, find x and y.
2. If $X_{m\times 3}Y_{p\times 4} = Z_{2\times b}$, for three matrices X, Y, Z, find the values of m,p and b.
3. If $\begin{pmatrix} 0 & a \\ 0 & 0 \end{pmatrix}$, find A^{16}.
4. Evaluate: $\begin{bmatrix} \sin^2\theta & 1 \\ \cot^2\theta & 0 \end{bmatrix} + \begin{bmatrix} \cos^2\theta & 0 \\ -\operatorname{cosec}^2\theta & 1 \end{bmatrix} + \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$
5. Evaluate the following: $\begin{bmatrix} a & b \end{bmatrix}\begin{bmatrix} c \\ d \end{bmatrix} + \begin{bmatrix} a & b & c & d \end{bmatrix}\begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix}$
6. Show that the elements on the main diagonal of a skew-symmetric matrix are all zeros.
7. If $A' = \begin{bmatrix} -2 & 3 \\ 1 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} -1 & 0 \\ 1 & 2 \end{bmatrix}$, then find $(A+2B)'$.
8. Show that the matrix $B'AB$ is symmetric or skew-symmetric according as A is symmetric or skew-symmetric.
9. If $f(x) = 3x^2 - 9x + 7$, then for a square matrix A, write $f(A)$.
10. The total number of elements in a matrix represents a prime number. How many possible orders a matrix can have?

<u>4/6 Mark Questions</u>

1. Find the values of x, y, z: if the matrix $A = \begin{bmatrix} 0 & 2y & z \\ x & y & -z \\ x & -y & z \end{bmatrix}$ obeys the law $A'A = I$.
2. If $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$, show that $A^2 - 5A + 7I = 0$.
3. Find X such that, $X\begin{bmatrix} 5 & -7 \\ -2 & 3 \end{bmatrix} = \begin{bmatrix} -16 & -6 \\ 7 & 2 \end{bmatrix}$
4. If $A = \begin{bmatrix} 1 \\ -5 \\ 7 \end{bmatrix}$, $B = \begin{bmatrix} 3 & 1 & -2 \end{bmatrix}$, verify that $(AB)' = B'A'$.
5. If $A = \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$, show that $f(x) = x^2 - 2x - 3$, show that $f(A) = 0$.

6. Express the following matrix as the sum of a symmetric and a skew-symmetric matrix: $\begin{bmatrix} 1 & 3 & 5 \\ -6 & 8 & 3 \\ -4 & 6 & 2 \end{bmatrix}$

7. If $A = \begin{bmatrix} 1 & 2 \\ 4 & 1 \end{bmatrix}$, find the value of $A^2 + 2A + 7I$.

8. If $A = \begin{pmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{pmatrix}$, then show that $A^2 = \begin{pmatrix} \cos 2\alpha & \sin 2\alpha \\ -\sin 2\alpha & \cos 2\alpha \end{pmatrix}$

9. Find the matrix X such that $\begin{bmatrix} 2 & -1 \\ 0 & 1 \\ -2 & 4 \end{bmatrix} X = \begin{bmatrix} -1 & -8 & -10 \\ 3 & 4 & 0 \\ 10 & 20 & 10 \end{bmatrix}$

Chapter – 4 Determinants

1 Mark MCQ

1) If A and B are square matrices of order 2, then det(A + B) = 0 is possible only when

(a) det(A) = 0 or det (B) = 0 (b) det(A) + det (B) = 0

(c) det(A) = 0 and det(B) = 0 (d) A + B = 0

2) The matrix $\begin{bmatrix} 5 & 10 & 3 \\ -2 & -4 & 6 \\ -1 & -2 & b \end{bmatrix}$ is a singular matrix, if the value of b is

(a) -3 (b) 3 (c) 0 (d) non-existent

3) Let $X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$, $A = \begin{bmatrix} 1 & -1 & 2 \\ 2 & 0 & 1 \\ 3 & 2 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 3 \\ 1 \\ 4 \end{bmatrix}$. If AX = B, then X is equal to

