JEE (ADVANCED) EXAM-2025

MATHEMATICS (PAPER-2)

SECTION 1 (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme**:

  Full Marks   : +3 If **ONLY** the correct option is chosen;

  Zero Marks   : 0 If none of the options is chosen (i.e. the question is unanswered);

  Negative Marks : –1 In all other cases.

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1. Let x_0 be the real number such that $e^{x_0} + x_0 = 0$. For a given real number α, define

$$g(x) = \frac{3xe^x + 3x - \alpha e^x - \alpha x}{3(e^x + 1)}$$

for all real numbers x.

Then which one of the following statements is TRUE?

(A) For $\alpha = 2, \lim_{x \to x_0} \left| \frac{g(x) + e^{x_0}}{x - x_0} \right| = 0$

(B) For $\alpha = 2, \lim_{x \to x_0} \left| \frac{g(x) + e^{x_0}}{x - x_0} \right| = 1$

(C) For $\alpha = 3, \lim_{x \to x_0} \left| \frac{g(x) + e^{x_0}}{x - x_0} \right| = 0$

(D) For $\alpha = 3, \lim_{x \to x_0} \left| \frac{g(x) + e^{x_0}}{x - x_0} \right| = \frac{2}{3}$

2. Let $\mathbb{R}$ denote the set of all real numbers. Then the area of the region

$$\left\{ (x, y) \in \mathbb{R} \times \mathbb{R} : x > 0, y > \frac{1}{x}, 5x - 4y - 1 > 0, 4x + 4y - 17 < 0 \right\}$$

Is

(A) $\frac{17}{16} - \log_e 4$

(B) $\frac{33}{8} - \log_e 4$

(C) $\frac{57}{8} - \log_e 4$

(D) $\frac{17}{2} - \log_e 4$

3. The total number of real solutions of the equation

$$\theta = \tan^{-1}(2\tan\theta) - \frac{1}{2}\sin^{-1}\left(\frac{6\tan\theta}{9+\tan^2\theta}\right)$$

is

(Here, the inverse trigonometric functions $\sin^{-1}x$ and $\tan^{-1}x$ assume values in $\left[-\dfrac{\pi}{2},\dfrac{\pi}{2}\right]$ and

$\left(-\dfrac{\pi}{2},\dfrac{\pi}{2}\right)$, respectively.)

(A) 1   (B) 2   (C) 3   (D) 5

4. Let S denote the locus of the point of intersection of the pair of lines

$$4x - 3y = 12\alpha$$

$$4\alpha x + 3\alpha y = 12$$

where α varies over the set of non-zero real numbers. Let T be the tangent to S passing through the

points $(p,0)$ and $(0,q), q > 0$, and parallel to the line $4x - \dfrac{3}{\sqrt{2}}y = 0$.

Then the value of pq is

(A) $-6\sqrt{2}$ (B) $-3\sqrt{2}$ (C) $-9\sqrt{2}$ (D) $-12\sqrt{2}$

SECTION-2 (Maximum Marks: 16)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme:**

  Full Marks   : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

  Partial Marks : +3 If all the four options are correct but **ONLY** three options are chosen;

  Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct;

  Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option;

  Zero Marks   : 0 If none of the options is chosen (i.e. the question is unanswered);

  Negative Marks : -2 In all other cases.

- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to correct answers, then

  choosing ONLY (A), (B) and (D) will get +4 marks;

  choosing ONLY (A) and (B) will get +2 marks;

  choosing ONLY (A) and (D) will get +2 marks;

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choosing ONLY (B) and (D) will get +2 marks;

choosing ONLY (A) will get +1 mark;

choosing ONLY (B) will get +1 mark;

choosing ONLY (D) will get +1 mark;

choosing no option (i.e. the question is unanswered) will get 0 marks; and

choosing any other combination of options will get -2 marks.

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5. Let $I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ and $P = \begin{pmatrix} 2 & 0 \\ 0 & 3 \end{pmatrix}$. Let $Q = \begin{pmatrix} x & y \\ z & 4 \end{pmatrix}$ for some non-zero real numbers x, y, and z, for

which there is a 2×2 matrix R with all entries being non-zero real numbers, such that $QR = RP$.

Then which of the following statements is (are) TRUE?

