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56 Students Selected in JEE Advanced 2016 out of 129 JEE Main 2016 Selection Success Ratio 43%

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93/120 Swastik Sharma, 93/120 Shashwat Rangnekar & Our 112+ Students Selected for Advanced

46 Students, Scored 90% or More in Maths Class 12 (8 in M. P. Board with state Rank 7th Shivansh Maheshwari) (38 in CBSE)

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SUCCESS RATIO 55%

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JEE Main

अन. Set D

Page - 1

Q. If curve $y^2 = 6x$... ?

(A) Tangent to $y^2 = 6x$. $y \cdot y_1 = 3(x + x_1)$

Tangent to $gx^2 + by^2 = 16$

$$gx_1x + by_1y = 16$$

$$by_1y = -gx_1x + 16$$

$$y = -\frac{gx_1}{by_1}x + \frac{16}{by_1}$$

$$\text{Slope} = -\frac{gx_1}{by_1}$$

$$\frac{3}{y_1} \times -\frac{g}{b} \times \frac{x_1}{y_1} = -1 \quad (\text{curves are orthogonal})$$

$$+ 27 \times \frac{x_1}{y_1^2} = +1$$

$$\Rightarrow 27 \times \frac{1}{6} = \left(\frac{y_1}{2}\right)$$

$$\text{② } y_1^2 = 6x_1 \Rightarrow \frac{1}{6} = \frac{x_1}{y_1^2}$$

let $u = \text{coptan cur.}$... ?

Ans.
PTO

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(2) (B) Let $\vec{u} = a\hat{i} + b\hat{j} + c\hat{k}$ Page - 2
 $\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & -1 \\ 0 & 1 & 1 \end{vmatrix} \Rightarrow \hat{i}(3+1) - \hat{j}(2) + \hat{k}2$

\vec{u} coplanar with \vec{a} & \vec{b}

$$\therefore \vec{u} \cdot (\vec{a} \times \vec{b}) = 0$$

$$(a\hat{i} + b\hat{j} + c\hat{k}) \cdot (4\hat{i} - 2\hat{j} + 2\hat{k}) = 0$$

$$4a - 2b + 2c = 0 \quad \dots (i)$$

$$\vec{a} \perp \vec{u}$$

$$\therefore \vec{a} \cdot \vec{u} = 0$$

$$(a\hat{i} + b\hat{j} + c\hat{k}) \cdot (2\hat{i} + 3\hat{j} - \hat{k}) = 0$$

$$2a + 3b - c = 0 \quad \dots (ii)$$

$$\vec{u} \cdot \vec{b} = 24$$

$$(a\hat{i} + b\hat{j} + c\hat{k}) \cdot (0\hat{i} + \hat{j} + \hat{k}) = 24$$

$$b + c = 24$$

$$b + c = 24 \Rightarrow 3b = 24 \Rightarrow b = 8$$

$$(ii) \times 2 - i = 4a + 6b - 2c - 4a + 2b - 2c = 0$$

$$8b - 4c = 0$$

$$2b = c \quad \dots (iii)$$

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$$b + c = 24$$

$$8 + c = 24$$

$$c = 16$$

$$2a + 3(8) - 16 = 0$$

$$2a + 24 - 16 = 0$$

$$2a = -8$$

$$a = -4$$

$$|\vec{u}| = \sqrt{a^2 + b^2 + c^2}$$

$$\sqrt{(4)^2 + (8)^2 + (16)^2}$$

$$\sqrt{16 + 64 + 256}$$

$$|\vec{u}| = \sqrt{336}$$

$$|\vec{u}|^2 = 336 \quad \text{Ans}$$

$$\begin{array}{r} 11 \\ 256 \\ 64 \\ 16 \\ \hline 336 \end{array}$$

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⑤ The value of $\int_{-\pi/2}^{\pi/2} \frac{\sin^2 x}{1+2^x} dx$. . . Page 4

