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JEE (MAIN) 2025

MEMORY BASED QUESTIONS & TEXT SOLUTION

SHIFT-2

DATE & DAY: 08th April 2025 & Tuesday

PAPER-1

Duration: 3 Hrs.

Time: 03:00 PM – 06:00 PM

SUBJECT: MATHEMATICS

Selections in JEE (Advanced)/
IIT-JEE Since 2002

52395

Selections in JEE (Main)/
AIEEE Since 2009

257576

Selections in NEET (UG)/
AIPT/AIIMS Since 2012

22494

Admission Open for 2025-26

Target: JEE (Advanced) | JEE (Main) | NEET (UG) | PCCP (Class V to X)

100% Scholarship on the basis of Class 10th & 12th
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PART : MATHEMATICS

1. If $P(A) = 0.7$, $P(B) = 0.4$ and $P(A \cap \bar{B}) = 0.5$ then find $P\left(\frac{B}{A \cup B}\right)$.

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

(2) $\frac{1}{4}$

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

(4) $\frac{1}{2}$

Ans. (2)

Sol.
$$P\left(\frac{B}{A \cup B}\right) = \frac{P(B \cap (A \cup \bar{B}))}{P(A \cup B)}$$
$$= \frac{P(A \cap B)}{1 - P(\bar{A} \cap \bar{B})}$$
$$= \frac{0.2}{1 - 0.2} = \frac{1}{4}$$

$P(A \cap \bar{B}) = P(A) - P(A \cap B) \Rightarrow 0.5 = 0.7 - P(A \cap B) \Rightarrow P(A \cap B) = 0.2$

2. Number of rational terms in the $\left(2^{\frac{1}{2}} + 3^{\frac{1}{8}}\right)^{1016}$ expression of

(1) 126

(2) 127

(3) 164

(4) 128

Ans. (3)

Sol. $T_{r+1} = {}^{1016}C_r \cdot 2^{\frac{1016-r}{2}} \cdot 3^{\frac{r}{8}}$

for rational terms

$\frac{1016-r}{2} \Rightarrow r = 0, \dots, 1016$

$\frac{r}{8} = \text{Integer} \Rightarrow r = 0, 8, 16, \dots, 1016$

Common $r = 0, 8, 16, \dots, 1016$

$1016 = 0 + (n-1) \times 8$

$10 = 8n$

$n = 128$

3. If $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \dots = \frac{\pi^2}{90}$, $\alpha = \frac{1}{1^4} + \frac{1}{3^4} + \frac{1}{5^4} + \dots$ & $\beta = \frac{1}{2^4} + \frac{1}{4^4} + \dots$ then find $\frac{\alpha}{\beta}$.

Ans. (15)

Sol. $\left(\frac{1}{1^4} + \frac{1}{3^4} + \frac{1}{5^4} + \dots\right) + \frac{1}{2^4} \left(\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \dots\right) = \frac{\pi^2}{90}$

$\alpha + \frac{1}{2^4} \left(\frac{\pi^2}{90}\right) = \frac{\pi^2}{90}$

$\alpha = \frac{\pi^2}{90} \left(1 - \frac{1}{16}\right) = \frac{\pi^2 \cdot (15)}{90 \cdot 16} = \frac{\pi^2}{6 \times 16}$

Now,

$\beta = \frac{\pi^2}{90} \cdot \left(\frac{1}{2^4}\right)$

$\frac{\alpha}{\beta} = 15$

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4. If $f(x) = \frac{3}{x} + \frac{x}{3} + 3$ is strictly increasing for $x \in (-\infty, \alpha_1) \cup (\alpha_2, \infty)$ and its strictly decreasing for $x \in (\alpha_3, \alpha_4)$

$\cup (\alpha_4, \alpha_5)$ then find $\sum_{i=1}^5 \alpha_i^2$

(1) 9

(2) 25

(3) 36

(4) 64

Ans. (3)

