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(Memory Based) JEE MAIN – 2020 September Session 03-09-2020 (Shift-II) (MATHEMATICS)

01. If $\int_0^{\frac{1}{2}} \frac{x^2}{\left(1-x^2\right)^{3/2}} dx = \frac{k}{6}$, then $k =$

1) $3\sqrt{2}+\pi$ 2) $2\sqrt{3}-\pi$ 3) $2\sqrt{3}+\pi$ 4) $3\sqrt{2}-\pi$

Ans: 2

Sol: Let $x=\sin\theta \Rightarrow dx=\cos\theta\, d\theta$

$$Given\ \text{int}\,egral\ becomes\ \frac{k}{6}=\int_0^{\frac{1}{2}}\frac{x^2}{\left(1-x^2\right)^{3/2}}dx$$

$$\Rightarrow \frac{k}{6}=\int \frac{\sin^2\theta}{\left(1-\sin^2\theta\right)^{3/2}}.\cos\theta\ d\theta \Rightarrow \frac{k}{6}=\int_0^{\frac{\pi}{6}}\frac{\sin^2\theta}{\cos^3\theta}\cos\theta\, d\theta$$

$$\Rightarrow \frac{k}{6}=\int_0^{\frac{\pi}{6}}\tan^2\theta\, d\theta=\int_0^{\frac{\pi}{6}}\left(\sec^2\theta-1\right)d\theta \Rightarrow \frac{k}{6}=\left(\tan\theta-\theta\right)_0^{\pi/6}=\left(\frac{1}{\sqrt{3}}-\frac{\pi}{6}\right)=\frac{2\sqrt{3}-\pi}{6}\Rightarrow k=2\sqrt{3}-\pi$$

02. Let $\frac{x^2}{25}+\frac{y^2}{b^2}=1$ and $\frac{x^2}{16}-\frac{y^2}{b^2}=1$ are ellipse and hyperbola having eccentricities e_1, e_2 respectively such that $e_1e_2=1$.If distance between foci of ellipse is α and that of hyperbola is β then (α,β) *is equal to*

1) $(4,5)$ 2) $(8,10)$ 3) $(10,7)$ 4) $(4,10)$

Ans: 2

Sol: $e_1=\sqrt{1-\frac{b^2}{25}}$; $e_2=\sqrt{1+\frac{b^2}{16}}$; $e_1e_2=1$

$$\Rightarrow (e_1\ e_2)^2=1 \Rightarrow \left(1-\frac{b^2}{25}\right)\left(1+\frac{b^2}{16}\right)=1 \Rightarrow 1+\frac{b^2}{16}-\frac{b^2}{25}-\frac{b^4}{25\times16}=1$$

$$\Rightarrow \frac{9}{16.25}b^2-\frac{b^4}{25.16}-0 \Rightarrow b^2=9$$

$$\alpha=2(5)(e_1)=8\ ;\ \beta=2(4)(e_2)=10$$

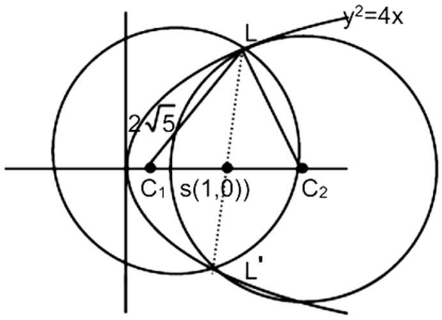
$$(\alpha,\beta)=(8,10)$$

03. Two equal circles of radius $2\sqrt{5}$ pass through extremities oflatusrectum of $y^2=4x$, then the distance betweencenters of circles is

1) 4 2) 8 3) 2 4) 6

Ans: 2

Sol:



Given parabola is $y^2 = 4x$, Focus is S=(1,0) and LR=4

From triangle $C_1LS, (C_1L)^2 = (C_1S)^2 + (LS)^2 \Rightarrow 20 = (C_1S)^2 + 4$