(A) The determinant of $Q - 2I$ is zero   (B) The determinant of $Q - 6I$ is 12

(C) The determinant of Q-3I is 15   (D) $yz = 2$

6. Let S denote the locus of the mid-points of those chords of the parabola $y^2 = x$, such that the area of

the region enclosed between the parabola and the chord is $\dfrac{4}{3}$. Let $\mathcal{R}$ denote the region lying in the

first quadrant, enclosed by the parabola $y^2 = x$, the curve S, and the lines $x = 1$ and $x = 4$.

Then which of the following statements is (are) TRUE?

(A) $(4, \sqrt{3}) \in S$ (B) $(5, \sqrt{2}) \in S$

(C) Area of $\mathcal{R}$ is $\dfrac{14}{3} - 2\sqrt{3}$ (D) Area of $\mathcal{R}$ is $\dfrac{14}{3} - \sqrt{3}$

7. Let $P(x_1, y_1)$ and $Q(x_2, y_2)$ be two distinct points on the ellipse

$$\frac{x^2}{9} + \frac{y^2}{4} = 1$$

such that $y_1 > 0$, and $y_2 > 0$. Let C denote the circle $x^2 + y^2 = 9$, and M be the point $(3, 0)$.

Suppose the line $x = x_1$ intersects C at R, and the line $x = x_2$ intersects C at S, such that the y-

coordinates of R and S are positive. Let $\angle ROM = \dfrac{\pi}{6}$ and $\angle SOM = \dfrac{\pi}{3}$, where O denotes the

origin $(0, 0)$. Let |XY| denote the length of the line segment XY.

Then which of the following statements is (are) TRUE?

(A) The equation of the line joining P and Q is $2x + 3y = 3(1 + \sqrt{3})$

(B) The equation of the line joining P and Q is $2x + y = 3(1 + \sqrt{3})$

(C) If $N_2 = (x_2, 0)$, then $3|N_2Q| = 2|N_2S|$

(D) If $N_1 = (x_1, 0)$, then $9|N_1P| = 4|N_1R|$

8.   Let $\mathbb{R}$ denote the set of all real numbers. Let $f : \mathbb{R} \to \mathbb{R}$ be defined by

$$f(x) = \begin{cases} \dfrac{6x + \sin x}{2x + \sin x} & \text{if } x \neq 0 \\ \dfrac{7}{3} & \text{if } x = 0 \end{cases}$$

Then which of the following statements is (are) TRUE?

(A) The point $x = 0$ is a point of local maxima of f

(B) The point $x = 0$ is a point of local minima of f

(C) Number of points of local maxima of f in the interval $[\pi, 6\pi]$ is 3

(D) Number of points of local minima of f in the interval $[2\pi, 4\pi]$ is 1

SECTION-3 (Maximum Marks: 32)

- This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE**.

- For each question, enter the correct numerical value of the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.

- If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

- Answer to each question will be evaluated **according to the following marking scheme:**

    Full Marks   : +4 If **ONLY** the correct numerical value is entered in the designated place;

    Zero Marks   : 0 In all other cases.

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9.   Let $y(x)$ be the solution of the differential equation

$$x^2 \frac{dy}{dx} + xy = x^2 + y^2, \quad x > \frac{1}{e}$$

satisfying $y(1) = 0$. Then the value of $2\dfrac{(y(e))^2}{y\left(e^2\right)}$ is _____ .

10.   Let $a_0, a_1, \ldots, a_{23}$ be real numbers such that

$$\left(1 + \frac{2}{5}x\right)^{23} = \sum_{i=0}^{23} a_i x^i$$

for every real number x. Let a_r be the largest among the numbers a_j for $0 \leq j \leq 23$.

Then the value of r is _____ .

11. A factory has a total of three manufacturing units, M_1, M_2, and M_3, which produce bulbs independent of each other. The units M_1, M_2, and M_3 produce bulbs in the proportions of 2 : 2 : 1, respectively. It is known that 20% of the bulbs produced in the factory are defective. It is also known that, of all the bulbs produced by $M_1, 15\%$ are defective. Suppose that, if a randomly chosen bulb produced in the factory is found to be defective, the probability that it was produced by M_2 is $\dfrac{2}{5}$.

