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:

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

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

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2. Consider a 3×3 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 3×3 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:

$$\boxed{2\sqrt{2}}$$

Quick Tip: For a 3×3 matrix:

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

Always remember the exponent is $n-1$.

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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.

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4. Maximize

$$Z = 3x + 4y$$

subject to

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

(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

$$x \geq 0, \qquad y \geq 0$$

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:

$$\boxed{(0, 10)}$$

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

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

(A) 3/7
(B) 3/8
(C) 2/7
(D) 5/14

Correct Answer: (A) 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:

$$3 \text{ red balls}$$

$$5 \text{ blue balls}$$

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:

$$3 \text{ red}$$

$$4 \text{ blue}$$

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.

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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:

$$-1 \le u \le 1$$

Step 1: Apply inverse sine condition

Given:

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

Therefore:

$$-1 \le 2x - 1 \le 1$$

Step 2: Solve the inequality

Add 1 throughout:

$$0 \le 2x \le 2$$

Divide throughout by 2:

$$0 \le x \le 1$$

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.

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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:

$$\boxed{\text{No}}$$

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 2×2 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:

$$1 \longleftrightarrow 4$$

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 2×2 matrices: Swap diagonal entries and change signs of off-diagonal entries.

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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.