(a) $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ (b) $\begin{bmatrix} -1 \\ -2 \\ -3 \end{bmatrix}$ (c) $\begin{bmatrix} 0 \\ 2 \\ 1 \end{bmatrix}$ (d) $\begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$

1/2 Mark Questions

1. If $\begin{vmatrix} x+2 & 3 \\ x+5 & 4 \end{vmatrix} = 3$, the value of x is …..

2. Evaluate: $\begin{vmatrix} a+ib & c+id \\ -c+id & a-ib \end{vmatrix}$.

3. Given determinant $\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}$. Find the value of $a_{11}C_{21} + a_{12}C_{22} + a_{13}C_{33}$.

4. Find the value of p, such that the matrix $\begin{bmatrix} -1 & 2 \\ 4 & p \end{bmatrix}$ is singular.

5. For the two given square matrices A and B of the same order, such that $|A| = 20$ and $|B| = -20$, then $|AB|$.……

6. Find the inverse of the matrix $\begin{bmatrix} 1 & 3 \\ -6 & -18 \end{bmatrix}$, is possible.

7. If $A = \begin{pmatrix} x & 0 & 1 \\ 2 & -1 & 4 \\ 1 & 2 & 0 \end{pmatrix}$ is a singular matrix, find *x*.

8. Find the value of *x*, if area of triangle is 35 square cms with vertices (*x*,4), (2, -6) and (5, 4).

9. If for matrix A, $|A| = 3$, find $|5A|$, where matrix A is of order 2×2.

10. Given $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$, such that $|A| = -10$. Find $a_{11}C_{11} + a_{12}C_{12}$.

11. A is a non-singular matrix of order 3 and |A| = - 4. Find |adj.A|.

12. Given a square matrix A of order 3×3, such that |A| = 12, find the value of |A.adj.A|.

<u>4/6 Mark Questions</u>

1. Find a matrix A such that $\begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix} A \begin{bmatrix} 0 & 2 \\ 1 & 3 \end{bmatrix} = \begin{bmatrix} 1 & 6 \\ 3 & -2 \end{bmatrix}$.

2. Given two matrices $A = \begin{bmatrix} 1 & -1 & 0 \\ 2 & 3 & 4 \\ 0 & 1 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 2 & -4 \\ -4 & 2 & -4 \\ 2 & -1 & 5 \end{bmatrix}$ verify that *BA* = *6I*. Use the result to solve the system $x - y = 3;\quad 2x + 3y + 4z = 17;\quad y + 2z = 7.$

3. Using matrices, solve the following system of equations:
$$x + 2y + z = 7$$
$$x + 3z = 11$$
$$2x - 3y = 1$$

4. Find a matrix A such that $\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix} A \begin{bmatrix} -3 & 2 \\ 5 & -3 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

5. Using matrix method, solve the following system of equations for *x*,*y* and *z*:
$$\frac{2}{x} + \frac{3}{y} + \frac{10}{z} = 4$$
$$\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 10$$
$$\frac{3}{x} - \frac{1}{y} + \frac{2}{z} = 13$$

6. Using matrix method, solve the following system of equations:
$$2x - y + 2z = 3$$
$$2x + y + z = -1$$
$$x - 3y + 2z = 6$$

7. For a matrix $A = \begin{bmatrix} 3 & 2 \\ 1 & 1 \end{bmatrix}$, find the numbers *a* and *b* such that $A^2 + aA + bI = O$. Hence find A^{-1}.

Chapter 5 DIFFERENTIATION

1 MARKS MCQ

1. If x = at², y = 2 at, then $\frac{d^2y}{dx^2} =$

(a) $-\frac{1}{t^2}$ (b) $\frac{1}{2at^3}$ (c) $-\frac{1}{t^3}$ (d) $-\frac{1}{2at^3}$

2. If $f(x) = \frac{\sin^{-1} x}{\sqrt{1-x^2}}$, then $(1 – x^2)$ f"(x) – xf(x) =

(a) 1 (b) -1 (c) 0 (d) none of these

3. If $y = \log\left(\frac{1-x^2}{1+x^2}\right)$, then $\frac{dy}{dx} =$

(a) $\frac{4x^3}{1-x^4}$ (b) $-\frac{4x}{1-x^4}$ (c) $\frac{1}{4-x^4}$ (d) $\frac{4x^3}{1-x^4}$

