CUET 2026 May 25 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. A bag contains 5 red and 3 blue balls. Two balls are drawn at random without replacement. The probability that both are red is:

(A) $\frac{5}{14}$
(B) $\frac{10}{28}$
(C) $\frac{5}{28}$
(D) $\frac{15}{56}$

Correct Answer: (A) $\frac{5}{14}$

Solution:

Concept: When drawing objects from a finite set without replacement, the outcomes of the two draws are dependent events. The probability of both events occurring successfully can be evaluated using multiplication rule of probability:

$$P(R_1 \cap R_2) = P(R_1) \times P(R_2|R_1)$$

Alternatively, the problem can be calculated using combinations to choose a subset of objects from the total available group:

$$P = \frac{\text{Number of favorable ways}}{\text{Total number of possible ways}} = \frac{\binom{\text{Red balls}}{2}}{\binom{\text{Total balls}}{2}}$$

Step 1: Determining total balls and analyzing sequential selection.

The bag contains:

- Number of Red balls $= 5$
- Number of Blue balls $= 3$
- Total number of balls $= 5 + 3 = 8$

Let R_1 be the event that the first ball drawn is red, and R_2 be the event that the second ball drawn is red.

Step 2: Calculating the probability step-by-step.

The probability that the first ball is red:

$$P(R_1) = \frac{5}{8}$$

Since the ball is drawn **without replacement**, the number of remaining red balls becomes $5 - 1 = 4$, and the total number of remaining balls in the bag drops to $8 - 1 = 7$.

The conditional probability that the second ball is red, given the first was red:

$$P(R_2|R_1) = \frac{4}{7}$$

Applying the multiplication rule for dependent events:

$$P(\text{Both are red}) = P(R_1) \times P(R_2|R_1) = \frac{5}{8} \times \frac{4}{7}$$

Simplifying the fractions by cancelling out common factors:

$$P(\text{Both are red}) = \frac{5 \times 1}{2 \times 7} = \frac{5}{14}$$

Quick Tip: Using combinations can sometimes save time and prevent sequential multiplication slip-ups:

$$P = \frac{\binom{5}{2}}{\binom{8}{2}} = \frac{\frac{5\times4}{2\times1}}{\frac{8\times7}{2\times1}} = \frac{20}{56} = \frac{5}{14}$$

Both methods yield identical results, but combinations scale much better if you are asked to select three or more balls at once.

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2. A die is thrown twice. The probability of getting a sum equal to 8 is:

(A) $\frac{1}{12}$

(B) $\frac{5}{36}$

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

(D) $\frac{7}{36}$

Correct Answer: (B) $\frac{5}{36}$

Solution:

Concept: When a single fair six-sided die is thrown twice, the sample space consists of ordered pairs (i, j), where i represents the outcome of the first throw and j represents the outcome of the second throw. The total number of possible outcomes in the sample space is:

$$n(S) = 6 \times 6 = 36$$

The probability of an event E is given by the ratio of the number of favorable outcomes $n(E)$ to the total number of outcomes $n(S)$:

$$P(E) = \frac{n(E)}{n(S)}$$

Step 1: Identifying the favorable outcomes for a sum of 8.

Let E be the event of getting a sum equal to 8. We look for pairs (i, j) such that $i + j = 8$, where $1 \leq i, j \leq 6$. Tracing out the possible outcomes systematically:

- If the first die shows 2, the second die must show 6 $\implies (2, 6)$
- If the first die shows 3, the second die must show 5 $\implies (3, 5)$
- If the first die shows 4, the second die must show 4 $\implies (4, 4)$

- If the first die shows 5, the second die must show 3 $\implies (5,3)$
- If the first die shows 6, the second die must show 2 $\implies (6,2)$

Note that pairs like $(1,7)$ are impossible because a standard die only has numbers up to 6. Thus, the set of favorable outcomes is:

$$E = \{(2,6),(3,5),(4,4),(5,3),(6,2)\}$$

The total number of favorable outcomes is $n(E) = 5$.

Step 2: Calculating the probability.

Substitute the values into the probability formula:

$$P(E) = \frac{n(E)}{n(S)} = \frac{5}{36}$$

Quick Tip: For problems involving the sum of two dice, the number of ways to get a sum S (where $2 \leq S \leq 7$) is always $(S-1)$. For a sum S (where $8 \leq S \leq 12$), the number of ways is $(13-S)$. Here, for a sum of 8, the number of ways is quickly found as $13-8=5$.

