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JEE
(Main)
PAPER-1 (B.E./B. TECH.)
2022

COMPUTER BASED TEST (CBT)
Memory Based Questions & Solutions

Date: 28 June, 2022 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)
Duration: 3 Hours | Max. Marks: 300

SUBJECT: MATHEMATICS

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PART : MATHEMATICS

1. If curve $y = f(x)$ satisfying $\left(\frac{x}{y} + e^{y/x} \right) x \frac{dy}{dx} = x + \sqrt{\frac{x}{y} + e^{y/x}}$ and passing through (1,0)

$$\left(\sqrt{x^2 - y^2} \right) dx - \left(\sqrt{x^2 - y^2} \right) dy$$

and $(2\alpha, \alpha)$ then the value of α is

- (1) $\frac{1}{2} e^{\left(\frac{\pi}{6} + e^{1/2} + 1\right)}$ (2) $\frac{1}{2} e^{\left(\frac{\pi}{6} + e^{1/2} - 1\right)}$ (3) $\frac{1}{4} e^{\left(\frac{\pi}{6} + e^{1/2} - 1\right)}$ (4) $\frac{1}{4} e^{\left(\frac{\pi}{6} + e^{1/2} + 1\right)}$

Ans. (2)

Sol. $\left(\frac{1}{\sqrt{1 - \left(\frac{y}{x}\right)^2}} + e^{y/x} \right) \frac{dy}{dx} = 1 + \frac{y}{x} \left(\frac{1}{\sqrt{1 - \left(\frac{y}{x}\right)^2}} + e^{y/x} \right)$

put $\frac{y}{x} = t$

$\frac{dt}{dx} = t + x \frac{dt}{dx}$

$\left(\frac{1}{\sqrt{1 - t^2}} + e^t \right) \left(t + x \frac{dt}{dx} \right) = 1 + t \left(\frac{1}{\sqrt{1 - t^2}} + e^t \right)$

$t \left(\frac{1}{\sqrt{1 - t^2}} + e^t \right) + \left(\frac{1}{\sqrt{1 - t^2}} + e^t \right) x \frac{dt}{dx} = 1 + t \left(\frac{1}{\sqrt{1 - t^2}} + e^t \right)$

$\left(\frac{1}{\sqrt{1 - t^2}} + e^t \right) dt = \frac{dx}{x}$

$\sin^{-1} t + e^t = \ln x + C$

$\sin^{-1} \left(\frac{y}{x} \right) + e^{y/x} = \ln x + C$

put $(1, 0)$ $0 + 1 = C$

$C = 1$

$\Rightarrow \sin^{-1} \left(\frac{y}{x} \right) + e^{y/x} = \ln x + 1$

put the value $(2\alpha, \alpha)$

$\frac{\pi}{6} + e^{1/2} - 1 = \ln 2\alpha$

$\alpha = \frac{1}{2} e^{\left(\frac{\pi}{6} + e^{1/2} - 1\right)}$

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2. Probability that in three digit number at least two digit are odd

- (1) $\frac{15}{36}$ (2) $\frac{19}{36}$ (3) $\frac{23}{36}$ (4) $\frac{13}{36}$

Ans. (2)

Sol. Total numbers of three digit numbers = 900

Total numbers with atleast two odd digit numbers

$OOO + EOO + OEO + OOE$

$5 \times 5 \times 5 - 4 \times 5 \times 5 + 5 \times 5 \times 5 + 5 \times 5 \times 5$

$25 (5 + 5 + 5 + 4) = 19 \times 25$

the required probability is $\frac{19 \times 25}{900} = \frac{19}{36}$

3. The number of 5 digit positive integer numbers divisible by 6 using digit 1,2,3,5,6,7, without repetition is

(1) 70 (2) 71 (3) 72 (4) 73

Ans. (3)

Sol. Case $\rightarrow 1\ 2\ 5\ 6\ 7 \Rightarrow 4! \times 2$
 $\rightarrow 1\ 2\ 3\ 5\ 7 \Rightarrow 4! \times 1$
 total $\rightarrow 72$

4. The mean and standard deviation of 15 observation are 8 and 3 respectively. If an observation 20 was misread as 5, then the correct variance is

Ans. 17

Sol. Mean = $\frac{\sum x_i}{15} = 8 \Rightarrow \sum x_i = 120$

S.D. = $\sqrt{\frac{(\sum x_i)^2}{15} - (\bar{x})^2}$

$9 = \frac{\sum x_i^2}{15} - 64$

$\Rightarrow \sum x_i^2 = 15 \times 73$

$\Rightarrow \sum x_i^2 = 1095$

Now 20 was misread as 5

$\therefore$ correct $\sum x_i = 120 - 5 + 20 = 135$

correct $\sum x_i^2 = 1095 - 25 + 400 = 1470$

$\therefore$ correct variance = $\frac{1470}{15} - \left(\frac{135}{15}\right)^2$