4. If $y = \tan^{-1}\left(\frac{\sin x + \cos x}{\cos x - \sin x}\right)$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{1}{2}$ (b) 0 (c) 1 (d) none of these

1 /2 Mark Questions

1. Differentiate ,$\cos^{-1}\sqrt{x}$,w.r.t x.
2. Differentiate w.r.t x: y = $\log_7$ (logx)
3. Given $f(0) = -2$, $f'(0) = 3$. Find $h'(0)$ where $h(x) = xf(x)$
4. Find dy/dx when y = $\sin x^0$

4/6 Mark Questions

1. If y = $\frac{\sin^{-1} x}{\sqrt{1-x^2}}$, show that $(1-x^2)\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} - y = 0$
2. Differentiate the following w.r.t x: $x^{\sin x} + (\sin x)^{\cos x}$
3. Find $\frac{dy}{dx}, y = \sin^{-1}(x\sqrt{1-x} - \sqrt{x}\sqrt{1-x^2})$
4. If y = $e^{a\sin^{-1} x}$, $-1 \le x \le 1$, then show that $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - a^2 y = 0$
5. If $x = a(\theta - \sin\theta), y = a(1-\cos\theta)$, find $\frac{d^2y}{dx^2}$ at $\theta = \pi/2$
6. If $y = x^x$ show that $\frac{d^2y}{dx^2} - \frac{1}{y}\left(\frac{dy}{dx}\right)^2 - \frac{y}{x} = 0$
7. If x = a sin2t (1+cos2t) and y = bcos 2t (1-cos2t), show that $\left(\frac{dy}{dx}\right) = \frac{b}{a}$ at t=$\pi/4$ and also find $\left(\frac{d^2y}{dx^2}\right)$ at t = $\pi/4$

8. If $\sqrt{1-x^6}+\sqrt{1-y^6} = a^3(x^3-y^3)$, prove that $\frac{dy}{dx}=\frac{x^2}{y^2}\sqrt{\frac{1-y^6}{1-x^6}}$

9. If $f(x)=\lambda x^2+\mu x+12$, $f'(4)=15$ and $f'(2)=11$, *then* find λ and μ

10. If $y=\sqrt{\frac{(x-3)(x^2+4)}{3x^2+4x+5}}$, find $\frac{dy}{dx}$

11. If $y = \log(x+\sqrt{x^2+1})$, then prove that $(x^2+4)\frac{d^2y}{dx^2}+x\frac{dy}{dx}=0$

12. If $x = \sin(\frac{1}{a}\log y)$, then show that $(1-x^2)y_2 - xy_1 - a^2 y = 0$

13. If $y = \tan^{-1}\frac{\sqrt{1+x^2}+\sqrt{1-x^2}}{\sqrt{1+x^2}-\sqrt{1-x^2}}$, then show that $\frac{dy}{dx}=-\frac{x}{\sqrt{1-x^4}}$

14. If $x^y=e^{x-y}$, prove that $\frac{dy}{dx}=\frac{\log x}{(1+\log x)^2}$

If $y = b\tan^{-1}\left\{\frac{x}{a}+\tan^{-1}\left(\frac{y}{x}\right)\right\}$, find $\frac{dy}{dx}$

15. Given that cosx/2 .cosx/4.cosx/8……..$=\frac{\sin x}{x}$, prove that

$$\frac{1}{2^2}\sec^2\frac{x}{2}+\frac{1}{2^4}\sec^2\frac{x}{4}+\frac{1}{2^6}\sec^2\frac{x}{8}+\ldots\ldots\ldots = \operatorname{cosec}^2 x-\frac{1}{x^2}$$

16. Let $f(x)=\begin{cases}\frac{b(1-\sin x)}{(\pi-2x)^2}, if : x>\pi/2\\ a, if : x=\pi/2\\ \frac{1-\sin^3 x}{3\cos^2 x}, if : x<\pi/2\end{cases}$, if f(x) be a continuous function at x = $\pi/2$, find a and b.