Sol. $f(x) = \frac{-3}{x^2} + \frac{1}{3} = \frac{x^2 - 9}{3x^2} = \frac{(x+3)(x-3)}{3x^2}$

$$\begin{array}{ccccccc} + & , & - & , & - & , & + \\ \hline & -3 & & 0 & & 3 & \end{array}$$

$f(x) \uparrow$ in $x \in (-\infty, -3) \cup (3, \infty)$

$f(x) \downarrow$ in $x \in (-3, 0) \cup (0, 3)$

$\alpha_1 = -3, \alpha_2 = 3, \alpha_3 = -3, \alpha_4 = 0, \alpha_5 = 3$

$\sum_{i=1}^5 \alpha_i^2 = 9 + 9 + 9 + 0 + 9 = 36$

5. Find value of $\int_{-1}^{3/2} x^2 \sin \pi x \, dx$.

(1) $1 + 3\pi$

(2) $2 + 3\pi$

(3) $1 + 2\pi$

(4) $4 + 3\pi$

Ans. (1)

Sol. $I = \int_{-1}^{3/2} x^2 \sin \pi x \, dx = \int_{-1}^{3/2} x \sin \pi x \, dx$

$I = \int_{-\pi}^{3\pi/2} t \sin t \, dt$ (let $\pi x = t \Rightarrow \pi dx = dt$)

$I = 2 \int_0^{\pi} t \sin t \, dt + \int_{\pi}^{3\pi/2} t \sin t \, dt$

$I = 2 \int_0^{\pi} t \sin t \, dt - \int_{\pi}^{3\pi/2} t \sin t \, dt$

$I = 2 \left((t - \cos t)_0^{\pi} - \int_0^{\pi} \cos t \, dt \right) - \left((t - \cos t)_{\pi}^{3\pi/2} - \int_{\pi}^{3\pi/2} \cos t \, dt \right)$

$I = 2 \left(\pi \cdot 1 + (\sin t)_0^{\pi} \right) - \left(\pi \cdot (-1) + (\sin t)_{\pi}^{3\pi/2} \right)$

$I = 2\pi + \pi + 1 = 1 + 3\pi$

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6. Find sum or square of roots of equation $|x-2|^2 + |x-2| - 2 = 0$ and $x^2 - 2|x-3| - 5 = 0$.

Ans. (36)

Sol. $|x-2|^2 + |x-2| - 2 = 0$

$$t^2 + t - 2 = 0$$

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

$$t = 1, -2$$

$$|x-2| = 1, -2$$

$$x - 2 = \pm 1$$

$$x = 3, 1$$

$$\text{Again : } x^2 - 2|x-3| - 5 = 0$$

If $x \geq 3$ then

$$x^2 - 2x + 6 - 5 = 0$$

$$x^2 - 2x + 1 = 0$$

$$x = 1 \text{ rejected}$$

If $x < 3$ then

$$x^2 + 2x - 6 - 5 = 0$$

$$x^2 + 2x - 11 = 0$$

$$x = \frac{-2 \pm \sqrt{4 + 44}}{2}$$

$$x = -1 \pm \sqrt{12} \text{ Selected}$$

$$\text{Now Sum of square of roots} = 3^2 + 1^2 + (-1 + \sqrt{12})^2 + (-1 - \sqrt{12})^2$$

$$10 + 12 + 1 - 2\sqrt{12} + 12 + 1 + 2\sqrt{12}$$

$$= 36$$

7. In a plane there are 12 points in which only 5 are collinear and no other 3 points are collinear. Then number of triangles formed.

(1) 210

(2) 220

(3) 170

(4) 190

Ans. (1)

Sol. ${}^{12}C_3 - {}^5C_3 = 210$

8. Product of last two digits of $(1919)^{1919}$, is :

(1) 65

(2) 63

(3) 67

(4) 69

Ans. (2)

Sol. $(1920-1)^{1919}$

$$= {}^{1919}C_0 (1920)^{1919} - \dots + {}^{1919}C_{1918} (1920) - {}^{1919}C_{1919}$$

$$= 100 (\text{..}) + 1919 \times 1920 - 1$$

$$= 100\text{..} + 3684880 - 1$$

$$100\text{..} + 3684879$$

$$\text{Product of last two digits is } = 7 \times 9 = 63$$

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9. Two lines $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ & $\frac{x-\lambda}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ has shortest distance $\frac{1}{\sqrt{6}}$.