If a bulb is chosen randomly from the bulbs produced by M_3, then the probability that it is defective is _____ .

12. Consider the vectors

$$\vec{x} = \hat{i} + 2\hat{j} + 3\hat{k}, \quad \vec{y} = 2\hat{i} + 3\hat{j} + \hat{k}, \quad \text{and} \quad \vec{z} = 3\hat{i} + \hat{j} + 2\hat{k}$$

For two distinct positive real numbers α and β, define

$$\vec{X} = \alpha\vec{x} + \beta\vec{y} - \vec{z}, \quad \vec{Y} = \alpha\vec{y} + \beta\vec{z} - \vec{x}, \quad \text{and} \quad \vec{Z} = \alpha\vec{z} + \beta\vec{x} - \vec{y}$$

If the vectors $\vec{X}, \vec{Y}$, and $\vec{Z}$ lie in a plane, then the value of $\alpha + \beta - 3$ is _____ .

13. For a non-zero complex number z, let $\arg(z)$ denote the principal argument of z, with $-\pi < \arg(z) \le \pi$. Let ω be the cube root of unity for which $0 < \arg(\omega) < \pi$. Let

$$\alpha = \arg\left(\sum_{n=1}^{2025} (-\omega)^n \right)$$

Then the value of $\dfrac{3\alpha}{\pi}$ is _____ .

14. Let $\mathbb{R}$ denote the set of all real numbers. Let $f : \mathbb{R} \to \mathbb{R}$ and $g : \mathbb{R} \to (0, 4)$ be functions defined by

$$f(x) = \log_e\left(x^2 + 2x + 4\right), \text{ and } g(x) = \frac{4}{1 + e^{-2x}}$$

Define the composite function $f \circ g^{-1}$ by $\left(f \circ g^{-1}\right)(x) = f\left(g^{-1}(x)\right)$, where g^{-1} is the inverse of the function g.

Then the value of the derivative of the composite function $f \circ g^{-1}$ at $x = 2$ is _____ .

15. Let

$$\alpha = \frac{1}{\sin 60^\circ \sin 61^\circ} + \frac{1}{\sin 62^\circ \sin 63^\circ} + \cdots + \frac{1}{\sin 118^\circ \sin 119^\circ}$$

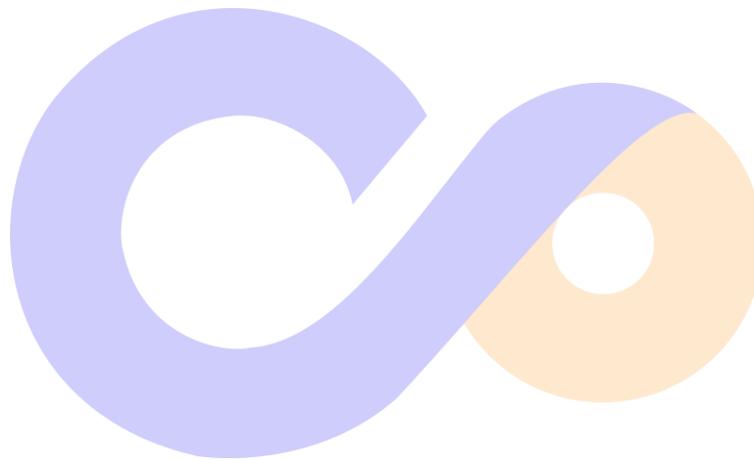Then the value of $\left(\dfrac{\operatorname{cosec} 1^\circ}{\alpha} \right)^2$

is _____ .

16. If

$$\alpha = \int_{\frac{1}{2}}^{2} \frac{\tan^{-1} x}{2x^2 - 3x + 2} dx$$

then the value of $\sqrt{7} \tan\left(\frac{2\alpha\sqrt{7}}{\pi}\right)$ is _____.

(Here, the inverse trigonometric function $\tan^{-1} x$ assumes values in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.)

NTA FINAL ANSWERS

1.	(C)	2.	(B)	3.	(C)	4.	(A)	5.	(A,B)
6.	(A,C)	7.	(A,C)	8.	(B,C,D)	9.	0.7 to 0.8	10.	6
11.	0.27 to 0.33	12.	–2	13.	–2	14.	0.2 to 0.3	15.	3
16.	21								