Higher Secondary Plus Two 2026 Mathematics Question Paper with Solutions(Memory Based)

Time Allowed :2 Hour 30 Mins	Maximum Marks :80	Total Questions :20

General Instructions

Read the following instructions very carefully and strictly follow them:

- The exam lasts 150 minutes (2 hours 30 minutes), including a 15-minute "cool-off time".
- Use the 15-minute "cool-off time" to read the question paper and plan your answers. You are not allowed to write during this period.
- The total score for the theory paper is 80 marks.
- There is no negative marking for incorrect answers; therefore, it is advisable to attempt all questions.
- The question paper is divided into multiple sections (A, B, C, and D) featuring very short, short, and long answer types.
- Internal choices are provided in most sections, such as "answer any 6 out of 8" or "any 3 out of 4".
- Question papers are available in both English and Malayalam versions.
- Calculators, mobile phones, and other electronic gadgets are strictly prohibited inside the examination hall.
- All rough work should be done on the space provided in the answer sheet itself.

1. Express the matrix $A = \begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & -3 \end{bmatrix}$ as a sum of symmetric and skew-symmetric matrices.

Solution:
Concept: Any square matrix A can be written as:

$$A = \frac{1}{2}(A + A^T) + \frac{1}{2}(A - A^T)$$

where:

- $\frac{1}{2}(A + A^T)$ is symmetric
- $\frac{1}{2}(A - A^T)$ is skew-symmetric

Step 1: Find transpose of A.

$$A^T = \begin{bmatrix} 2 & -1 & 1 \\ -2 & 3 & -2 \\ -4 & 4 & -3 \end{bmatrix}$$

Step 2: Compute symmetric part.

$$A + A^T = \begin{bmatrix} 4 & -3 & -3 \\ -3 & 6 & 2 \\ -3 & 2 & -6 \end{bmatrix}$$

$$\frac{1}{2}(A + A^T) = \begin{bmatrix} 2 & -\frac{3}{2} & -\frac{3}{2} \\ -\frac{3}{2} & 3 & 1 \\ -\frac{3}{2} & 1 & -3 \end{bmatrix}$$

Step 3: Compute skew-symmetric part.

$$A - A^T = \begin{bmatrix} 0 & -1 & -5 \\ 1 & 0 & 6 \\ 5 & -6 & 0 \end{bmatrix}$$

$$\frac{1}{2}(A - A^T) = \begin{bmatrix} 0 & -\frac{1}{2} & -\frac{5}{2} \\ \frac{1}{2} & 0 & 3 \\ \frac{5}{2} & -3 & 0 \end{bmatrix}$$

Step 4: Final expression.

$$A = \begin{bmatrix} 2 & -\frac{3}{2} & -\frac{3}{2} \\ -\frac{3}{2} & 3 & 1 \\ -\frac{3}{2} & 1 & -3 \end{bmatrix} + \begin{bmatrix} 0 & -\frac{1}{2} & -\frac{5}{2} \\ \frac{1}{2} & 0 & 3 \\ \frac{5}{2} & -3 & 0 \end{bmatrix}$$

Step 5: Conclusion.
Thus, A is expressed as the sum of a symmetric and a skew-symmetric matrix.

Quick Tip

Remember: $A = \frac{1}{2}(A + A^T) + \frac{1}{2}(A - A^T)$ always works.

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2. Find the shortest distance between the lines $\vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}) + \lambda(\hat{i} - 3\hat{j} + 2\hat{k})$ and $\vec{r} = (4\hat{i} + 5\hat{j} + 6\hat{k}) + \mu(2\hat{i} + 3\hat{j} + \hat{k})$.

Solution:
Concept: The shortest distance between two skew lines is given by:

$$\text{Distance} = \frac{|(\vec{a_2} - \vec{a_1}) \cdot (\vec{b_1} \times \vec{b_2})|}{|\vec{b_1} \times \vec{b_2}|}$$

where $\vec{a_1}, \vec{a_2}$ are points on the lines and $\vec{b_1}, \vec{b_2}$ are direction vectors.

