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JEE

(Main)

PAPER-2 (B.E./B. TECH.)

2022

COMPUTER BASED TEST (CBT)


Memory Based Questions & Solutions

Date: 29 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 06.00 p.m)
Duration: 3 Hours | Max. Marks: 300

SUBJECT: MATHEMATICS

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PART : MATHEMATICS

1. The value of $\lim_{x \rightarrow 1} \frac{(x^2 - 1)\sin^2 \pi x}{x^4 - 2x^3 + 2x - 1}$ is

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

Ans. (2)
Sol. Given

$$\lim_{x \rightarrow 1} \frac{(x^2 - 1)\sin^2 \pi x}{x^2 - 2x^3 + 2x - 1}$$

$$= \lim_{x \rightarrow 1} \frac{(x-1)(x+1)\sin^2 \pi x}{(x-1)^3(x+1)}$$

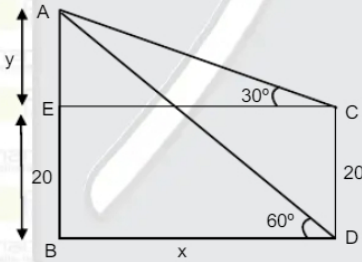
Put $x = 1 + h$

$$= \lim_{h \rightarrow 0} \frac{\sin^2 \pi(1+h)}{(1+h-1)^2}$$

$$\lim_{h \rightarrow 0} \frac{\sin^2 \pi h}{\pi^2 h^2} = \pi^2$$

2. The angle of elevation of the top of a tower from the top and bottom of a pole are 30° and 60° respectively. If the height of pole is 20m then the height of the tower is (in meters)
- (1) 35 (2) 30 (3) 40 (4) 45

Ans. (2)
Sol.



In $\triangle ABD$

$$\tan 60^\circ = \frac{20+y}{x} \quad \dots\dots(1)$$

In $\triangle AEC$

$$\tan 30^\circ = \frac{y}{x} \quad \dots\dots(2)$$

from equation $\frac{\tan 60^\circ}{\tan 30^\circ} = \frac{20+y}{y} \Rightarrow \frac{\sqrt{3}}{1/\sqrt{3}} = \frac{20+y}{y}$

$$\Rightarrow \frac{20+y}{y} = 3 \Rightarrow y = 10$$

height of tower = $20 + y = 30\text{m}$

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3. Negation of $(p \wedge q) \Rightarrow (\sim p) \wedge r$ is
- (1) $p \vee q$ (2) $p \wedge q$ (3) $(p \wedge q) \vee \sim r$ (4) $p \vee \sim r$

Ans. (2)

Sol. Given $(p \wedge q) \Rightarrow (\sim p) \wedge r$

\therefore Negation is $(p \wedge q) \wedge \sim (\sim p \wedge r)$

$$= (p \wedge q) \wedge (p \vee \sim r)$$

$$= (p \wedge q)$$

4. Let 3,6,9upto 78th term and 5,9,13,17.....upto 59th term are two A.P., then the sum of common terms of two series is

Ans. (2223)

Sol. 3,6,9 upto 78th term

$$t_{78} = 3 + (78 - 1) 3 = 234$$

5,9,13,17.....upto 59th term

$$T_{59} = 5 + (59-1) 4 = 237$$

Now series of common term is

9,21,33.....

$$t_n = 9 + (n-1) 12 \leq 234$$

$$12n \leq 237$$

$$n \leq 19.75 \Rightarrow n = 19$$

$$\therefore S_{19} = \frac{19}{2} [18 + (19-1)12] = 19 \times 117 = 2223$$

5. The sum of series $1 + \frac{5}{6} + \frac{12}{6^2} + \frac{22}{6^3} + \dots$ upto infinite terms is

- (1) $\frac{287}{125}$ (2) $\frac{286}{125}$ (3) $\frac{288}{125}$ (4) $\frac{289}{125}$

Ans. (3)

Sol. Let $S = 1 + \frac{5}{6} + \frac{12}{6^2} + \frac{22}{6^3} + \dots$ (1)

$$\frac{S}{6} = \frac{1}{6} + \frac{5}{6^2} + \frac{12}{6^3} + \dots$$
 (2)

Equation (1) - (2)

$$\frac{5S}{6} = 1 + \frac{4}{6} + \frac{7}{6^2} + \frac{10}{6^3} + \dots$$
 (3)

$$\frac{5S}{36} = \frac{1}{6} + \frac{4}{6^2} + \frac{7}{6^3} + \dots$$
 (4)