$\Rightarrow C_1C_2 = 2C_1S = 2\sqrt{20-4} = 8$

04. If $\int \sin^{-1}\left(\frac{\sqrt{x}}{\sqrt{1+x}}\right)dx = A(x)\tan^{-1}\sqrt{x} + B(x) + C$, then $A(x)$ and $B(x)$ will be

1) $1+x, \sqrt{x}$ 2) $1-x, -\sqrt{x}$ 3) $1+x, -\sqrt{x}$ 4) $1-x, \sqrt{x}$

Ans: 3

Sol: $I = \int \sin^{-1}\left(\frac{\sqrt{x}}{\sqrt{1+x}}\right)dx, (Let\ \sin^{-1}\left(\frac{\sqrt{x}}{\sqrt{1+x}}\right) = A \Rightarrow \sin A = \frac{\sqrt{x}}{\sqrt{1+x}} \Rightarrow \tan A = \sqrt{x} \Rightarrow A = \tan^{-1}(\sqrt{x}))$,

$= \int \tan^{-1}(\sqrt{x})dx = x\tan^{-1}\sqrt{x} - \int \frac{1}{1+x}.\frac{1}{2\sqrt{x}}.xdx + C = x\tan^{-1}\sqrt{x} - \frac{1}{2}\int \frac{t.2t.dt}{1+t^2} + C \quad (Put\ \ x = t^2)$

$= x\tan^{-1}\sqrt{x} - \int \frac{t^2}{1+t^2}dt + C = x\tan^{-1}\sqrt{x} - t + \tan^{-1}(t) + C = x\tan^{-1}\sqrt{x} - \sqrt{x} + \tan^{-1}\sqrt{x} + C$

$= (x+1)\tan^{-1}\sqrt{x} - \sqrt{x} + C \Rightarrow (Ax) = x+1 \Rightarrow B(x) = -\sqrt{x}$

(OR)

Put $x = \tan^2\theta$ then apply integration byparts.

05. The coefficient of term independent of x in the expansion of $\left(\frac{3x^2}{2} - \frac{1}{3x}\right)^9$ is λ, then 18λ is

1) 9 2) 7 3) 6 4) 4

Ans:(2)

Sol: $T_{r+1} = {}^9C_r\left(\frac{3x^2}{2}\right)^{9-r}\left(-\frac{1}{3x}\right)^r = {}^9C_r\left(\frac{3}{2}\right)^{9-r}\left(-\frac{1}{3}\right)^r x^{18-3r}$

For the term independent of x ,put $18 - 3r = 0 \Rightarrow r = 6$

$Now\ T_7 = {}^9C_6\left(\frac{3}{2}\right)^3\left(-\frac{1}{3}\right)^6 = {}^9C_6\left(\frac{1}{6}\right)^3 = \frac{9\times8\times7}{3\times2\times1}\left(\frac{1}{6}\right)^3 = \left(\frac{7}{18}\right)$

06. If $|Z_1-1|=\text{Re}(Z_1), |Z_2-1|=\text{Re}(Z_2)$ and $\text{Arg}(Z_1-Z_2)=\frac{\pi}{3}$, then $\text{Im}(Z_1+Z_2)=$

1) $\frac{1}{\sqrt{3}}$ 2) $\frac{2}{\sqrt{3}}$ 3) $\frac{\sqrt{3}}{2}$ 4) $\sqrt{3}$

Ans: 2

Sol:

Let $z_1=x_1+iy_1$ *and* $z_2=x_2+iy_2$

$|Z_1-1|=\text{Re}(Z_1)\Rightarrow(x_1-1)^2+y_1^2=x_1^2\Rightarrow y_1^2-2x_1+1=0$ ....(1)

$|z_2-1|=\text{Re}(z_2)\Rightarrow(x_2-1)^2+y_2^2=x_2^2\Rightarrow y_2^2-2x_2+1=0$ ....(2)

$(1)-(2)\Rightarrow y_1^2-y_2^2-2(x_1-x_2)=0\Rightarrow(y_1-y_2)(y_1+y_2)=2(x_1-x_2)\Rightarrow y_1+y_2=2\left(\frac{x_1-x_2}{y_1-y_2}\right)$......(3)