Step 1: Identify vectors.

$$\vec{a_1} = (1, 2, 3), \quad \vec{b_1} = (1, -3, 2)$$
$$\vec{a_2} = (4, 5, 6), \quad \vec{b_2} = (2, 3, 1)$$

Step 2: Compute $\vec{a_2} - \vec{a_1}$.

$$\vec{a_2} - \vec{a_1} = (3, 3, 3)$$

Step 3: Find cross product $\vec{b_1} \times \vec{b_2}$.

$$\vec{b_1} \times \vec{b_2} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -3 & 2 \\ 2 & 3 & 1 \end{vmatrix}$$

$$= \hat{i}((-3)(1) - (2)(3)) - \hat{j}((1)(1) - (2)(2)) + \hat{k}((1)(3) - (-3)(2))$$

$$= \hat{i}(-3 - 6) - \hat{j}(1 - 4) + \hat{k}(3 + 6)$$

$$= (-9)\hat{i} + 3\hat{j} + 9\hat{k}$$

Step 4: Dot product.

$$(\vec{a_2} - \vec{a_1}) \cdot (\vec{b_1} \times \vec{b_2}) = (3, 3, 3) \cdot (-9, 3, 9)$$
$$= -27 + 9 + 27 = 9$$

Step 5: Magnitude of cross product.

$$|\vec{b_1} \times \vec{b_2}| = \sqrt{(-9)^2 + 3^2 + 9^2} = \sqrt{81 + 9 + 81} = \sqrt{171}$$

Step 6: Final distance.

$$\text{Distance} = \frac{|9|}{\sqrt{171}} = \frac{9}{\sqrt{171}}$$

Step 7: Simplified form.

$$\text{Distance} = \frac{3}{\sqrt{19}}$$

Step 8: Conclusion.
Thus, the shortest distance between the given lines is $\frac{3}{\sqrt{19}}$.

Quick Tip

Remember: Shortest distance (skew lines) $= \frac{|(\vec{a_2} - \vec{a_1}) \cdot (\vec{b_1} \times \vec{b_2})|}{|\vec{b_1} \times \vec{b_2}|}$.

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3. Solve the LPP graphically: Minimize $Z = 5x + 10y$ subject to $x + 2y \leq 120$, $x + y \geq 60$, $x, y \geq 0$.

Solution:
Concept: In graphical method, we:

- Convert inequalities into equations
- Plot lines and find feasible region
- Evaluate objective function at corner points

Step 1: Convert constraints to equations.

$$x + 2y = 120 \quad \text{(Line 1)}$$
$$x + y = 60 \quad \text{(Line 2)}$$

Step 2: Find intercepts.
For $x + 2y = 120$:

$$(120, 0), \quad (0, 60)$$

For $x + y = 60$:

$$(60, 0), \quad (0, 60)$$

Step 3: Feasible region.
Region satisfies:

$$x + 2y \leq 120, \quad x + y \geq 60, \quad x, y \geq 0$$

Step 4: Corner points.

$$A(60, 0), \quad B(120, 0), \quad C(0, 60)$$

Step 5: Evaluate objective function.

$$Z = 5x + 10y$$

At $A(60, 0)$:

$$Z = 5(60) = 300$$

At $B(120, 0)$:

$$Z = 600$$

At $C(0, 60)$:

$$Z = 600$$

Step 6: Minimum value.

$$Z_{\text{min}} = 300 \text{ at } (60, 0)$$

Step 7: Conclusion.
The minimum value of Z is 300 at $(x, y) = (60, 0)$.

Quick Tip

Remember: For minimization, check all corner points of feasible region.

4. Prove that the function $f(x) = |x|$ is continuous but not differentiable at $x = 0$.

Solution:
Concept: A function is continuous at a point if left-hand limit (LHL), right-hand limit (RHL), and function value are equal. It is differentiable if left-hand derivative (LHD) equals right-hand derivative (RHD).
Step 1: Definition of $|x|$.

$$|x| = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$$

Step 2: Check continuity at $x = 0$.

LHL:

$$\lim_{x \to 0^-} |x| = \lim_{x \to 0^-} (-x) = 0$$

RHL:

$$\lim_{x \to 0^+} |x| = \lim_{x \to 0^+} x = 0$$

Function value:

$$f(0) = |0| = 0$$

Since LHL = RHL = $f(0)$, the function is continuous at $x = 0$.
Step 3: Check differentiability at $x = 0$.

LHD:

$$\lim_{h \to 0^-} \frac{|h| - 0}{h} = \lim_{h \to 0^-} \frac{-h}{h} = -1$$

RHD:

$$\lim_{h \to 0^+} \frac{|h| - 0}{h} = \lim_{h \to 0^+} \frac{h}{h} = 1$$

Step 4: Compare derivatives.

$$\text{LHD} = -1 \neq 1 = \text{RHD}$$

Step 5: Conclusion.
Since LHD $\neq$ RHD, the function is not differentiable at $x = 0$.

$$\boxed{f(x) = |x| \text{ is continuous but not differentiable at } x = 0}$$

Quick Tip

Remember: Sharp corner (cusp) $\to$ continuous but not differentiable.