$= 98 - 81$

$= 17$

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5. If A is a square matrix of order 3 such that $|A| = 2$ then the value of $|A \cdot \text{adj}(5 \cdot \text{adj}(A^3))|$ is

- (1) $2^{15} \cdot 5^6$ (2) $2^{15} \cdot 5^4$ (3) $2^{15} \cdot 5^3$ (4) $2^{13} \cdot 5^6$

Ans. (1)

Sol. $A_{3 \times 3}$ such that $|A| = 2$

Now $|A \cdot \text{adj}(5 \cdot \text{adj}(A^3))|$

$$= |A^3| \cdot |\text{adj}(5 \cdot \text{adj}(A^3))|$$

$$= |A^3| \cdot (5^2)^3 \cdot |\text{adj}(\text{adj} A^3)|$$

$$= 2^3 \cdot 5^6 \cdot |\text{adj}(\text{adj} A^3)|$$

$$= 2^3 \cdot 5^6 \cdot |\text{adj}(\text{adj} A)^3|$$

$$= 2^3 \cdot 5^6 \cdot (|A|^{(3-1)^2})^3$$

$$= 2^3 \cdot 5^6 \cdot |A|^{12}$$

$$= 2^3 \cdot 5^6 \times 2^{12}$$

$$= 2^{15} \cdot 5^6$$

6. AB and PQ are two poles 160 meter apart and C is mid point of BQ. Where B and Q are on level ground.

If the height of PQ is twice of AB and angles of elevation of P and A from C are $\frac{\pi}{8}$ and Q respectively

then the value of $\tan^2\theta$ is

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

Ans. (4)

Sol. $\tan \frac{\pi}{8} = \frac{2x}{80}$

$\tan \theta = \frac{x}{80}$

$\frac{\tan \theta}{\tan \frac{\pi}{8}} = \frac{1}{2}$

$\tan \theta = \frac{1}{2} \tan \frac{\pi}{8}$

$\tan^2 \theta = \frac{1}{4} \left(\frac{\sin^2 \frac{\pi}{8}}{\cos^2 \frac{\pi}{8}} \right) = \frac{1}{4} \left(\frac{1 - \cos \frac{\pi}{4}}{1 + \cos \frac{\pi}{4}} \right)$

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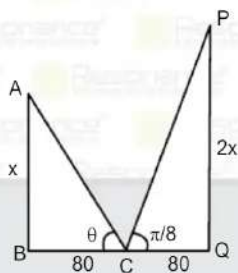
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$= \frac{1}{4} \cdot \frac{\sqrt{2}-1}{\sqrt{2}+1} = \frac{(\sqrt{2}-1)^2}{4}$

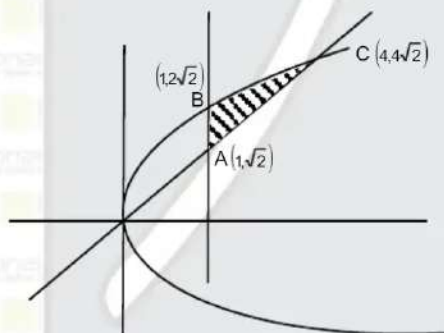


7. The area bounded between the curves $y^2 \leq 8x$, $y \geq \sqrt{2}x$ and $x \geq 1$ is

- (1) $\frac{11\sqrt{2}}{12}$ (2) $\frac{11\sqrt{2}}{3}$ (3) $\frac{11\sqrt{2}}{6}$ (4) $\frac{11\sqrt{2}}{8}$

Ans. (3)

Sol.



Required area is

$\frac{11\sqrt{2}}{6}$

$$\begin{aligned}
 &= \int_1^4 (2\sqrt{x} - \sqrt{x}) dx \\
 &\Rightarrow \left(2\sqrt{2} \frac{x^{3/2}}{3/2} - \sqrt{2} \frac{x^2}{2} \right)_1^4 \\
 &\Rightarrow \left(\frac{4\sqrt{2}}{3} \cdot 4^{3/2} - \sqrt{2} \cdot \frac{4^2}{2} \right) - \left(\frac{4\sqrt{2}}{3} - \frac{\sqrt{2}}{2} \right) \\
 &= \frac{28\sqrt{2}}{3} - \frac{15\sqrt{2}}{2} = \frac{11\sqrt{2}}{6}
 \end{aligned}$$

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8. The positive integral value of k for which the constant term in the expansion of $\left(2x^3 + \frac{3}{x^k}\right)^{12}$ is

$2^8 \cdot \ell$, where ℓ is an odd integer

Ans. (06.00)

