CUET 2026 May 21 shift 1 Mathematics

Question Paper (Memory-Based) with Solutions

Conducted by National Testing Agency (NTA)

General Instructions

(i) The examination will be conducted in Computer-Based Test (CBT) mode.

(ii) Each question carries +5 marks for correct answer and -1 mark for wrong answer.

(iii) The total number of questions are 50.

(iv) Duration of the exam is 1 hour (60 minutes).

1. If the function $f(x)$ defined below is continuous at $x = 2$, find the value of the constant k:

$$f(x) = \begin{cases} kx^2 & \text{if } x \leq 2 \\ 3x - 2 & \text{if } x > 2 \end{cases}$$

(A) 1

(B) 2

(C) 4

(D) 0

Correct Answer: (A) 1

Solution:

Concept: For a piecewise function to be continuous at a transition boundary point $x = c$, the Left-Hand Limit (LHL), the Right-Hand Limit (RHL), and the functional value at that point $f(c)$ must all be equal:

$$\lim_{x \to c^-} f(x) = \lim_{x \to c^+} f(x) = f(c)$$

If these conditions match, the graph connects smoothly without any breaks or jumps at the boundary.

Step 1: Evaluate the Left-Hand Limit and the functional value at $x = 2$.

The left-hand slice of the function handles the region where $x \leq 2$. Substituting the boundary value directly into the expression:

$$\lim_{x \to 2^-} f(x) = f(2) = k(2)^2 = 4k$$

Step 2: Evaluate the Right-Hand Limit at $x = 2$.

The right-hand slice of the function handles the region where $x > 2$. Evaluating the limit for this polynomial expression:

$$\lim_{x \to 2^+} f(x) = 3(2) - 2 = 6 - 2 = 4$$

Step 3: Equate the limits to isolate the value of the constant k.

Since the problem states that the function is continuous at $x = 2$, we equate our LHL and RHL results:

$$4k = 4 \quad \Rightarrow \quad k = 1$$

Quick Tip: For continuity problems involving piecewise functions, locate the boundary point first. Simply plug that boundary value into both expressions and solve the resulting basic algebraic equation to find the missing coefficients quickly.

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2. Find the slope of the normal to the curve $y = 2x^2 + 3\sin x$ at the coordinate point where $x = 0$.

(A) $-\frac{1}{3}$

(B) 3

(C) -3

(D) $\frac{1}{3}$

Correct Answer: (A) $-\frac{1}{3}$

Solution:

Concept: The first derivative of a function evaluated at a given point gives the slope of the tangent line ($m_{\text{tangent}} = \frac{dy}{dx}$) at that point. Since a normal line is perpendicular to the tangent line at the point of contact, their slopes share an inverse perpendicular relationship:

$$m_{\text{tangent}} \cdot m_{\text{normal}} = -1 \quad \Rightarrow \quad m_{\text{normal}} = -\frac{1}{\left(\frac{dy}{dx}\right)}$$

Step 1: Differentiate the curve equation with respect to x.

Given the function $y = 2x^2 + 3\sin x$, we apply standard differentiation rules:

$$\frac{dy}{dx} = \frac{d}{dx}(2x^2) + \frac{d}{dx}(3\sin x) = 4x + 3\cos x$$

Step 2: Evaluate the derivative at the given coordinate point $x = 0$.

Substitute $x = 0$ into the derivative expression to calculate the slope of the tangent line:

$$m_{\text{tangent}} = \left.\frac{dy}{dx}\right|_{x=0} = 4(0) + 3\cos(0)$$

Since $\cos(0) = 1$:

$$m_{\text{tangent}} = 0 + 3(1) = 3$$

Step 3: Calculate the perpendicular slope of the normal line.

Using the perpendicular relation rule, take the negative reciprocal of the tangent slope:

$$m_{\text{normal}} = -\frac{1}{m_{\text{tangent}}} = -\frac{1}{3}$$

Quick Tip: Always read the question carefully to see if it asks for the slope of the **tangent** or the **normal**. Tangent is just the direct derivative value, while normal requires taking the negative reciprocal ($-1/m$). Skipping this inversion step is a very common cause of lost marks.

