

# CUET 2026 May 29 Shift 2 Mathematics

## Question Paper (Memory-Based) With Solution

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. Identify the order and degree of the differential equation:

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

- (A) Order 3, Degree 4
- (B) Order 3, Degree 2
- (C) Order 4, Degree 3
- (D) Order 1, Degree 4

**Correct Answer:** (B) Order 3, Degree 2

### Solution:

#### Concept:

- Order = Highest order derivative present in the differential equation.
- Degree = Power of the highest order derivative after removing radicals and fractions in derivatives.

**Step 1: Identify the highest order derivative**

Given equation:

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

The derivatives present are:

$$\frac{dy}{dx} \quad \text{and} \quad \frac{d^3y}{dx^3}$$

Among these, the highest order derivative is:

$$\frac{d^3y}{dx^3}$$

Hence,

$$\boxed{\text{Order} = 3}$$

**Step 2: Determine the degree**

The highest order derivative appears as:

$$\left(\frac{d^3y}{dx^3}\right)^2$$

Therefore, its power is 2.

Hence,

$$\boxed{\text{Degree} = 2}$$

**Final Answer:**

$$\boxed{\text{Order 3, Degree 2}}$$

**Quick Tip:** Degree depends only on the power of the highest order derivative, not on lower order derivatives.

2. Consider a  $3 \times 3$  matrix  $A$ . If

$$\text{adj}(A) = \begin{pmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{pmatrix}$$

find  $\det(A)$ .

- (A) 8
- (B) 4
- (C)  $2\sqrt{2}$
- (D) 2

**Correct Answer:** (C)  $2\sqrt{2}$

**Solution:**

**Concept:**

For an  $n \times n$  matrix:

$$\det(\text{adj}A) = (\det A)^{n-1}$$

Since  $A$  is a  $3 \times 3$  matrix:

$$\det(\text{adj}A) = (\det A)^2$$

**Step 1: Find determinant of adjoint matrix**

Given:

$$\text{adj}(A) = \begin{pmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{pmatrix}$$

This is a diagonal matrix.

The determinant of a diagonal matrix equals the product of its diagonal entries.

Therefore,

$$\det(\text{adj}A) = 2 \times 2 \times 2$$

$$= 8$$

**Step 2: Apply determinant property**

Using:

$$(\det A)^2 = 8$$

Take square root on both sides:

$$\det A = \sqrt{8}$$

$$= 2\sqrt{2}$$

**Final Answer:**

$$2\sqrt{2}$$

**Quick Tip:** For a  $3 \times 3$  matrix:

$$\det(\text{adj}A) = (\det A)^2$$

Always remember the exponent is  $n - 1$ .

### 3. Find the shortest distance between the lines

$$\vec{r} = \hat{i} + 2\hat{j} + \hat{k} + \lambda(\hat{i} - \hat{j} + \hat{k})$$

and

$$\vec{r} = 2\hat{i} - \hat{j} - \hat{k} + \mu(2\hat{i} + \hat{j} + 2\hat{k})$$

- (A)  $3/\sqrt{2}$
- (B)  $9/\sqrt{54}$
- (C)  $\sqrt{6}$
- (D) 0

**Correct Answer:** (B)  $9/\sqrt{54}$

**Solution:**

**Concept:**

Shortest distance between two skew lines is:

$$d = \frac{|(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2)|}{|\vec{b}_1 \times \vec{b}_2|}$$

where:

- $\vec{a}_1, \vec{a}_2$  are points on the lines
- $\vec{b}_1, \vec{b}_2$  are direction vectors

### Step 1: Identify position and direction vectors

From first line:

$$\vec{a}_1 = (1, 2, 1)$$

$$\vec{b}_1 = (1, -1, 1)$$

From second line:

$$\vec{a}_2 = (2, -1, -1)$$

$$\vec{b}_2 = (2, 1, 2)$$

### Step 2: Find cross product of direction vectors

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 1 \\ 2 & 1 & 2 \end{vmatrix}$$

Expanding determinant:

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

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

$$= -3\hat{i} + 0\hat{j} + 3\hat{k}$$

Thus:

$$\vec{b}_1 \times \vec{b}_2 = (-3, 0, 3)$$

Magnitude:

$$|\vec{b}_1 \times \vec{b}_2| = \sqrt{(-3)^2 + 0^2 + 3^2}$$

$$= \sqrt{9 + 9}$$

$$= \sqrt{18}$$

**Step 3: Find connecting vector**

$$\vec{a}_2 - \vec{a}_1 = (2 - 1, -1 - 2, -1 - 1)$$

$$= (1, -3, -2)$$

**Step 4: Apply shortest distance formula**

$$d = \frac{|(1, -3, -2) \cdot (-3, 0, 3)|}{\sqrt{18}}$$

Compute dot product:

$$= (1)(-3) + (-3)(0) + (-2)(3)$$

$$= -3 + 0 - 6$$

$$= -9$$

Taking modulus:

$$|-9| = 9$$

Thus:

$$d = \frac{9}{\sqrt{18}}$$

Rationalized form:

$$= \frac{9}{\sqrt{54}}$$

**Final Answer:**

$$\boxed{\frac{9}{\sqrt{54}}}$$

**Quick Tip:** Cross product gives a vector perpendicular to both lines and is essential in shortest-distance problems.

#### 4. Maximize

$$Z = 3x + 4y$$

subject to

$$x + y \leq 10, \quad x, y \geq 0$$

- (A) (10, 0)
- (B) (0, 10)
- (C) (5, 5)
- (D) (0, 0)

**Correct Answer:** (B) (0, 10)

**Solution:**

**Concept:**

In Linear Programming Problems (LPP), the maximum or minimum value of the objective function occurs at the corner points of the feasible region.

**Step 1: Identify constraints**

Given:

$$x + y \leq 10$$

and

$$x \geq 0, \quad y \geq 0$$

These inequalities represent the feasible region in the first quadrant.

**Step 2: Find corner points**

The line:

$$x + y = 10$$

cuts the axes at:

$$(10, 0) \quad \text{and} \quad (0, 10)$$

Including the origin, corner points are:

$$(0, 0), (10, 0), (0, 10)$$

**Step 3: Evaluate objective function**

Objective function:

$$Z = 3x + 4y$$

At (0, 0):

$$Z = 3(0) + 4(0) = 0$$

At (10, 0):

$$Z = 3(10) + 4(0) = 30$$

At (0, 10):

$$Z = 3(0) + 4(10) = 40$$

**Step 4: Choose maximum value**

Largest value is:

40

obtained at:

(0, 10)

**Final Answer:**

(0, 10)

**Quick Tip:** In LPP, always test all corner points because optimum values occur only at vertices.

5. Probability that the second ball is red, given the first was blue (3 red and 5 blue balls, without replacement).

- (A)  $\frac{3}{7}$
- (B)  $\frac{3}{8}$
- (C)  $\frac{2}{7}$
- (D)  $\frac{5}{14}$

**Correct Answer:** (A)  $\frac{3}{7}$



### Solution:

#### Concept:

This is a conditional probability problem.

Since balls are drawn without replacement, the total number of balls changes after the first draw.

#### Step 1: Write initial number of balls

Initially:

3 red balls

5 blue balls

Total balls:

$$3 + 5 = 8$$

#### Step 2: Apply given condition

It is given that the first ball drawn was blue.

So one blue ball is removed.

Remaining balls:

3 red

4 blue

Total remaining:

$$7$$

#### Step 3: Find required probability

Probability that second ball is red:

$$P(\text{Red}) = \frac{\text{Number of red balls remaining}}{\text{Total balls remaining}}$$

$$= \frac{3}{7}$$

**Final Answer:**

$$\boxed{\frac{3}{7}}$$

**Quick Tip:** Without replacement means the denominator decreases after each draw.

6. Find the local maximum of

$$f(x) = x^3 - 3x + 2$$

- (A)  $x = 1$
- (B)  $x = -1$
- (C)  $x = 0$
- (D)  $x = 2$

**Correct Answer:** (B)  $x = -1$

**Solution:**

**Concept:**

A local maximum or minimum occurs at points where:

$$f'(x) = 0$$

These points are called critical points.

To determine whether the point is maximum or minimum, we use the second derivative test.

**Step 1: Find first derivative**

Given:

$$f(x) = x^3 - 3x + 2$$

Differentiate with respect to  $x$ :

$$f'(x) = 3x^2 - 3$$

**Step 2: Find critical points**

Set:

$$f'(x) = 0$$

$$3x^2 - 3 = 0$$

Divide by 3:

$$x^2 - 1 = 0$$

$$x^2 = 1$$

$$x = \pm 1$$

Thus the critical points are:

$$x = 1, \quad x = -1$$

**Step 3: Find second derivative**

Differentiate again:

$$f''(x) = 6x$$

**Step 4: Apply second derivative test**

At:

$$x = -1$$

$$f''(-1) = 6(-1) = -6$$

Since:

$$f''(-1) < 0$$

the curve is concave downward.

Hence:

$$x = -1$$

gives a local maximum.

**Final Answer:**

$$\boxed{x = -1}$$

**Quick Tip:** If

$$f''(x) < 0$$

then the function has a local maximum at that point.