Sol. Let $T_{r+1} = {}^{12}C_r \cdot (2x^3)^{12-r} \cdot \left(\frac{3}{x^k}\right)^r = 2^{24-r} \cdot 3^r \cdot x^{36-3r-kr}$

$$\Rightarrow {}^{12}C_r \cdot 2^{12-r} \cdot 3^r \cdot x^{36-3r-kr} = 2^8 \cdot \ell$$

$$\Rightarrow 36 - 3r - kr = 0 \text{ and } {}^{12}C_r \cdot 2^{12-r} \cdot 3^r = 2^8 \cdot \ell$$

$$\Rightarrow 36 = (3+k)r \text{ and } {}^{12}C_r \cdot 2^{12-r} \cdot 3^r = 2^8 \cdot \ell$$

$$\Rightarrow r = \frac{36}{3+k} \text{ and } {}^{12}C_r \cdot 2^{4-r} \cdot 3^r = \ell$$

$$k=1 \Rightarrow r=9$$

$$k=3 \Rightarrow r=9$$

$$k=6 \Rightarrow r=4; \ell \text{ is odd}$$

$$\text{so, } k=6$$

9. If $\sum_{k=1}^{31} {}^{31}C_k \cdot {}^{31}C_{k-1} - \sum_{k=1}^{30} {}^{30}C_k \cdot {}^{30}C_{k-1} = \alpha \cdot \frac{60}{30!3!}$ then the value of α is

$$(1) 2800$$

$$(2) 2821$$

$$(3) 2822$$

$$(4) 3000$$

Ans. (3)

Sol. $(1+x)^{31} = {}^{31}C_0 + {}^{31}C_1 x^1 + {}^{31}C_2 x^2 + \dots$

$$(x+1)^{31} = {}^{31}C_0 x^{31} + {}^{31}C_1 x^{30} + {}^{31}C_2 x^{29} + \dots$$

$$\sum_{k=1}^{31} {}^{31}C_k \cdot {}^{31}C_{k-1} = {}^{31}C_1 \cdot {}^{31}C_0 + {}^{31}C_2 \cdot {}^{31}C_1 + \dots + {}^{31}C_{31} \cdot {}^{31}C_{30}$$

coefficient x^{30} in $(1+x)^{62}$ is ${}^{62}C_{30}$

$$\sum_{k=1}^{30} {}^{30}C_k \cdot {}^{30}C_{k-1} = {}^{30}C_1 \cdot {}^{30}C_0 + {}^{30}C_2 \cdot {}^{30}C_1 + \dots + {}^{30}C_{30} \cdot {}^{30}C_{29}$$

coefficient x^{29} in $(1+x)^{60}$ is ${}^{60}C_{29}$

$${}^{62}C_{30} - {}^{60}C_{29}$$

$$\frac{62!}{30!32!} - \frac{60!}{29!31!} = \frac{60!}{30!32!} \left(\frac{62 \times 61}{1} - 30 \times 32 \right)$$

$$\text{so } \alpha = 62 \times 61 - 30 \times 32$$

$$\alpha = 2822$$

10. If line $y = 2x + c$ is a tangent to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, whose eccentricity and latus rectum are $\sqrt{\frac{5}{2}}$

and $6\sqrt{2}$ respectively, then the value of C^2 is

$$(1) 2\sqrt{5}$$

$$(2) 20$$

$$(3) 24$$

$$(4) 16$$

Ans. (2)

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Sol. $\because 1 + \frac{b^2}{a^2} = \frac{5}{2} \Rightarrow b^2 = \frac{3}{2}a^2$ (1)

$\because \frac{2b^2}{a} = 6\sqrt{2} \Rightarrow b^2 = 3\sqrt{2}a$ (2)

from equation (1) and (2)

$b^2 = 12$ and $a^2 = 8$

$\because c^2 = a^2m^2 - b^2$ where $m = 2$

$\Rightarrow c^2 = 32 - 12 = 20$

11. The number of real solution of $x^7 + x^5 + x^3 + x - 1 = 0$ is

(1) 0

(2) 1

(3) 2

(4) 3

Ans. (2)

Sol. $f(x) = x^7 + x^5 + x^3 + x - 1$

$f'(x) = 7x^6 + 5x^4 + 3x^2 + 1 > 0, \forall x \in \mathbb{R}$

$\Rightarrow f(x)$ is strictly increasing

$\Rightarrow$ Equation $f(x) = 0$ has only 1 real root

12. If $p, p^n \in \{1, 2, 3, \dots, 50\}$, and relation $R_1 = \{(p, p^n) | p \text{ is prime} \& n \geq 0, n \text{ is integer}\}$
 $R_2 = \{(p, p^n) | p \text{ is prime} \& n = 0 \text{ or } 1\}$, then the number of elements in $R_1 - R_2$ is

