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# JEE (Main) 2021

## COMPUTER BASED TEST (CBT)



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**Date: 20 July, 2021 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)**

**Duration: 3 Hours | Max. Marks: 300**

## SUBJECT: MATHEMATICS

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**1** All possible words with or without meaning were formed using all the letters of the word 'EXAMINATION'. The probability that 'M' appears at fourth position is :

(1) $\frac{2}{11}$ (2) $\frac{1}{11}$ (3) $\frac{4}{11}$ (4) $\frac{8}{11}$

**Ans.** (2)

**Sol.** EXAMINATION

$E \rightarrow 1$ $\quad n(S) = \frac{11!}{2!\,2!2!}$

$X \rightarrow 1$ $\quad n(E) = \frac{10!}{2!\,2!2!}$

$A \rightarrow 2$ $\quad P(E) = \frac{n(E)}{n(s)} = \frac{1}{11}$

$M \rightarrow 1$

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$T \rightarrow 1$

$N \rightarrow 2$

$I \rightarrow 2$

**2** If a cricket team consist of 15 players have 6 batsmen , 7 Ballers and 2 wicket keepers then the number of ways in which cricket team formed with atleast 4 batsmen, 5 ballers and 1 wicket keeper

(1) 567 (2) 525 (3) 462 (4) 777

**Ans.** **(4)**

**Sol.** **Case-I :** Team consist 5 Batsman , 5 Bowlers and 1 wicket keeper then number of ways.

$= {}^6C_5 \times {}^7C_5 \times {}^2C_1 = 6 \times 21 \times 2 = 252$

**Case - II** 4 Batsmen, 6 blowers and 1 wicket keeper

$= {}^6C_4 \times {}^7C_6 \times {}^2C_1 = 15 \times 7 \times 2 = 210$



${}^6C_4 \times {}^7C_5 \times {}^2C_2 = 15 \times 21 \times 1 = 315$

Total 252 + 210 + 315 = 777





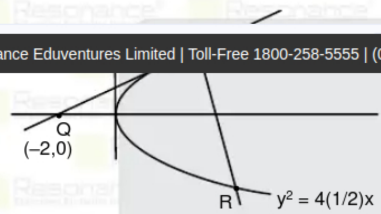


**3** Tangent drawn at a point P(2,2) to parabola $y^2 = 2x$ cuts x-axis at point Q and normal drawn at point P(2,2) to parabola cut parabola again at point R then area of $\Delta PQR$ is

(1) 25 (2) $\frac{25}{2}$ (3) $\frac{15}{2}$ (4) 50

**Ans.** **(2)**

**Sol.**






Equation of tangent at P(2,2) is T = 0

$2y = x + 2$

$y^2 = 4$ So, Q (–2,0)

$2at_1 = 1 \Rightarrow t_1 = 2$

$t_2 = -t_1 - \frac{2}{t_1} = -2 - \frac{2}{2} = -3$

$\therefore R\left(\frac{1}{2}(-3)^2, 2\left(\frac{1}{2}\right)(-3)\right) = \left(\frac{9}{2}, -3\right)$



Area of $\Delta PQR = \frac{1}{2}\begin{vmatrix} 2 & 2 & 1 \\ -2 & 0 & 1 \\ \frac{9}{2} & -3 & 1 \end{vmatrix}$

$= \frac{1}{2}[2(0+3) - 2(-2 - 9/2) + 1(6 - 0)] = \frac{1}{2}[6 + 4 + 9 + 6] = \frac{25}{2}$ sq. unit.

**4.** Coefficient of $x^{256}$ in the expansion of $(1 - x)^{101}(x^2 + x + 1)^{100}$ is

(1) ${}^{100}C_{86}$ (2) ${}^{100}C_{85}$ (3) ${}^{100}C_{84}$ (4) ${}^{100}C_{83}$

**Ans.** **(2)**

**Sol.** $\Rightarrow (1 - x)^{101}(x^2 + x + 1)^{100}$

$\Rightarrow (1 - x)^{100}(x^2 + x + 1)^{100}(1 - x)$

$\Rightarrow (1 - x^3)^{100}(1 - x)$

$\Rightarrow (1-x)\,({}^{100}C_0 - {}^{100}C_1x^3 + {}^{100}C_2x^6 + .... + {}^{100}C_{84}x^{252} - {}^{100}C_{85}x^{255} + {}^{100}C_{86}x^{256} + .....)$