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3. Evaluate: $\int x \cdot e^x \, dx$

(A) $xe^x + C$

(B) $e^x(x-1)+C$

(C) $e^x(x+1)+C$

(D) $x^2e^x + C$

Correct Answer: (B) $e^x(x-1)+C$

Solution:

Concept: To integrate the product of an algebraic function and an exponential function, we apply the **Integration by Parts** method. The formula is stated as:

$$\int u \cdot v \, dx = u \int v \, dx - \int \left(\frac{du}{dx} \int v \, dx \right) dx$$

We use the **ILATE** rule (Inverse trigonometric, Logarithmic, Algebraic, Trigonometric, Exponential) to select the first function (u). In this case:

- First function, $u = x$ (Algebraic)
- Second function, $v = e^x$ (Exponential)

Step 1: Applying the Integration by Parts formula.

Differentiating u and integrating v:

$$\frac{du}{dx} = 1 \quad \text{and} \quad \int e^x \, dx = e^x$$

Substituting these components into the integration by parts formula:

$$\int x \cdot e^x \, dx = x \cdot (e^x) - \int (1 \cdot e^x) \, dx$$

Step 2: Evaluating the remaining integral and simplifying.

$$\int x \cdot e^x \, dx = xe^x - \int e^x \, dx$$

$$\int x \cdot e^x \, dx = xe^x - e^x + C$$

Factoring out the common exponential term e^x:

$$\int x \cdot e^x \, dx = e^x(x-1) + C$$

Quick Tip: For integrals of the form $\int P(x)e^x \, dx$ where $P(x)$ is a polynomial, you can use tabular integration (DI method): alternatingly write the polynomial and its derivatives alongside the integrals of e^x, then multiply across diagonals. $(+)[x \cdot e^x] - (-)[1 \cdot e^x] = e^x(x-1) + C$.

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4. If $y = \log(\sin x) + \log(\cos x)$, then $\frac{dy}{dx}$ is:

(A) $\cos x - \sin x$

(B) $\sin x - \cos x$

(C) $\cot x - \tan x$

(D) $-\sin x - \cos x$

Correct Answer: (C) $\cot x - \tan x$

Solution:

Concept: We can determine the derivative either by differentiating each term directly using the **Chain Rule**:

$$\frac{d}{dx}(\log(f(x))) = \frac{1}{f(x)} \cdot f'(x)$$

Alternatively, we can first apply logarithmic properties to condense the expression before executing the differentiation step:

$$\log a + \log b = \log(a \cdot b)$$

Step 1: Differentiating the terms individually using the Chain Rule.

Given function:

$$y = \log(\sin x) + \log(\cos x)$$

Differentiating both sides with respect to x:

$$\frac{dy}{dx} = \frac{d}{dx}[\log(\sin x)] + \frac{d}{dx}[\log(\cos x)]$$

Applying the chain rule onto both components:

$$\frac{dy}{dx} = \left(\frac{1}{\sin x} \cdot \frac{d}{dx}(\sin x)\right) + \left(\frac{1}{\cos x} \cdot \frac{d}{dx}(\cos x)\right)$$

Since $\frac{d}{dx}(\sin x) = \cos x$ and $\frac{d}{dx}(\cos x) = -\sin x$:

$$\frac{dy}{dx} = \left(\frac{1}{\sin x} \cdot \cos x\right) + \left(\frac{1}{\cos x} \cdot (-\sin x)\right)$$

Step 2: Simplifying the expression using trigonometric ratios.

Using basic definitions $\frac{\cos x}{\sin x} = \cot x$ and $\frac{\sin x}{\cos x} = \tan x$:

$$\frac{dy}{dx} = \cot x - \tan x$$

Quick Tip: Using logarithmic properties simplifies the equation first: $y = \log(\sin x \cdot \cos x)$. Differentiating gives $\frac{1}{\sin x \cos x} \cdot (\cos^2 x - \sin^2 x) = \frac{\cos^2 x}{\sin x \cos x} - \frac{\sin^2 x}{\sin x \cos x} = \cot x - \tan x$.

5. Evaluate: $\int_0^{\pi/2} \sin x \, dx$

(A) 0

(B) 1

(C) 2

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

Correct Answer: (B) 1

Solution:

Concept: According to the **Fundamental Theorem of Calculus**, the value of a definite integral is computed by evaluating the anti-derivative of the function at the upper limit and subtracting its value at the lower limit:

$$\int_a^b f(x)\,dx = [F(x)]_a^b = F(b) - F(a)$$

Where $F'(x) = f(x)$. The basic standard formula for the anti-derivative of $\sin x$ is:

$$\int \sin x \, dx = -\cos x$$

Step 1: Finding the definite limits execution.

Apply the anti-derivative tracking boundaries from 0 to $\frac{\pi}{2}$:

$$\int_0^{\pi/2} \sin x \, dx = \Big[-\cos x\Big]_0^{\pi/2}$$

Step 2: Substituting the boundary values.