7. Find the domain of

$$f(x) = \sin^{-1}(2x - 1)$$

- (A)  $[0, 1]$
- (B)  $[-1, 1]$
- (C)  $[0, \infty)$
- (D)  $[-0.5, 0.5]$

**Correct Answer:** (A)  $[0, 1]$

**Solution:**

**Concept:**

For inverse sine function:

$$\sin^{-1}(u)$$

the input value must satisfy:

$$-1 \leq u \leq 1$$

**Step 1: Apply inverse sine condition**

Given:

$$f(x) = \sin^{-1}(2x - 1)$$

Therefore:

$$-1 \leq 2x - 1 \leq 1$$

**Step 2: Solve the inequality**

Add 1 throughout:

$$0 \leq 2x \leq 2$$

Divide throughout by 2:

$$0 \leq x \leq 1$$

**Step 3: Write domain**

Hence the domain is:

$$[0, 1]$$

**Final Answer:**

$$\boxed{[0, 1]}$$

**Quick Tip:** For inverse trigonometric functions, always restrict the inner expression to the valid range.

8. Is

$$f(x) = |x - 2|$$

differentiable at  $x = 2$ ?

- (A) Yes
- (B) No
- (C) Only for  $x > 2$
- (D) Only for  $x < 2$

**Correct Answer:** (B) No

**Solution:**

**Concept:**

A function is differentiable at a point only if:

$$LHD = RHD$$

Absolute value functions create a sharp corner where the expression inside modulus becomes zero.

**Step 1: Find left hand derivative**

For:

$$x < 2$$

$$|x - 2| = -(x - 2)$$

$$= -x + 2$$

Differentiate:

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

Thus:

$$LHD = -1$$

**Step 2: Find right hand derivative**

For:

$$x > 2$$

$$|x - 2| = x - 2$$

Differentiate:

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

Thus:

$$RHD = 1$$

**Step 3: Compare derivatives**

$$LHD = -1$$

$$RHD = 1$$

Since:

$$LHD \neq RHD$$

the function is not differentiable at:

$$x = 2$$

**Final Answer:**

No

**Quick Tip:** Functions of the form  $|x - a|$  are non-differentiable at  $x = a$ .

9. Find the adjoint of

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

(A)

$$\begin{pmatrix} 4 & -2 \\ -3 & 1 \end{pmatrix}$$

(B)

$$\begin{pmatrix} 1 & 3 \\ 2 & 4 \end{pmatrix}$$

(C)

$$\begin{pmatrix} 4 & 2 \\ 3 & 1 \end{pmatrix}$$

(D)

$$\begin{pmatrix} -4 & 2 \\ 3 & -1 \end{pmatrix}$$

**Correct Answer:** (A)

$$\begin{pmatrix} 4 & -2 \\ -3 & 1 \end{pmatrix}$$

**Solution:**

**Concept:**

For a  $2 \times 2$  matrix:

$$A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

the adjoint is:

$$\text{adj}(A) = \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

**Step 1: Identify matrix entries**

Given:

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

Hence:

$$a = 1, \quad b = 2, \quad c = 3, \quad d = 4$$

**Step 2: Apply adjoint formula**

Swap diagonal elements:

$$1 \leftrightarrow 4$$

Change signs of off-diagonal elements:

$$2 \rightarrow -2$$

$$3 \rightarrow -3$$

Thus:

$$\text{adj}(A) = \begin{pmatrix} 4 & -2 \\ -3 & 1 \end{pmatrix}$$

**Final Answer:**

$$\boxed{\begin{pmatrix} 4 & -2 \\ -3 & 1 \end{pmatrix}}$$

**Quick Tip:** For  $2 \times 2$  matrices: Swap diagonal entries and change signs of off-diagonal entries.

**10. Find the derivative of**

$$f(x) = e^{x^2}$$



- (A)  $e^{x^2}$   
(B)  $2xe^{x^2}$   
(C)  $x^2e^{x^2-1}$   
(D)  $e^{2x}$

**Correct Answer:** (B)  $2xe^{x^2}$

**Solution:**

**Concept:**

Use Chain Rule:

$$\frac{d}{dx}(e^u) = e^u \frac{du}{dx}$$

where  $u$  is a function of  $x$ .

**Step 1: Choose inner function**

Let:

$$u = x^2$$

Differentiate:

$$\frac{du}{dx} = 2x$$

**Step 2: Apply chain rule**

$$\frac{d}{dx}(e^{x^2}) = e^{x^2} \cdot \frac{d}{dx}(x^2)$$

$$= e^{x^2} \cdot 2x$$

$$= 2xe^{x^2}$$

**Step 3: Write final derivative**

Hence:

$$\boxed{2xe^{x^2}}$$

**Final Answer:**

$$\boxed{2xe^{x^2}}$$

**Quick Tip:** Whenever an exponential contains another function inside it, always apply the chain rule.