$\Rightarrow {}^{100}C_{85}x^{256}$







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**Ans.** 1

**Sol.** $\lim\limits_{x\to 0}\left(2-\cos\sqrt{\cos 2x}\right)^{\frac{x^2+2}{x}}$ $\quad (1^\infty \text{ form})$

$= e^{\lim\limits_{x\to 0}\frac{\left(1-\cos x\sqrt{\cos 2x}\right)}{x}(x^2+2)}$

$= e^{\lim\limits_{x\to 0}\left\{\frac{1-\cos^2 x(\cos 2x)}{x}\right\}(x^2+2)}$

$= e^{\lim\limits_{x\to 0}\left\{\frac{1-\cos^2 x(\cos 2x)}{x}\right\}\left(\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}\right)}$

$= e^{\lim\limits_{x\to 0}\left\{\frac{1-\cos^2(2\cos^2 x-1)}{x}\right\}\left(\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}\right)}$

$= e^{\lim\limits_{x\to 0}\frac{(1-2\cos^4 x+\cos^2 x)}{x}\cdot\frac{x^2+2}{...}}$

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$= e^{\lim\limits_{x\to 0}\frac{-(2\cos^4 x-\cos^2 x-1)}{x}\cdot\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$

$= e^{\lim\limits_{x\to 0}\frac{(2\cos^2 x+1)(\cos^2 x-1)}{x}\cdot\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$

$= e^{\lim\limits_{x\to 0}\frac{+(2\cos^2 x+1)\sin^2 x}{x}\cdot\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$

$= e^{\lim\limits_{x\to 0}(2\cos^2 x+1)\frac{\sin x}{x}.\sin x\,\frac{x^2+2}{1+\cos x\sqrt{\cos 2x}}}$

$= e^0 = 1$

**6.** If the focal chord y = mx + c of parabola $y^2 = -64x$ is also the tangent to the circle $(x+10)^2 + y^2 = 4$ then absolute value of $4\sqrt{2}\,(m + c)$ is

**Ans.** 34

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So, $-16m+c= 0 \Rightarrow c = 16m$ ......(i)w

Now slope form of tangent to the circle

$(x+10)^2 + y^2 = 4$ is given by

$y = m(x+10) \pm 2\sqrt{1+m^2}$

So, $c = 10m \pm 2\sqrt{1+m^2}$ .......... (ii)

By (i) and (ii)



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$16m = 10m \pm 2\sqrt{1+m^2}$

$\Rightarrow 9m^2 = 1 + m^2 \Rightarrow m = \pm\frac{1}{2\sqrt{2}}$

$\Rightarrow c = 16m = \pm\frac{8}{\sqrt{2}}$

$\therefore \; 4\sqrt{2}(m+c) = \pm 34$



two :

(1) 10 ,11 (2) 11, 12 (3) 9, 12 (4) 9, 11

**Ans.** (1)

**Sol.** Let two number x and y according to question

$18 + x + y = 39$

$x + y = 21$ …………(1)

$10.25 = \frac{\sum x_i^2}{n} - (\bar{x})^2$

$10.25 = \frac{x^2+y^2+4+16+25+49}{6} - (6.5)^2$

$10.25 = \frac{x^2+y^2+94}{6} - (6.5)^2$

$\Rightarrow x^2 + y^2 = 221$ …………(2)



So, x = 10 or y = 11

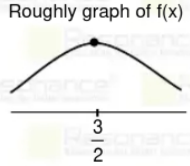
**8.** A continuous & differentiable function f(x) is increasing in $\left(-\infty, \frac{3}{2}\right)$ and decreasing in $\left(\frac{3}{2}, \infty\right)$ then $x = \frac{3}{2}$ is:

(1) point of local maxima (2) point of local minima

(3) point of Inflection (4) None of these

**Ans.** (1)

**Sol.** Roughly graph of f(x) can be drawn as













(1) $50.3^{24}$ (2) $51.3^{24}$ (3) $52.3^{24}$ (4) $104.3^{24}$

**Ans.** (3)

**Sol.** $x^2 + \sqrt{3} = -3^{\frac{1}{4}}x$

$\Rightarrow x^4 + 2\sqrt{3}x^2 + 3 = \sqrt{3}x^2$

$\Rightarrow x^4 + \sqrt{3}x^2 + 3 = 0$

$\Rightarrow x^{8}+6x^{4}+9=3x^{4}$

$\Rightarrow x^8+3x^4+9=0$

$\Rightarrow \alpha^8=-9-3\alpha^4$

$\Rightarrow \alpha^{12}=-9\alpha^4-3\alpha^8=-9\alpha^4-3(-9-3\alpha^4)=27$

Similarly $\beta^{12}=27$



**10.** In a $\Delta ABC$, If AB = 5, $\angle B=\cos^{-1}(3/5)$ and radius of circumcircle of triangle is 5 then the area of $\Delta ABC$ is :