Evaluate at the upper limit and lower limit:

$$\int_0^{\pi/2} \sin x \, dx = -\left(\cos\frac{\pi}{2} - \cos 0\right)$$

We know the standard exact exact trigonometric values are $\cos\frac{\pi}{2} = 0$ and $\cos 0 = 1$:

$$\int_0^{\pi/2} \sin x \, dx = -(0-1) = 1$$

Quick Tip: The area of a single standard loop quadrant of either a sine or cosine curve between consecutive axis intercepts (e.g., from 0 to $\frac{\pi}{2}$) is always exactly 1 unit^2. Remembering this geometric curve property makes evaluating simple definite trigonometric integrations instantaneous.

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6. If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, then adj$(A)$ is:

(A) $\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

(B) $\begin{bmatrix} 1 & -2 \\ -3 & 4 \end{bmatrix}$

(C) $\begin{bmatrix} 4 & 2 \\ 3 & 1 \end{bmatrix}$

(D) $\begin{bmatrix} -4 & 2 \\ 3 & -1 \end{bmatrix}$

Correct Answer: (A) $\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

Solution:

Concept: The adjugate matrix (adj(A)) of a matrix is the transpose of its cofactor matrix:

$$\text{adj}(A) = (C)^{\text{T}}$$

Where each entry C_{ij} is the cofactor of element a_{ij}, calculated using the formula:

$$C_{ij} = (-1)^{i+j} M_{ij} \quad (M_{ij} \text{ is the minor matrix determinant})$$

Step 1: Calculating the cofactors for each element of matrix A.

Given matrix:

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

Let's find the cofactors for all 4 positions:

- $C_{11} = (-1)^{1+1} \cdot (4) = +4$
- $C_{12} = (-1)^{1+2} \cdot (3) = -3$
- $C_{21} = (-1)^{2+1} \cdot (2) = -2$
- $C_{22} = (-1)^{2+2} \cdot (1) = +1$

Constructing the cofactor matrix C:

$$C = \begin{bmatrix} 4 & -3 \\ -2 & 1 \end{bmatrix}$$

Step 2: Transposing the cofactor matrix to determine the adjugate.

$$\text{adj}(A) = C^{\text{T}} = \begin{bmatrix} 4 & -3 \\ -2 & 1 \end{bmatrix}^{\text{T}} = \begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$$

Quick Tip: For any 2×2 matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$, you can find the adjugate instantly using a simple shortcut rule: **Swap the elements on the main diagonal (a and d), and change the signs of the off-diagonal elements (b and c)**. Applying this rule to $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ immediately yields $\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$.

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7. For any square matrix A, $A \cdot \text{adj}(A) =$

(A) A

(B) $|A|I$

(C) I

(D) $|A|^2 A$

Correct Answer: (B) $|A|I$

Solution:

Concept: For any square matrix A of order n, a fundamental identity connects the matrix, its adjugate, and its determinant. This relation is stated as:

$$A \cdot \text{adj}(A) = \text{adj}(A) \cdot A = |A| I_n$$

Where $|A|$ represents the scalar value of the determinant of matrix A, and I_n is the Identity matrix matching the size order of A. This relationship forms the mathematical basis for deriving the matrix inversion formula ($A^{-1} = \frac{\text{adj}(A)}{|A|}$).

Step 1: Verifying via definition properties.

Let's consider a generic matrix definition block to confirm why this multiplication pattern collapses to the identity scaled. When row i of matrix A is multiplied by the corresponding column i of adj(A) (which consists of cofactors from row i), the sum matches the expansion formula for the determinant:

$$\sum_{k=1}^{n} a_{ik} C_{ik} = |A|$$

Conversely, when elements from row i of matrix A are multiplied by cofactors from a completely different row j ($i \neq j$), the components cancel out and sum to zero:

$$\sum_{k=1}^{n} a_{ik} C_{jk} = 0$$

Step 2: Final matrix expression composition.

Performing this row-by-column multiplication creates a diagonal matrix format where the scalar determinant values sit along the main diagonal, and all other entries are zero:

$$A \cdot \text{adj}(A) = \begin{bmatrix} |A| & 0 & \dots & 0 \\ 0 & |A| & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & |A| \end{bmatrix}$$

Factoring out the scalar determinant value $|A|$ leaves the identity structure:

$$A \cdot \text{adj}(A) = |A| \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{bmatrix} = |A| I$$

Quick Tip: This property is exceptionally useful for solving determinant operations on adjugates. Taking the determinant of both sides reveals that: $|A \cdot \text{adj}(A)| = ||A|I| \implies |A| \cdot |\text{adj}(A)| = |A|^n \implies |\text{adj}(A)| = |A|^{n-1}$.