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3. The total area of a parallelogram constructed with adjacent vector sides given by $\vec{a} = \hat{i} - \hat{j} + 3\hat{k}$ and $\vec{b} = 2\hat{i} - 7\hat{j} + \hat{k}$ is equal to:

(A) $15\sqrt{2}$

(B) 15

(C) $\sqrt{35}$

(D) 0

Correct Answer: (A) $15\sqrt{2}$

Solution:

Concept: The geometric area of a parallelogram spanned by two adjacent vector sides $\vec{a}$ and $\vec{b}$ is equal to the vector magnitude of their cross product:

$$\text{Area} = \left|\vec{a} \times \vec{b}\right|$$

This cross product vector is calculated using a standard 3×3 matrix determinant layout.

Step 1: Compute the vector cross product $\vec{a} \times \vec{b}$.

Set up the component determinant using unit vectors:

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 3 \\ 2 & -7 & 1 \end{vmatrix}$$

Expanding the determinant along the top row:

$$= \hat{i}\,[(-1)(1) - (3)(-7)] - \hat{j}\,[(1)(1) - (3)(2)] + \hat{k}\,[(1)(-7) - (-1)(2)]$$

$$= \hat{i}(-1 + 21) - \hat{j}(1 - 6) + \hat{k}(-7 + 2)$$

$$= 20\hat{i} + 5\hat{j} - 5\hat{k}$$

Step 2: Calculate the magnitude of this cross product vector.

The magnitude gives the scalar area of the bounded parallelogram region:

$$\text{Area} = \sqrt{(20)^2 + (5)^2 + (-5)^2} = \sqrt{400 + 25 + 25} = \sqrt{450}$$

Simplify the radical expression by factoring out perfect squares:

$$\sqrt{450} = \sqrt{225 \times 2} = 15\sqrt{2} \text{ square units}$$

Quick Tip: If a question asks for the area of a **triangle** sharing those same adjacent vector sides instead of a parallelogram, simply evaluate the cross product magnitude and divide it by two (Area $= \frac{1}{2}|\vec{a} \times \vec{b}|$).

4. A random variable X has the following probability distribution table: Find the exact value

X	0	1	2
$P(X)$	k	$2k$	$3k$

of the unknown parameter k.

(A) $\frac{1}{6}$

(B) $\frac{1}{3}$

(C) 1

(D) $\frac{1}{5}$

Correct Answer: (A) $\frac{1}{6}$

Solution:

Concept: For any discrete random variable to have a mathematically valid probability distribution, it must follow two foundational rules:

1. Every individual probability value must be non-negative: $P(X_i) \geq 0$
2. The sum of all individual probabilities across the entire sample space must equal exactly 1:
$$\sum_{i=1}^{n} P(X_i) = 1$$

Step 1: Sum all the entries in the probability row.

From the provided distribution table, extract and add the individual probability terms:

$$\sum P(X) = P(0) + P(1) + P(2) = k + 2k + 3k$$

Combine the like terms together:

$$\sum P(X) = 6k$$

Step 2: Equate this total sum to 1 to solve for the parameter k.

Applying the total probability axiom rule:

$$6k = 1 \quad \Rightarrow \quad k = \frac{1}{6}$$

Quick Tip: Always use the total probability condition ($\sum P(X) = 1$) as your first step to clear out unknowns like k or a before attempting to calculate further metrics like the Mean (μ) or Variance (σ^2).

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5. If two vectors $\vec{a} = 2\hat{i} + \lambda\hat{j} + \hat{k}$ and $\vec{b} = 4\hat{i} - 2\hat{j} - 2\hat{k}$ are perpendicular to each other, determine the value of the scalar constant λ.

(A) 3

(B) -3

(C) 6

(D) 0

Correct Answer: (A) 3

Solution:

Concept: Two non-zero vector coordinates $\vec{a}$ and $\vec{b}$ are perpendicular (orthogonal) to each other if and only if their scalar dot product evaluates to exactly zero:

$$\vec{a} \cdot \vec{b} = 0$$

This follows from the definition $\vec{a} \cdot \vec{b} = |\vec{a}||\vec{b}| \cos\theta$, where a perpendicular alignment angle of $\theta = 90^\circ$ makes $\cos(90^\circ) = 0$.

Step 1: Set up the algebraic expression for the scalar dot product.

Multiply corresponding components (x, y, and z) of both vectors and sum them up:

$$\vec{a} \cdot \vec{b} = (2)(4) + (\lambda)(-2) + (1)(-2)$$

Simplify the arithmetic multiplication steps:

$$\vec{a} \cdot \vec{b} = 8 - 2\lambda - 2 = 6 - 2\lambda$$

Step 2: Equate the dot product to zero to solve for λ.