$\text{Arg}(z_1-z_2)=\frac{\pi}{3}\Rightarrow\tan^{-1}\left(\frac{y_1-y_2}{x_1-x_2}\right)=\frac{\pi}{3}\Rightarrow\frac{y_1-y_2}{x_1-x_2}=\sqrt{3}$ ……………..(4)

$\therefore y_1+y_2=\frac{2}{\sqrt{3}}\Rightarrow Im(z_1+z_2)=\frac{2}{\sqrt{3}}$

07. The probability that a randomly selected 5 digit number contain exactly two distinct digits is

1) $\frac{135}{10^4}$ 2) $\frac{125}{10^4}$ 3) $\frac{144}{10^4}$ 4) $\frac{127}{10^4}$

Ans: 1

Sol: *Total number of ways* $=9(10^4)$

Favourable number of ways =Number of 5 digit numbers excluding ‘0’ having exactly 2 distinct digits+Number of 5 digit numbers including ‘0’ having exactly two distinct digits

$={}^9C_2(2^5-2)+{}^9C_1(2^4-1)=36(30)+9(15)=1080+135$

Probability = $\frac{36\times30+9\times15}{9\times10^4}=\frac{4\times30+15}{10^4}=\frac{135}{10^4}$

08. Let $(\lambda^2+1)x^2-4\lambda x+2=0$ be a quadratic equation ,then set of values of λ if exactly one root of the equation lies in the interval $(0,1)$ is

1) $(2,3)$ 2) $(1,3)$ 3) $[1,2)$ 4) $(1,3]$

Ans: 4

Sol: $f(0)f(1)\le0\Rightarrow2(\lambda^2+1-4\lambda+2)\le0\Rightarrow2(\lambda^2-4\lambda+3)\le0\Rightarrow(\lambda-1)(\lambda-3)\le0\Rightarrow\lambda\in[1,3]$

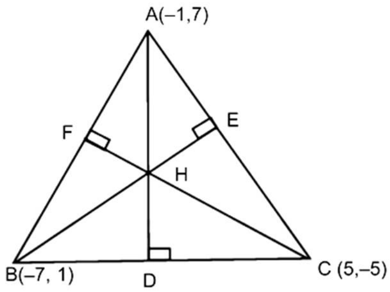
But at $\lambda=1$, *both roots are* 1. *So* $\lambda\ne1$ $\therefore\lambda\in(1,3]$

09. The orthocenter of ΔABC whose vertices are $A(-1,7)\,B(-7,1)\,C(5,-5)$ is

1) $(-3,3)$ 2) $(3,-3)$ 3) $(3,3)$ 4) $(-3,-3)$

Ans: 1

Sol:



$m_{BC} = \frac{6}{-12} = -\frac{1}{2}$ $\therefore$ Equation of AD is $y-7=2(x+1) \Rightarrow y=2x+9$ ………(1)

$m_{AC} = \frac{12}{-6} = -2$, Equation of BE is $y-1=\frac{1}{2}(x+7)$ $y=\frac{x}{2}+\frac{9}{2}$ …….. ……(2)

By (1) and (2) ; $2x+9=\frac{x+9}{2} \Rightarrow 4x+18=x+9 \Rightarrow 3x=-9 \Rightarrow x=-3$

From (1), $y=3$. Therefore orthocenter of triangle ABC is (-3,3)

10. If relation $R_1=\{(a,b):a,b\in R, a^2+b^2\in Q\}$ *and* $R_2=\{(a,b):a,b\in R, a^2+b^2\notin Q\}$ *then*

1) R_1 is transitive, R_2 is not transitive 2) R_1 is not transitive R_2 is not transitive

3) R_1 is transitive R_2 is transitive 4) R_1 is not transitive R_2 is transitive

Ans. (2)

Sol. For R_1 , let a = $1+\sqrt{2}, b=1-\sqrt{2}, c=8^{1/4}$

$aR_1b \Rightarrow a^2+b^2=6\in Q$

$aR_1c \Rightarrow b^2+c^2=(1-\sqrt{2})^2+(8^{1/4})^2=3\in Q$

$aR_1c \Rightarrow a^2+c^2=(1+\sqrt{2})^2+(8^{1/4})^2=3+4\sqrt{2}\notin Q$

R_1 is not transitive.