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8. The feasible region of an LPP is always:

(A) Circle

(B) Triangle only

(C) Convex polygon

(D) Straight line

Correct Answer: (C) Convex polygon

Solution:

Concept: In **Linear Programming Problems (LPP)**, constraints are represented by linear inequalities. Graphically, each linear inequality defines a half-plane, which is a convex set. Key architectural geometric theorems dictate that:

- The intersection of any finite collection of convex sets is always a convex set.
- The geometric region formed by intersecting multiple linear half-planes creates a bounded or unbounded region enclosed by straight-line edges, known as a **convex polygon** (or a convex polyhedral set).

Step 1: Understanding the definition of a Convex Set.

A geometric set is defined as convex if, for any two points selected anywhere inside the region, the straight line segment connecting those two points lies completely within the boundaries of that region.

Since all system constraint boundaries in a standard linear programming model are straight lines, the resulting feasible solution space cannot have indented contours or curved boundaries.

Step 2: Matching properties with options.

The intersecting boundary space forms vertices and edges, which matches the definition of a polygon. Because it must remain a convex structural set, the entire feasible region of an LPP is classified as a **convex polygon**.

Quick Tip: Since the feasible region is a convex polygon, the **Corner Point Theorem** states that the optimal solution (maximum or minimum value of the objective function) is guaranteed to occur at one of the corner points (vertices) of this polygon.

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9. Find the maximum value of $f(x) = -x^2 + 4x + 1$

(A) 3

(B) 4

(C) 5

(D) 6

Correct Answer: (C) 5

Solution:

Concept: To locate the absolute maximum point of a smooth polynomial function, we apply calculus minimization/maximization principles through the **First Derivative Test**:

- Find the critical points where the first derivative equals zero: $f'(x) = 0$
- Use the Second Derivative Test to confirm a maximum: if $f''(x) < 0$, the point is a local maximum.

Alternatively, this can be solved algebraically by completing the square on the quadratic function.

Step 1: Finding the critical value using differentiation.

Given function:

$$f(x) = -x^2 + 4x + 1$$

Differentiate with respect to x:

$$f'(x) = \frac{d}{dx}(-x^2 + 4x + 1) = -2x + 4$$

Set the first derivative to zero to locate the critical turning point:

$$-2x + 4 = 0 \quad \Rightarrow \quad 2x = 4 \quad \Rightarrow \quad x = 2$$

Let's check the second derivative to confirm the behavior:

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

Since $f''(2) = -2 < 0$, the function reaches a local maximum at $x = 2$.

Step 2: Calculating the maximum value.

Substitute the critical coordinate position $x = 2$ back into the original function equation:

$$f(2) = -(2)^2 + 4(2) + 1$$

$$f(2) = -4 + 8 + 1 = 5$$

Thus, the maximum value of the function is 5.

Quick Tip: For any quadratic equation form $f(x) = ax^2 + bx + c$ where $a < 0$, the vertex occurs at $x = -\frac{b}{2a}$ and the maximum value is given directly by $\frac{4ac-b^2}{4a}$. Substituting our coefficients: $\frac{4(-1)(1)-(4)^2}{4(-1)} = \frac{-4-16}{-4} = \frac{-20}{-4} = 5$.

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10. Evaluate: $\int \frac{1}{1+x^2}\,dx$

(A) $\sin^{-1} x + C$

(B) $\tan^{-1} x + C$

(C) $\log(1+x^2) + C$

(D) $\sec^{-1} x + C$

Correct Answer: (B) $\tan^{-1} x + C$

Solution:

Concept: This is a core standard integral form derived directly from basic differential calculus rules. Integration is the inverse process of differentiation. If the derivative of a function $F(x)$ is $f(x)$:

$$\frac{d}{dx}[F(x)] = f(x) \implies \int f(x)\,dx = F(x) + C$$

Step 1: Connecting with standard trigonometric derivatives.

Recall the standard derivative formula for inverse trigonometric functions, specifically the inverse tangent function:

$$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$$

Step 2: Applying the indefinite integral mapping.

By reversing this derivative relationship, the anti-derivative is found immediately:

$$\int \frac{1}{1+x^2}\,dx = \tan^{-1} x + C$$

Quick Tip: Be careful not to confuse this with the logarithmic form! An integral like $\int \frac{2x}{1+x^2}\,dx$ evaluates to $\log(1+x^2)+C$ via substitution, because the derivative of the denominator is present in the numerator. However, without that x variable on top, the form is strictly an inverse trigonometric arctan curve.