17. Let $f(x)=\begin{cases}\frac{1-\cos 4x}{x^2}, x<0\\ a, x=0\\ \frac{\sqrt{x}}{\sqrt{16+\sqrt{x}}-4}, x>0\end{cases}$ For what value of a, is f continuous at x = 0?

18. Determine the value of a,b,c for which the function

$$f(x)=\begin{cases}\frac{\sin(a+1)x+\sin x}{x}, x<0\\ c, x=0\\ \frac{\sqrt{x+bx^2}-\sqrt{x}}{b\sqrt{x^3}}, x<0\end{cases}$$ may be continuous at x = 0

Chapter 6 Application of Derivatives

1 Mark MCQ

1. The radius of a sphere is changing at the rate of 0.1 cm/sec. The rate of change of its surface area when the radius is 200 cm is

   (a) $8\pi cm^2/sec$ (b) $12\pi cm^2/sec$ (c) 160π cm^2/sec (d) $200cm^2/sec$

2. The coordinates of the point on the ellipse $16x^2 + 9y^2 = 400$ where the ordinate decreases at the same rate at which the abscissa increases, are

   (a) (3, 16/3)   (b) (-3, 16/3)   (c) (3, -16/3)   (d) (3,-3)

3. The function $f(x) = x^9 + 3x^7 + 64$ is increasing on

   (a) R   (b) $(-\infty, 0)$ (c) $(0, \infty)$ (d) R_0

1/2 Mark Questions

1. Find the rate of change of area of a square when its side is increasing at the rate of 2cm/min and the length of the side is 10 cm.
2. The total revenue received from the sale of x units of a product is given by
   $R(x) = 3x^2 + 36x + 5$. Find the marginal revenue when x = 5.

4/6 Mark Questions

1. Find the intervals in which the function f(x) is increasing or decreasing:
   (1) $f(x) = 2x^3 - 9x^2 + 12x + 15$ (2) $f(x) = x^3 - 12x^2 + 36x + 17$
   (3) $f(x) = \sin x - \cos x, 0 < x < 2\pi$
2. Find the interval(s) for which the function f(x) = $\log(2+x) - \frac{2x}{2+x}$ is increasing or decreasing
3. Water is running into a conical tank of height 10m and diameter 10m at the top, at a constant rate of $18m^3/\text{min}$. How fast is the water rising in the tank at any instant?
4. Find the intervals in which the function is increasing or decreasing: $f(x) = x^4 - 8x^3 + 22x^2 - 24x + 21$.
5. Find the intervals in which the function is increasing or decreasing: $f(x) = \frac{4\sin x - 2x - x\cos x}{2 + \cos x}$.
6. An open box with a square base is to be made out of a given quantity of sheet of area a^2. Show that the maximum volume of the box is $\frac{a^3}{6\sqrt{3}}$.
7. A window is in the form of a rectangle above which there is a semicircle. If the perimeter of the window is p cm. Show that the window will allow the maximum possible light only when the radius of the semicircle is $\frac{p}{\pi + 4}$ cm.
8. A large spherical balloon is inflated by pumping in $16m^3$/sec of gas.. At the instant when the balloon contains $36\pi m^3$ of gas, how fast is the radius increasing.
9. Find the absolute maximum or minimum of the function given by $f(x) = \cos^2 x + \sin x, x \in [0, \pi]$.
10. Show that the altitude of a right circular cone of maximum volume that can be inscribed in a sphere of radius r is 4r/3.
11. Show that the volume of greatest cylinder which can be inscribed in a cone of height h and semi-vertical angle 30^0 is $\frac{4}{81}\pi h^3$.
12. Show that the rectangle of maximum area that can be inscribed in a circle of radius r is a square of side $\sqrt{2}$ r.
13. Show that the altitude of a right circular cone of maximum volume that can be inscribed in a sphere of radius r is $\frac{4r}{3}$.