For R_2, let a $=1+\sqrt{2}, b=\sqrt{2}, c=1-\sqrt{2}$

$aR_2b \Rightarrow a^2+b^2=\left(1+\sqrt{2}\right)^2+(\sqrt{2})^2=5+2\sqrt{2}\notin Q$

$bR_2b \Rightarrow b^2+c^2=\left(\sqrt{2}\right)^2+(1-\sqrt{2})^2=5-2\sqrt{2}\notin Q$

$aR_2c \Rightarrow a^2+c^2=\left(1+\sqrt{2}\right)^2+(1-\sqrt{2})^2=6\in Q$

$\therefore R_2$ is not transitive.

11. If the sum of first n terms of series $20+19\frac{3}{5}+19\frac{1}{5}+18\frac{4}{5}+....$ is 488 and nthterm is negative then the

n^{th} *term is*

1) -4 2) 4 3) 1 4) 6

Ans. (4)

Sol. $488 = \frac{n}{2}\left[2\left(\frac{100}{5}\right) + (n-1)\left(-\frac{2}{5}\right)\right]$

$488 = \frac{n}{5}(101-n) \Rightarrow n^2 - 101n + 2440 = 0$

$\Rightarrow \quad n = 61 \quad (or) \quad 40$

$For \quad n = 40 \quad , \quad T_n > 0$

Therefore n = 61

$n^{th}\ term = 20 + 60\left(\frac{-2}{5}\right) = -4$

12. Surface area of cube is increasing at rate of 3.6 cm^2/s ,then the rate at which its volume is increasing at the moment , when length of edge is 10 cm., is

1) 9 2) 10 3) 18 4) 20

Ans. (1)

Sol. $S = 6a^2 \Rightarrow \quad \frac{ds}{dt} = 12a.\frac{da}{dt} = 3.6 \quad \Rightarrow \quad 12(10)\frac{da}{dt} = 3.6 \quad \Rightarrow \quad \frac{da}{dt} = 0.03$

$V = a^3 \Rightarrow \quad \frac{dv}{dt} = 3a^2.\frac{da}{dt} = 3(10)^2.\left(\frac{3}{100}\right) = 9$

13. Which of the following point lies on plane containing lines

$\vec{r} = \hat{i} + \lambda\left(\hat{i} + \hat{j} + \hat{k}\right)\ and\ \ \vec{r} = -\hat{j} + \mu\left(-\hat{i} - 2\hat{j} + \hat{k}\right)\ is$

1) (1,3,6) 2) (1,-3,6) 3) (-2,1,2) 4) (1,3,1)

Ans. (2)

Sol. Normal of plane is $\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 1 \\ -1 & -2 & 1 \end{vmatrix}$ i.e., $\bar{n} = 3\hat{i} - 2\hat{j} - \hat{k}$

D.R.s normal to the plane are $3, -2, -1$

Equation of the Plane is $3(x-1) - 2(y-0) - 1(z-0) = 0 \Rightarrow 3x - 2y - z - 3 = 0$

14. $\lim_{x \to a} \frac{\left(a^2 + 2x^2\right)^{1/3} - \left(3x^2\right)^{1/3}}{\left(3a^2 + x^2\right)^{1/3} - \left(4x^2\right)^{1/3}} =$

1) $\left(\frac{4}{3}\right)^{2/3}$ 2) $\frac{1}{3}\left(\frac{3}{4}\right)^{2/3}$ 3) $\frac{1}{3}\left(\frac{2}{3}\right)^{2/3}$ 4) $\frac{1}{3}\left(\frac{4}{3}\right)^{2/3}$

Ans. (4)

Sol. $\lim_{x\to a} \dfrac{\frac{1}{3}\left(a^2+2x^2\right)^{-2/3}4x-\frac{1}{3}.\left(3x^2\right)^{-2/3}.6x}{\frac{1}{3}\left(3a^2+x^2\right)^{-2/3}.2x-\frac{1}{3}\left(4x^2\right)^{-2/3}.8x}=\dfrac{(3a^2)^{-2/3}}{(4a^2)^{-2/3}}\times\dfrac{2}{6}=\dfrac{1}{3}.\dfrac{4^{2/3}}{3^{2/3}}$