Equation (3) - (4)

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$$\frac{25S}{36} = 1 + \frac{3}{6} + \frac{3}{6^2} + \frac{3}{6^3} + \dots$$

$$= 1 + \frac{\frac{3}{6}}{1 - \frac{1}{6}} = 1 + \frac{3}{5}$$

$$\frac{25S}{36} = \frac{8}{5} \Rightarrow S = \frac{288}{125}$$

6. The number of solution of equation $\sin x = \cos^2 x$ in the interval $(0, 10)$ is

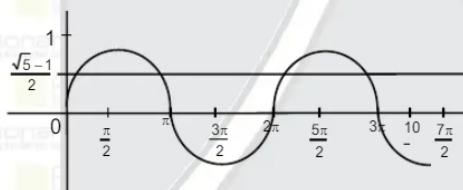
Ans. (04.00)

Sol. Given equation $\sin x = \cos^2 x$

$$\Rightarrow \sin^2 x + \sin x - 1 = 0$$

$$\Rightarrow \sin x = \frac{-1 \pm \sqrt{5}}{2}$$

$$\Rightarrow \sin x = \frac{\sqrt{5} - 1}{2}$$



\therefore Number of solution = 4

7. Let α be the root of equation $x^4 + x^2 + 1 = 0$, then the value of $\alpha^{1011} + \alpha^{2022} - \alpha^{3033}$ is :

- (1) $1 + 2\alpha$ (2) α (3) 1 (4) $1 + \alpha$

Ans. (3)

Sol. $x^4 + x^2 + 1 = 0$

$$\alpha \text{ is a root } \therefore \alpha^4 + \alpha^2 + 1 = 0$$

$$\Rightarrow \alpha^2 = \omega \text{ or } \omega^2$$

$$\text{Now } \alpha^{1011} + \alpha^{2022} - \alpha^{3033}$$

$$= \alpha \cdot (\alpha^2)^{505} + (\alpha^2)^{1011} - \alpha \cdot (\alpha^2)^{1516}$$

$$= \alpha \cdot \omega^{505} + \omega^{1011} - \alpha \cdot \omega^{1516}$$

$$= \alpha\omega + 1 - \alpha\omega$$

$$= 1$$

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8. If $A = \begin{bmatrix} 2 & -1 \\ 0 & 2 \end{bmatrix}$ and $B = I - {}^5C_1(\text{adj } A) + {}^5C_2(\text{adj } A)^2 - {}^5C_3(\text{adj } A)^3 + {}^5C_4(\text{adj } A)^4 - {}^5C_5(\text{adj } A)^5$, then the sum of elements of B is

- (1) -5 (2) -7 (3) -6 (4) -4

Ans. (2)

Sol. $B = (I - (\text{adj } A))^5 = \left(\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - \begin{bmatrix} 2 & -1 \\ 0 & 2 \end{bmatrix} \right)^5 = \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix}^5 = C^5$

$$C^2 = \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$$

$$C^4 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 4 \\ 0 & 1 \end{bmatrix}$$

$$B = C^4 C = \begin{bmatrix} 1 & 4 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} -1 & -5 \\ 0 & -1 \end{bmatrix}$$

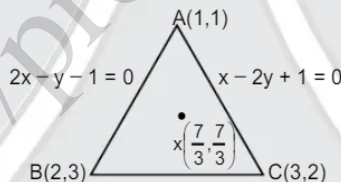
Sum of elements = $(-1) + (-5) + (-1) = -7$

9. The two sides of a triangle are $2x - y - 1 = 0$ and $x - 2y + 1 = 0$. If orthocentre of triangle is $\left(\frac{7}{3}, \frac{7}{3}\right)$, then distance of origin from centroid of triangle is

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

Ans. (2)

Sol.



altitude through B is $2x + y + \lambda = 0$

$$\Rightarrow \frac{14}{3} + \frac{7}{3} + \lambda = 0$$

$$\lambda = -7$$

\therefore altitude is $2x + y - 7 = 0$

equation of AB is $2x - y - 1 = 0$

\therefore B (2, 3), similarly C(3,2)

\therefore centroid G (2,2)

$$\therefore OG = \sqrt{4+4} = 2\sqrt{2}$$

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