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5. Evaluate $\displaystyle\int \frac{dx}{\sqrt{x^2 + 2x + 2}}$.

Solution:
Concept: Use completing the square to simplify the expression inside the square root and then apply standard integral formulas.
Step 1: Complete the square.

$$x^2 + 2x + 2 = (x+1)^2 + 1$$

Step 2: Substitute.
Let $u = x + 1 \Rightarrow du = dx$

$$\int \frac{dx}{\sqrt{x^2+2x+2}} = \int \frac{du}{\sqrt{u^2+1}}$$

Step 3: Use standard formula.

$$\int \frac{du}{\sqrt{u^2+1}} = \ln \left| u + \sqrt{u^2+1} \right| + C$$

Step 4: Substitute back.

$$= \ln \left| x + 1 + \sqrt{x^2+2x+2} \right| + C$$

Step 5: Conclusion.

$$\boxed{\int \frac{dx}{\sqrt{x^2+2x+2}} = \ln \left| x + 1 + \sqrt{x^2+2x+2} \right| + C}$$

Quick Tip

Remember: $\int \frac{dx}{\sqrt{x^2+a^2}} = \ln|x + \sqrt{x^2+a^2}| + C$.

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6. Find the area of the region bounded by the curve $y^2 = x$ and the lines $x = 1$, $x = 4$ and the x-axis.

Solution:
Concept: The curve $y^2 = x$ represents a right-opening parabola. Since the region is bounded by the x-axis, we take the upper branch:

$$y = \sqrt{x}$$

Step 1: Set up the integral.
Area between curve and x-axis from $x = 1$ to $x = 4$:

$$A = \int_1^4 \sqrt{x}\, dx$$

Step 2: Integrate.

$$\int \sqrt{x}\, dx = \int x^{1/2} dx = \frac{2}{3} x^{3/2}$$

Step 3: Apply limits.

$$A = \left[\frac{2}{3}x^{3/2}\right]_1^4$$

$$= \frac{2}{3}\left(4^{3/2} - 1^{3/2}\right)$$

$$4^{3/2} = (\sqrt{4})^3 = 2^3 = 8$$

$$A = \frac{2}{3}(8-1) = \frac{2}{3} \times 7 = \frac{14}{3}$$

Step 4: Conclusion.

$$\boxed{\text{Area} = \frac{14}{3} \text{ square units}}$$

Quick Tip

Remember: For $y^2 = x$, use $y = \sqrt{x}$ when area is above x-axis.

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7. If $P(E) = 0.6$, $P(F) = 0.3$ and $P(E \cap F) = 0.2$, find $P(E|F)$ and $P(F|E)$.

Solution:
Concept: Conditional probability is given by:

$$P(E|F) = \frac{P(E \cap F)}{P(F)}, \quad P(F|E) = \frac{P(E \cap F)}{P(E)}$$

Step 1: Calculate $P(E|F)$.

$$P(E|F) = \frac{0.2}{0.3} = \frac{2}{3}$$

Step 2: Calculate $P(F|E)$.

$$P(F|E) = \frac{0.2}{0.6} = \frac{1}{3}$$

Step 3: Conclusion.

$$\boxed{P(E|F) = \frac{2}{3}, \quad P(F|E) = \frac{1}{3}}$$

Quick Tip

Remember: $P(A|B) = \frac{P(A \cap B)}{P(B)}$.

8. Solve the differential equation $\frac{dy}{dx} + \frac{y}{x} = x^2$.

Solution:
Concept: This is a linear differential equation of the form:

$$\frac{dy}{dx} + P(x)y = Q(x)$$

where $P(x) = \frac{1}{x}$ and $Q(x) = x^2$.
Step 1: Find the integrating factor (I.F.).

$$\text{I.F.} = e^{\int P(x)\,dx} = e^{\int \frac{1}{x}dx} = e^{\ln x} = x$$

Step 2: Multiply both sides by I.F.

$$x\frac{dy}{dx} + y = x^3$$

Step 3: Recognize LHS as derivative.

$$\frac{d}{dx}(xy) = x^3$$

Step 4: Integrate both sides.

$$xy = \int x^3 dx = \frac{x^4}{4} + C$$

Step 5: Solve for y.

$$y = \frac{x^3}{4} + \frac{C}{x}$$

Step 6: Conclusion.

$$\boxed{y = \frac{x^3}{4} + \frac{C}{x}}$$

Quick Tip

Remember: Linear DE → Use integrating factor $e^{\int P(x)dx}$.