15. If $x^3dy+xydx=2ydx+x^2dy$ & $y(2)=e$,*then* $y(4)$ is equal to

1) $\frac{1}{2}+\sqrt{e}$ 2) $\frac{1}{2}\sqrt{e}$ 3) $\sqrt{e}$ 4) $\frac{3}{2}\sqrt{e}$

Ans. (4)

Sol. $x^3dy+xydx=2ydx+x^2dy$

$\Rightarrow \left(x^3-x^2\right)dy=\left(2-x\right)ydx \Rightarrow \dfrac{dy}{y}=\dfrac{2-x}{x^2\left(x-1\right)}dx$

$\Rightarrow \int\dfrac{dy}{y}=\int\dfrac{2-x}{x^2\left(x-1\right)}dx$ ....(*i*)

Let $\dfrac{2-x}{x^2\left(x-1\right)}=\dfrac{A}{x}+\dfrac{B}{x^2}+\dfrac{C}{x-1}$

$\Rightarrow 2-x=A\left(x-1\right)+B\left(x-1\right)+Cx^2 \Rightarrow C=1, B=-2 \text{ and } A=-1$

$\Rightarrow \int\dfrac{dy}{y}=\int\left\{\dfrac{-1}{x}-\dfrac{2}{x^2}+\dfrac{1}{x-1}\right\}dx \Rightarrow \ln y=-\ln x+\dfrac{2}{x}+\ln\left|x-1\right|+C$

$\therefore y\left(2\right)=e$

$\Rightarrow 1=-\ln 2+1+0+C \Rightarrow C=\ln 2$

$\Rightarrow \ln y=-\ln x+\dfrac{2}{x}+\ln\left|x-1\right|+\ln 2$

at $x=4$

$\Rightarrow \ln y(4)=-\ln 4+\dfrac{1}{2}+\ln 3+\ln 2$

$\Rightarrow \ln y(4)=\ln\left(\dfrac{3}{2}\right)+\dfrac{1}{2}=\ln\left(\dfrac{3}{2}e^{1/2}\right) \Rightarrow y(4)=\dfrac{3}{2}e^{1/2}$

16. If $\dfrac{a}{\cos\theta}=\dfrac{b}{\cos\left(\theta+\frac{2\pi}{3}\right)}=\dfrac{c}{\cos\left(\theta+\frac{4\pi}{3}\right)}$,then the angle between vectors $a\hat{i}+b\hat{i}+c\hat{k}$ and $b\hat{i}+c\hat{j}+a\hat{k}$,where $\theta=\dfrac{2\pi}{9}$ and $a^2+b^2+c^2=1$, is

1) $\frac{\pi}{3}$ 2) $\frac{\pi}{6}$ 3) $\frac{2\pi}{3}$ 4) $\frac{5\pi}{6}$

Ans: (3)

SoL: $\dfrac{a}{\cos\theta}=\dfrac{b}{\cos\left(\theta+\frac{2\pi}{3}\right)}=\dfrac{c}{\cos\left(\theta+\frac{4\pi}{3}\right)}=\dfrac{a+b+c}{\cos\theta+\cos\left(\theta+\frac{2\pi}{3}\right)+\cos\left(\theta+\frac{4\pi}{3}\right)}=\dfrac{a+b+c}{0}$

$\Rightarrow a+b+c=0 \Rightarrow a^2+b^2+c^2+2(ab+bc+ca)=0 \Rightarrow ab+bc+ca=-\frac{1}{2}$

Now let angle between given vectors is ϕ

$\therefore \cos\phi = \frac{(a\hat{i}+b\hat{j}+c\hat{k})(b\hat{i}+c\hat{j}+a\hat{k})}{a^2+b^2+c^2} \Rightarrow \cos\phi = \frac{ab+bc+ca}{1} = \frac{-1}{2} \Rightarrow \phi = \frac{2\pi}{3}$

17. If $(p \wedge q) \rightarrow (\sim q \vee r)$ has truth value false then the truth values of p,q,r respectively are

1) T,T,F 2) T,F,T 3) F,FT 4) T,T,T

Ans: 1

Sol: $(p \wedge q)$ should be TRUE and $(-q \vee r)$ should be FALSE.