If λ_1, λ_2 are two values of λ then radius of circle passing through $(0, 0)$, (λ_1, λ_2) and (λ_2, λ_1) is

- (1) $\frac{5}{2\sqrt{2}}$ (2) $\frac{\sqrt{5}}{2}$ (3) $\sqrt{\frac{5}{2}}$ (4) $\frac{5}{2}$

Ans. (1)

Sol. S.D. = $\frac{|(\lambda-1)\mathbf{i} + (3-2)\mathbf{j} + (4-3)\mathbf{k}| \cdot (\mathbf{b} \times \mathbf{d})}{\mathbf{b} \times \mathbf{d}}$

where

$$\mathbf{b} \times \mathbf{d} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 2 & 3 & 4 \\ 3 & 4 & 5 \end{vmatrix} = \mathbf{i}(-1) - \mathbf{j}(-2) + \mathbf{k}(-1)$$

Now $\frac{1}{\sqrt{6}} = \frac{|(-\lambda+1)+2-1|}{\sqrt{6}}$

$$2-\lambda = \pm 1$$

$$\lambda = 1, 3$$

Let circle, $x^2 + y^2 + 2gx + 2fy = 0$ (through origin)

It also passes through $(1, 3)$ & $(3, 1)$

$$9 + 1 + 6g + 2f = 0$$

$$1 + 9 + 2g + 6f = 0$$

Solving $-16f - 20 = 0$

$$f = -\frac{5}{4}$$

and $6g = -10 + \frac{5}{4}$

$$g = \frac{-15}{12} = -\frac{5}{4}$$

Circle radius $= \sqrt{g^2 + f^2} = \sqrt{\frac{25}{16} \times 2} = \frac{5}{2\sqrt{2}}$

10. Value of $\cot^{-1}\left(\frac{\sqrt{\sec^2 2 + 1}}{\tan 2}\right) - \cot^{-1}\left(\frac{\sqrt{\sec^2 \frac{1}{2} + 1}}{\tan \frac{1}{2}}\right)$

- (1) π (2) $\frac{\pi}{2}$ (3) $\frac{3\pi}{4}$ (4) $\frac{-\pi}{2}$

Ans. (2)

Sol. $\cot^{-1}\left(\frac{|\tan 2|}{\tan 2}\right) - \cot^{-1}\left(\frac{|\tan \frac{1}{2}|}{\tan \frac{1}{2}}\right)$

$$\cot^{-1}(-1) - \cot^{-1}(1)$$

$$= \frac{+3\pi}{4} - \frac{\pi}{4} = \frac{\pi}{2}$$

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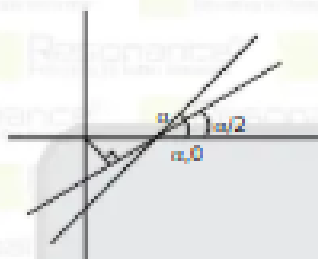
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11. A line passing through $(a, 0)$ making an acute angle α with positive direction of x-axis is rotated clockwise by an angle $\frac{\alpha}{2}$ about point $(a, 0)$ to make a slope $2 - \sqrt{3}$. If the perpendicular distance from the origin to this line (after rotation) is $\frac{\sqrt{3}}{2\sqrt{2}}$, then the value of $4a^2 \tan^2 \alpha + 2\sqrt{3}$ is

Ans. (4)

Sol.