(1) $6+8\sqrt{3}$ (2) $3+4\sqrt{3}$ (3) $3+8\sqrt{3}$ (4) $6+4\sqrt{3}$

**Ans.** (1)

**Sol.** $\cos B=\frac{3}{5}\Rightarrow \sin B=\frac{4}{5}$, R = 5

$\Rightarrow \frac{b}{2R}=\frac{4}{5}\Rightarrow b=8,\ c=5$

$\cos B=\frac{a^2+c^2-b^2}{2ac}=\frac{3}{5}\Rightarrow \frac{a^2+25-64}{2a(5)}=\frac{3}{5}$

$a^2-39=6a\Rightarrow a^2-6a-39=0$



$\Delta=\frac{abc}{4R}=\frac{(3+4\sqrt{3})(8)(5)}{4(5)}=6+8\sqrt{3}$

**11.** The number of integral terms is the expansion of $\left(4^{\frac{1}{4}}+5^{\frac{1}{6}}\right)^{120}$ is :

(1)11 (2)21 (3)20 (4)30

**Ans.** (2)









**Sol.** General term of $\left(2^{\frac{1}{2}}+5^{\frac{1}{6}}\right)^{120}$ is

given by $T_{r+1}={}^{120}C_r\left(2^{\frac{1}{2}}\right)^{120-r}\left(5^{\frac{1}{6}}\right)^{r}$

For integral term, r should be a multiple of 6

i.e $r\in\{0,6,12,18,\ldots\ldots.,120\}$



$\therefore$ 21 integral terms are there in the expansion

**12.** If the shortest distance between the lines $\vec{r}_1=\alpha\hat{i}+2\hat{j}+2\hat{k}+\lambda(\hat{i}-2\hat{j}+2\hat{k}),\lambda\in R,\alpha>0$ and $\vec{r}_2=-4\hat{i}-\hat{k}+\mu(3\hat{i}-2\hat{j}-2\hat{k}),\mu\in R$ is 9, then the value of $\alpha$ is

(1)2 (2)4 (3) 6 (4) $\sqrt{6}$

**Ans.** **(3)**

**Sol.** Shortest distance $=\left|\frac{(a_2-a_1).(b_1\times b_2)}{|b_1\times b_2|}\right|$

$\Rightarrow 9=\left|\frac{((\alpha+4)\hat{i}+2\hat{j}+3\hat{k}).(8\hat{i}+8\hat{j}+4\hat{k})}{\sqrt{64+64+16}}\right|$

$\therefore \alpha = 6$

**13.** If $\vec{a}, \vec{b}, \vec{c}$ are mutually $\perp$ unit vectors equally inclined to $\vec{a}+\vec{b}+\vec{c}$ at an angle $\theta$, find $36\cos^2 2\theta$.

**Ans.** 4

**Sol.** $|\vec{a}+\vec{b}+\vec{c}|^2 = (\vec{a}+\vec{b}+\vec{c}).(\vec{a}+\vec{b}+\vec{c}) = |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 = 3$

$\Rightarrow |\vec{a}+\vec{b}+\vec{c}| = \sqrt{3}$

Now $\vec{a}.(\vec{a}+\vec{b}+\vec{c}) = |\vec{a}||\vec{a}+\vec{b}+\vec{c}|\cos\theta$

$\Rightarrow \cos\theta = \frac{1}{\sqrt{3}} \Rightarrow \cos 2\theta = 2\cos^2\theta - 1$

$\Rightarrow \cos 2\theta = -\frac{1}{3} \Rightarrow \cos^2 2\theta = \frac{1}{9} \Rightarrow 36\cos^2 2\theta = 4$

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

**Ans.** (4)

**Sol.** Let $z = re^{i\theta}$ & $\omega = \frac{1}{r}e^{i\left(\theta - \frac{3\pi}{2}\right)}$

then $\frac{1-2\bar{z}\omega}{1+3\bar{z}\omega} = \frac{1-2re^{-i\theta}.\frac{1}{r}e^{i\left(\theta-\frac{3\pi}{2}\right)}}{1+3re^{-i\theta}.\frac{1}{r}e^{i\left(\theta-\frac{3\pi}{2}\right)}}$