Since the problem specifies that the lines run perpendicular to each other:

$$6 - 2\lambda = 0 \quad \Rightarrow \quad 2\lambda = 6 \quad \Rightarrow \quad \lambda = 3$$

Quick Tip: Keep this clear distinction in mind: use a **zero dot product** ($\vec{a} \cdot \vec{b} = 0$) to test for **perpendicular** lines, and use proportional directional components ($\frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3}$) to test for **parallel** lines.

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6. Evaluate the principal value of the inverse trigonometric expression: $\sin^{-1}\left(\sin \frac{2\pi}{3}\right)$

(A) $\frac{\pi}{3}$

(B) $\frac{2\pi}{3}$

(C) $-\frac{\pi}{3}$

(D) $\frac{\pi}{6}$

Correct Answer: (A) $\frac{\pi}{3}$

Solution:

Concept: The identity $\sin^{-1}(\sin\theta) = \theta$ holds true if and only if the angle θ falls inside the restricted principal value branch of the inverse sine function:

$$\theta \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$$

If the given angle falls outside this boundary domain, you must rewrite it using standard trigonometric quadrant identity properties first.

Step 1: Verify if the given angle falls within the principal branch region.

The given angle is $\theta = \frac{2\pi}{3}$ (which is $120°$). This values sits outside the eligible principal boundary range of $[-\frac{\pi}{2}, \frac{\pi}{2}]$ ($[-90°, 90°]$), meaning we cannot cancel the operators directly.

$$\frac{2\pi}{3} \notin \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$$

Step 2: Use trigonometric identities to map the angle into the principal quadrant.

Since the sine function is positive in the second quadrant, we use the supplementary identity rule $\sin(\pi - x) = \sin x$:

$$\sin\left(\frac{2\pi}{3}\right) = \sin\left(\pi - \frac{\pi}{3}\right) = \sin\left(\frac{\pi}{3}\right)$$

Step 3: Evaluate the principal inverse value expression.

Substitute our rewritten equivalent expression back into the function:

$$\sin^{-1}\left(\sin\frac{2\pi}{3}\right) = \sin^{-1}\left(\sin\frac{\pi}{3}\right)$$

Since $\frac{\pi}{3}$ (60°) sits safely inside the valid principal interval, the operators cancel out directly:

$$\sin^{-1}\left(\sin\frac{\pi}{3}\right) = \frac{\pi}{3}$$

Quick Tip: Never pick the original angle choice directly if it sits outside the principal range branch limits. For inverse sine codes tracking second-quadrant angles, your conversion shortcut is simply $\pi - \theta$.

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7. If a square matrix A satisfies the condition $A^T = -A$, then the matrix A is classified as a:

(A) Skew-symmetric matrix

(B) Symmetric matrix

(C) Identity matrix

(D) Orthogonal matrix

Correct Answer: (A) Skew-symmetric matrix

Solution:

Concept: Square matrices are classified into distinct structural groups based on how they behave when transformed by a transpose operation:

- **Symmetric matrix:** Transposing the array yields the exact same matrix layout ($A^T = A$).
- **Skew-symmetric matrix:** Transposing the array changes the sign of every element, yielding its negative ($A^T = -A$).

Step 1: Analyze the algebraic definition provided in the problem statement.

The problem states that transposing matrix A results in its negative:

$$A^T = -A$$

This matches the exact definition of a **skew-symmetric matrix**.

Step 2: Review the structural properties of skew-symmetric elements.

For a matrix entry position, this means $a_{ji} = -a_{ij}$. If we look at the main diagonal entries where column and row indices are equal ($i = j$):

$$a_{ii} = -a_{ii} \quad \Rightarrow \quad 2a_{ii} = 0 \quad \Rightarrow \quad a_{ii} = 0$$

This proves that every entry along the main diagonal of a skew-symmetric matrix must be exactly zero.

Quick Tip: To identify a skew-symmetric matrix instantly by eye, verify two traits: first, check if all entries along its main diagonal are exactly zero, and second, look to see if elements across from the diagonal mirror each other with opposite signs.

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8. Find the interval where the function $f(x) = x^2 - 4x + 6$ is strictly decreasing.