By observing truth table we can conclude that p = T,q = T,r = F

18. If m A.M's and 3 G.M's are inserted between 3 and 243 such that 2nd GM = 4thAM ,then m is equal to

Ans. 39.00

Sol. $3, A_1, A_2, A_3, ...A_m, 243$ *are in A.P*

Common Difference is $d = \frac{243-3}{m+1} = \frac{240}{m+1}$

$3, G_1, G_2, G_3, 243$ *are in G.P*

Common Ratio is $r = \left(\frac{243}{3}\right)^{\frac{0}{3+1}} = (81)^{1/4} = 3$

Given $G_2 = A_4 \Rightarrow 3(3)^2 = 3+4\left(\frac{240}{m+1}\right) \Rightarrow 27 = 3+\frac{960}{m+1} \Rightarrow m+1=40 \Rightarrow m=39$

19. A normal is drawn to parabola $y^2 = 4x$ at (1,2) and tangent is drawn to the curve $y=e^x$ at (c, e^c). If tangent and normal intersect at x – axis, then the value of c is

Ans. 04.00

Sol. For $(1,2)$ of $y^2 = 4x \Rightarrow t=1,\ a=1$

Normal to the parabola at t is $tx+y=2at+at^3$

$\Rightarrow x+y=3$ intersect x-axis at (3,0)

$y=e^x \Rightarrow \frac{dy}{dx} = e^x$

Equation of tangent to $y=e^x$ at (c, e^c) *is* $\Rightarrow y-e^c = e^c(x+c)$--------(1)

Equation (1) passes through (3,0)$\Rightarrow 0-e^c = e^c(3-c) \Rightarrow c=4$

20. The number of 3 digited numbers such that the sum of their digits is 10,is

Ans. 55.00

Sol. Let xyz be the three digit number

$x+y+z=10,\ where\ \ x\geq 1, y\geq 0, z\geq 0$

$\Rightarrow (x-1)+y+z=9,\ where\ x-1\geq 0, y\geq 0, z\geq 0$

Number of non-nagivtive integral solutions of the above equation= ${}^{n+r-1}C_{r-1} = {}^{(9+3-1)}C_{(3-1)} = {}^{11}C_2 = 55$

21. If $\sum_{i=1}^{10}(x_i-p)=3\ and \sum_{i=1}^{10}(x_i-p)^2=9$, then the standard deviation of $x_1, x_2, ..., x_{10}$ is

Ans: (00.90)

Sol: $$S.D=\sqrt{\frac{\sum_{i=1}^{10}(x_i-p)^2}{10}-\left(\frac{\sum_{i=1}^{10}(x_i-p)}{10}\right)^2}=\sqrt{\frac{9}{10}-\frac{9}{100}}=0.9$$

22. Let S be the set of all integral solutions (x,y,z) of the system of equations $x-2y+5z=0$, $-2x+4y+z=0\ and\ -7x+14y+9z=0$ such that $15\leq x^2+y^2+z^2\leq 150$, then the number of elements in the set S is equal to

Ans: 08.00

Sol: Given system of equations

$$x-2y+5z=0------(1)$$

$$-2x+4y+z=0-----(2)$$

$$-7x+14y+9z=0----(3)$$

(1)*2+(2)$\Rightarrow 11z=0 \Rightarrow z=0$

From (1) , $x=2y$

Also given , $15\leq x^2+y^2+z^2\leq 150$

$$\Rightarrow 15\leq 5y^2\leq 150$$

$$\Rightarrow 3\leq y^2\leq 30$$

$$\Rightarrow \sqrt{3}\leq |y|\leq \sqrt{30}$$

$$\Rightarrow y=-2,-3,-4,-5,2,3,4,5.$$


thank you