$= \frac{1-2e^{-i\frac{3\pi}{2}}}{1+3e^{-i\frac{3\pi}{2}}} = \frac{1-2i}{1+3i}$

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The arg $\left(-\frac{1}{2}-\frac{1}{2}i\right) = -\frac{3\pi}{4}$

**15.** If f(x) = $\begin{cases} \sin x - e^x ; & x \le 0 \\ a + [-x] ; & 0 < x < 1 \\ 2x - b ; & x \ge 1 \end{cases}$ is continuous and differentiable function then find the value of a + b.

(where [•] is GIF)

**Ans.** (03.00)

**Sol.** Since f(x) is continuous at x = 0

So $\lim_{x\to 0^-} f(x) = \lim_{x\to 0^+} f(x) = f(0)$

$-1 = a - 1 = -1 \Rightarrow a = 0$

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$a - 1 = 2 - b = 2 - b$

$\Rightarrow a = 0$, so $0 - 1 = 2 - b$

$\Rightarrow -3 = -b$

$\Rightarrow$ b = 3

So the value of a + b = 3







**16.** If $A = [a_{ij}]_{3\times 3}$ where $a_{ij} = \begin{cases} 1 & i = j \\ -x & |i-j| = 1 \\ 2x+1 & \text{otherwise} \end{cases}$ and f(x) = det (A), then the sum of local maximum and local minimum value of f(x) is:

(1) $\frac{20}{27}$ (2) $\frac{-20}{27}$ (3) $\frac{88}{27}$ (4) $\frac{-88}{27}$

**Ans.** (4)


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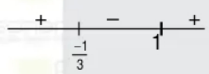
$|2x+1 \quad -x \quad 1|$

$\Rightarrow f(x) = 4x^3 - 4x^2 - 4x$

$\Rightarrow f'(x) = 12x^2 - 8x - 4$

$= 4(3x^2 - 2x - 1)$

$= 4(x-1)(3x+1)$



$\Rightarrow$ f(x) is maximum at $x = \frac{-1}{3}$ and minimum at x = 1

$\therefore$ maximum value $= \frac{20}{27}$ and minimum value = –4

$\therefore$ sum $\frac{20}{...}$ 4 $\frac{88}{...}$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(1) 60 (2) 45 (3) 40 (4) 90

**Ans.** (1)

**Sol.** $(ab + bc + ac)^6 = \sum_{p+q+r=6} \frac{6!}{p!q!r!}(ab)^p(bc)^q(ca)^r$

$= \sum_{p+q+r=6} \frac{6!}{p!q!r!} a^{p+r} b^{p+q} c^{q+r}$

For $a^3b^4c^5$, we need

$p + r = 3$

$p + q = 4$

$q + r = 5$

Solving we get, p = 1, q=3, r=2

$\therefore$ coefficient of $a^3 b^4 c^5$ in $(ab + bc + ac)^6$ is $\frac{6!}{1!.2!.3!} = 60$


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**18.** If an invertible function f(x) is defined as f(x) = 3x – 2 , g(x) is also an invertible function such that



(1) $\frac{x-8}{3}$ (2) $\frac{x+8}{3}$ (3) $\frac{x-3}{8}$ (4) $\frac{x+3}{8}$

**Ans.** (2)

**Sol.** $f^{-1}(g^{-1}(x)) = x - 2$

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

$3(x-2) - 2 = g^{-1}(x)$

$3x - 8 = g^{-1}(x)$

$g^{-1}(x) = 3x - 8$

or $x = 3g(x) - 8$

$g(x) = \frac{x+8}{3}$

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(1) $\pi + \ell n2$ (2) $2\ell n2$ (3) $\frac{\pi}{2} - 1 + \ell n2$ (4) $\ell n2 - \frac{\pi}{2} - 1$

**Ans.** **(4)**

**Sol.** $f(x) = \ell n\left(\sqrt{1-x} + \sqrt{1+x}\right)$ $x \in [-1, 1]$ is an even function

$\Rightarrow I = 2\int_0^1 \ell n\left(\sqrt{1-x} + \sqrt{1+x}\right)dx$

Put $x = \cos 2\theta \Rightarrow dx = -2\sin 2\theta \, d\theta$

$\therefore \cos 2\theta = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$

$\Rightarrow I = -4\int_{\pi/4}^{0}\left[\ell n\left\{(\sin\theta + \cos\theta)\sqrt{2}\right\}\right]\sin 2\theta \, d\theta$