$$\tan \frac{\alpha}{2} = 2 - \sqrt{3}$$

$$\alpha = 30^\circ$$

$$y - 0 = (2 - \sqrt{3})(x - a)$$

$$\frac{\sqrt{3}}{2\sqrt{2}} = \frac{|(2 - \sqrt{3})a|}{\sqrt{4 + 3 - 4\sqrt{3} + 1}}$$

$$|a|(2 - \sqrt{3}) = \frac{\sqrt{3}}{\sqrt{2}} \sqrt{2 - \sqrt{3}} \Rightarrow a = \frac{\sqrt{3}}{\sqrt{2}} \frac{1}{\sqrt{2 - \sqrt{3}}}$$

$$4a^2 \tan^2 \alpha - 2\sqrt{3} = 4 \times \frac{3}{2} (2 - \sqrt{3}) \frac{1}{3} + 2\sqrt{3} = 4$$

12. $f(x) = x - 1, g(x) = e^x \forall x \in \mathbb{R}$. If $\frac{dy}{dx} = e^{-2\sqrt{x}} \cdot (g \circ f \circ f(x)) - \frac{y}{\sqrt{x}}$ has solution $y(x)$ and $y(0) = 0$ then $y(1) =$

(1) $\frac{1}{e^3} - \frac{1}{e^4}$

(2) $e^3 - e^4$

(3) $\frac{1}{e} - e^2$

(4) $e^2 - \frac{1}{e^2}$

Ans. (1)

Sol.

$\therefore f(x) = x - 2$ and $g \circ f \circ f(x) = e^{x-2}$

$$\frac{dy}{dx} + \frac{y}{\sqrt{x}} = e^{-2\sqrt{x}} \cdot e^{x-2}$$

$$\text{If } e^{\int \frac{1}{\sqrt{x}} dx} = e^{-2\sqrt{x}}$$

So Solution is

$$y \cdot e^{-2\sqrt{x}} = \int e^{-2\sqrt{x}} \cdot e^{x-2} dx + c$$

$$y e^{2\sqrt{x}} = \int e^{x-2} dx + c$$

$$y e^{2\sqrt{x}} = e^{x-2} + c$$

from $y(0) = 0$

$$c = -\frac{1}{e^2}$$

$$\text{Now } y e^{2\sqrt{x}} = e^{x-2} - \frac{1}{e^2}$$

$$\text{at } x=1 \Rightarrow y = e^{-1} - \frac{1}{e^4}$$

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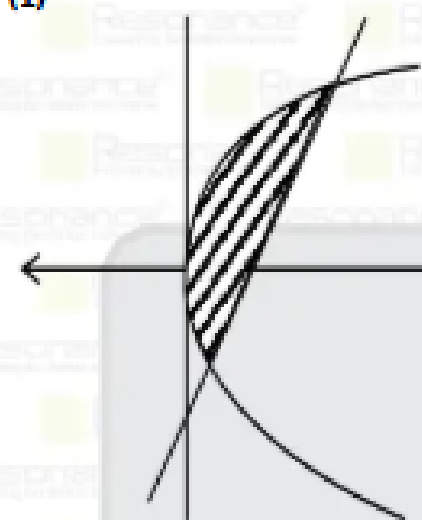
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13. If area bounded by $\{(x, y); y^2 \leq 9x \text{ and } y \geq 3x - 6\}$ be A then $6A$ is equal to

- (1) 93 (2) 90 (3) 120 (4) 87

Ans. (1)

Sol.



Solving $9x = y^2$ and $\frac{y+6}{3} = x$

$$3y + 18 = y^2$$

$$y^2 - 3y - 18 = 0$$

$$y = 6, -3$$

$$\text{Area} = \int_{-3}^6 \left(\frac{y+6}{3} - \frac{y^2}{9} \right) dy = \left(\frac{y^2}{6} + 2y - \frac{y^3}{27} \right)_{-3}^6$$

$$= \left(6 + 12 - \frac{216}{27} \right) - \left(\frac{9}{6} - 6 + \frac{27}{27} \right)$$

$$= 18 - 8 + \frac{9}{2} + 1 = \frac{31}{2}$$

$$6A = 93$$

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