Ans. (08.00)

Sol. R_1 contains (2, 1) (2, 2) (2, 4) (2, 8) (2, 16), (2, 32)

(3, 1) (3, 3) (3, 9) (3, 27)

(5, 1) (5, 5) (5, 25)

(7, 1) (7, 7) (7, 49)

(11, 1) (11, 11)

(13, 1) (13, 13)

(17, 1) (17, 17)

R_2 contains (2, 1), (2, 2)

(3, 1), (3, 3)

(5, 1), (5, 5)

(7, 1), (7, 7)

(11, 1), (11, 11)

So, $R_1 - R_2$ has 8 elements

13. The value of integral $\int_0^1 [-8x^2 + 6x - 1] dx$ is (where $[\]$ is G.I.F.)

(1) $\frac{\sqrt{17}-11}{8}$

(2) $\frac{\sqrt{17}+11}{8}$

(3) $\frac{\sqrt{17}-11}{4}$

(4) $\frac{\sqrt{17}+11}{4}$

Ans. (1)

Sol. Let $f(x) = -8x^2 + 6x - 1$

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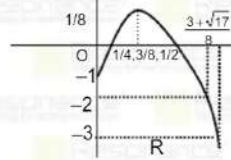
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$$\begin{aligned} \therefore \int_0^{\frac{1}{4}} (-1) dx + \int_{\frac{1}{4}}^{\frac{1}{2}} 0 dx + \int_{\frac{1}{2}}^{\frac{3+\sqrt{17}}{8}} (-1) dx + \int_{\frac{3+\sqrt{17}}{8}}^1 (-2) dx \\ = -\frac{1}{4} + 0 - \frac{3-\sqrt{17}}{8} + \frac{1}{2} - 2 + 2 \cdot \frac{3+\sqrt{17}}{8} \\ = \frac{3+\sqrt{17}}{8} - \frac{7}{4} = \frac{\sqrt{17}-11}{8} \end{aligned}$$

14. Let $a_1, a_2, a_3, \dots$ are in G.P such that $a_1 \cdot a_3 \cdot a_5 \cdot a_7 = \frac{1}{1296}$ and $a_2 + a_4 = \frac{7}{36}$, then value of $a_6 + a_8 + a_{10}$ is

Ans. (43.00)

Sol. Let $a_1, a_2, a_3, a_4, \dots$ in G.P

$$\begin{aligned} \therefore a_1 \cdot a_3 \cdot a_5 \cdot a_7 &= \frac{1}{1296} \Rightarrow a^4 r^{12} = \frac{1}{1296} \\ &= ar^3 = \frac{1}{6} = a_4 \end{aligned}$$

$$\text{Now } a_2 + a_4 = \frac{7}{36} \therefore a_2 = \frac{1}{36} = ar$$

$$\therefore r^2 = 6$$

$$\begin{aligned} \text{Now } a_6 + a_8 + a_{10} &= ar^5 + ar^7 + ar^9 \\ &= ar^3 (r^2 + r^4 + r^6) \\ &= \frac{1}{6} (6 + 36 + 216) \\ &= 1 + 6 + 36 = 43 \end{aligned}$$

15. Tangents are drawn at points $O(0, 0)$ and $P(1 + \sqrt{5}, 2)$ to the circle $x^2 + y^2 - 2x - 4y = 0$. If these tangents meet at point Q , then the area of $\triangle OPQ$ is equal to

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

Ans. (2)

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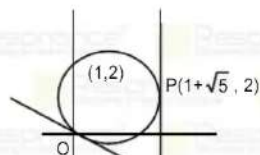
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Sol.



$$Q(1+\sqrt{5}, y_1)$$

Equation of tangent at $O(0, 0)$

$$0 + 0 - 2 \frac{(x+0)}{2} - 4 \left(\frac{y+0}{2} \right) = 0$$

$$x + 2y = 0$$

it passes through $(1+\sqrt{5}, y_1)$

$$\Rightarrow 1 + \sqrt{5} + 2y_1 = 0$$

$$y_1 = -\left(\frac{\sqrt{5}+1}{2} \right)$$

$$\begin{aligned} \text{So area of } \triangle OPQ &= \frac{1}{2} \left| \begin{array}{cc} 0 & 0 \\ \sqrt{5}+1 & -(\sqrt{5}+1) \\ \sqrt{5}+1 & 2 \end{array} \right| \\ &= \frac{1}{2} \left(2\sqrt{5} + 2 + \frac{5+1+2\sqrt{5}}{2} \right) \\ &= \frac{1}{2} (2\sqrt{5} + 2 + 3 + \sqrt{5}) \\ &= \frac{1}{2} (5 + 3\sqrt{5}) \end{aligned}$$

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