$= 4\int_0^{\pi/4}\left[\ell n\left\{(\sin\theta + \cos\theta)\sqrt{2}\right\}\right]\sin 2\theta \, d\theta$

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$= 4\int_0 \ell n(\sin\theta + \cos\theta)\sin 2\theta \, d\theta + 4\,\ell n\sqrt{2}\int_0 \sin 2\theta \, d\theta$

$= 4\left[\left|-\ell n(\sin\theta + \cos\theta)\frac{\cos 2\theta}{2}\right|_0^{\pi/4} + \int_0^{\pi/4} -\frac{\cos\theta - \sin\theta}{\sin\theta + \cos\theta}\cdot\frac{\cos 2\theta}{2}d\theta\right] + 4\ell n\sqrt{2}\left(-\frac{\cos 2\theta}{2}\right)_0^{\pi/4}$

$= 4\left[0 - \frac{1}{2}\int_0^{\pi/4}(\cos\theta - \sin\theta)^2 d\theta\right] + 4\ell n\sqrt{2}\left(0 + \frac{1}{2}\right)$



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$= 4\left[0 - \frac{1}{2}\int_0^{\pi/4}(1 - \sin 2\theta)d\theta\right] + 2\ell n\sqrt{2}$

$= -2\left[\theta + \frac{\cos 2\theta}{2}\right]_0^{\pi/4} + \ell n2$

$= -2\left[\frac{\pi}{4} - \frac{1}{2}\right] + \ell n2$

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**20.** The probability of selecting integers $a \in [-5,30]$, such that $x^2 + 2(a+4)x - 5a + 64 > 0$ for all $x \in R$ is :

(1) $\frac{7}{9}$ (2) $\frac{4}{9}$ (3) $\frac{5}{9}$ (4) $\frac{1}{3}$

**Ans.** (3)

**Sol.** $x^2 + 2(a+4)x - (5a - 64) > 0$

$D < 0$

$\therefore 4(a+4)^2 + 4(5a - 64) < 0$

$\Rightarrow (a+4)^2 + (5a - 64) < 0$

$\Rightarrow a^2 + 13a - 48 < 0$

$a = \frac{-13 \pm \sqrt{169+192}}{2}$

So, $a \in [-16, 3]$



**21.** If $\int_0^a e^{x-[x]}dx = 10e - 9$, then the value of 'a' is (where [•] is GIF)

(1) $9+\ell n2$ (2) $10+\ell n2$ (3) 10 (4) 9

**Ans.** (2)

**Sol.** Let $a = 10 + K$, $0 \le K < 1$

$\int_0^a e^{\{x\}}dx = 10e - 9$

$\int_0^{10} e^{\{x\}}dx + \int_{10}^{10+K} e^{\{x\}}dx = 10e - 10 + 1 \Rightarrow \int_{10}^{10+K} e^{\{x\}}dx = 1 \Rightarrow \int_0^K e^{\{x\}}dx = 1$

$e^K - 1 = 1$

$K = \ell n2$

so, $a = 10 + \ell n2$

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**22.** If $\vec{A}.\vec{B} = |\vec{A} \times \vec{B}|$, then $|\vec{A} - \vec{B}|$ is

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(1) $\sqrt{A^2+B^2+\sqrt{2}AB}$ (2) $\sqrt{A^2+B^2-\sqrt{2}AB}$ (3) $\sqrt{A^2+B^2+\sqrt{2}AB}$ (4) $\sqrt{A^2+B^2-\sqrt{2}AB}$

**Ans.** (4)

**Sol.** $\vec{A}.\vec{B} = |\vec{A} \times \vec{B}| \Rightarrow \cos\theta = \sin\theta \Rightarrow \tan\theta = 1$

$\theta = \frac{\pi}{4}$

$|\vec{A} - \vec{B}|^2 = A^2 + B^2 - 2\vec{A}.\vec{B}$

$= A^2 + B^2 - 2AB\cos\left(\frac{\pi}{4}\right)$

$= A^2 + B^2 - \sqrt{2}AB$

$\Rightarrow |\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - \sqrt{2}AB}$

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