(A) $(-\infty, 2)$

(B) $(2, \infty)$

(C) $(-\infty, 4)$

(D) $[-2, 2]$

Correct Answer: (A) $(-\infty, 2)$

Solution:

Concept: A continuous function $f(x)$ is strictly decreasing on any interval where its first derivative remains strictly negative:

$$f'(x) < 0$$

Conversely, it is strictly increasing across zones where the first derivative remains strictly positive ($f'(x) > 0$).

Step 1: Calculate the first derivative of the function $f'(x)$.

Given the quadratic function $f(x) = x^2 - 4x + 6$, apply the power rule for derivatives:

$$f'(x) = \frac{d}{dx}(x^2) - \frac{d}{dx}(4x) + \frac{d}{dx}(6) = 2x - 4$$

Step 2: Set up the inequality for the strictly decreasing condition.

Set the derivative expression to be strictly less than zero:

$$2x - 4 < 0$$

Isolate the variable term by moving constants across the inequality sign:

$$2x < 4 \quad \Rightarrow \quad x < 2$$

Step 3: Convert the solution into standard interval notation.

The condition $x < 2$ includes all real numbers from negative infinity up to but not including 2. Expressed as an open interval:

$$x \in (-\infty, 2)$$

Quick Tip: Always double-check whether the question specifies "strictly decreasing" ($f'(x) < 0$) or simply "decreasing" ($f'(x) \leq 0$). Strictly decreasing requires using open parentheses, while standard decreasing uses a closed bracket at the critical point.

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9. Simplify the following expression using inverse trigonometric properties: $\tan\left(\sin^{-1} x + \cos^{-1} x\right)$ **where** $|x| \leq 1$**.**

(A) Not defined (∞)

(B) 1

(C) 0

(D) $\frac{\pi}{2}$

Correct Answer: (A) Not defined (∞)

Solution:

Concept: Inverse trigonometric functions share complementary angle identity pairs. For any valid domain argument value where $|x| \leq 1$, the sum of inverse sine and inverse cosine matches a constant right angle expression:

$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2}$$

Step 1: Apply the complementary identity property to substitute the interior expression.

Identify the core identity inside the function brackets:

$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2}$$

Plugging this constant angle value into our outer function expression simplifies it to:

$$\tan\left(\sin^{-1}x + \cos^{-1}x\right) = \tan\left(\frac{\pi}{2}\right)$$

Step 2: Evaluate the outer trigonometric tangent function value.

The tangent of an angle is defined as the ratio of sine to cosine:

$$\tan\left(\frac{\pi}{2}\right) = \frac{\sin(\pi/2)}{\cos(\pi/2)} = \frac{1}{0}$$

Because division by zero is impossible in real arithmetic, the value is **not defined** (approaching positive infinity).

Quick Tip: Memorize the three core complementary inverse identities to save time on multiple-choice questions: $\sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}$, $\tan^{-1}x + \cot^{-1}x = \frac{\pi}{2}$, and $\sec^{-1}x + \csc^{-1}x = \frac{\pi}{2}$.

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10. Calculate the mean (expected value) of a random variable X given its probability distribution setup below:

X	1	2	3
$P(X)$	0.2	0.5	0.3

(A) 2.1

(B) 2.0

(C) 1.0

(D) 3.0

Correct Answer: (A) 2.1

Solution:

Concept: The mean, mathematical expectation, or Expected Value (μ or $E(X)$) of a discrete random variable tells us the long-run average outcome value. It is calculated by finding the sum of each possible outcome value multiplied by its individual probability:

$$\mu = E(X) = \sum x_i \cdot P(x_i)$$

Step 1: Set up the individual product terms from the columns.

Multiply each value of variable X by its corresponding probability weight entry:

$$\mu = (1 \cdot P(1)) + (2 \cdot P(2)) + (3 \cdot P(3))$$

Substitute the numerical decimals from our table:

$$\mu = (1 \cdot 0.2) + (2 \cdot 0.5) + (3 \cdot 0.3)$$

Step 2: Calculate the products and sum them up to find the final mean.

Evaluate each multiplication step:

$$1 \cdot 0.2 = 0.2$$

$$2 \cdot 0.5 = 1.0$$

$$3 \cdot 0.3 = 0.9$$

Add the values together to complete the calculation:

$$\mu = 0.2 + 1.0 + 0.9 = 2.1$$

Quick Tip: The expected value does not have to be a whole number, nor does it have to match one of the exact coordinates listed in your table. It simply represents a weighted average position for the distribution.