①

$$I = \int_{-\pi/2}^{\pi/2} \frac{\sin^2 x}{1+2^x} dx$$

$$I = \int_{-\pi/2}^{\pi/2} \frac{\sin^2(\frac{\pi}{2} - \frac{\pi}{2} - x)}{1+2^{\frac{\pi}{2} - \frac{\pi}{2} - x}} dx \quad \text{proper } f(x) = f(a+b-x)$$

$$I = \int_{-\pi/2}^{\pi/2} \frac{\sin^2 x}{1+2^{-x}} dx$$

$$I = \int_{-\pi/2}^{\pi/2} \frac{2^x \sin^2 x}{2^x + 1} dx$$

$$\textcircled{+} \quad 2I = \int_{-\pi/2}^{\pi/2} \frac{\sin^2 x (2^x + 1)}{2^x + 1} dx$$

$$2I = \int_{-\pi/2}^{\pi/2} \sin^2 x dx$$

$$2I = 2 \int_0^{\pi/2} \sin^2 x dx$$

$$2I = 2 \times \frac{\pi}{4}$$

$$I = \frac{\pi}{4} \quad \text{Ans P.T.O.}$$

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(6) $g(x) = \cos x^2$ $f(x) = \sqrt{x}$

Page 5

(B)

$$18x^2 - 9\pi x + \pi^2 = 0$$

$$18x^2 - 6\pi x - 3\pi x + \pi^2 = 0$$

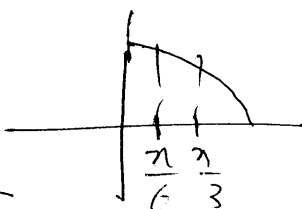
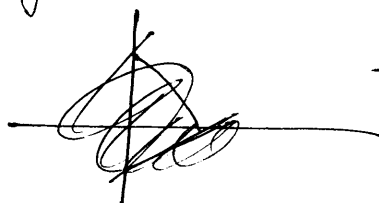
$$6x(3x - \pi) - \pi(3x - \pi) = 0$$

$$(3x - \pi)(6x - \pi) = 0$$

$$x = \frac{\pi}{3} \quad y = \frac{\pi}{6}$$

$$x = \frac{\pi}{6} \quad y = \frac{\pi}{3}$$

$$g \circ f(x) = \cos x$$



$$\int_{\pi/6}^{\pi/3} \cos x \, dx = [\sin x]_{\pi/6}^{\pi/3}$$

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

(7) If sum of all solutions - $8(\cos(\cos) - ?)$

(C) $8 \cos x \left(\cos\left(\frac{\pi}{6} + x\right) \cos\left(\frac{\pi}{6} - x\right) - \frac{1}{2} \right) = 1$

$4 \cos x \left(2 \cos\left(\frac{\pi}{6} + x\right) \cos\left(\frac{\pi}{6} - x\right) - 1 \right) = 1$ P.T.O

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$$(\cos x)^4 \left[\cos \frac{\pi}{3} + \cos 2x - 1 \right] = 1$$

Page 6

$$(\cos x)^4 \left(\frac{1}{2} + \cos 2x - 1 \right) = 1$$

$$4 (\cos x)^4 \left(\cos 2x - \frac{1}{2} \right) = 1$$

$$4 (\cos x)^4 (\cos 2x) - 2 (\cos x)^4 = 1$$

$$4 (\cos x)^4 (\cos 2x) = 1 + 2 (\cos x)^4$$

$$2 (2 (\cos x)^4 (\cos 2x)) = 1 + 2 (\cos x)^4$$

$$2 (\cos^4 x + \cos^6 x) = 1 + 2 (\cos x)^4$$

$$2 (\cos^6 x) = 1$$

$$(\cos^6 x) = \frac{1}{2}$$

$$0 \leq x < \pi$$

$$0 \leq 3x \leq 3\pi$$

$$3x \rightarrow \frac{\pi}{3}, 2\pi - \frac{\pi}{3}, 2\pi + \frac{\pi}{3}$$

$$3x \rightarrow \frac{\pi}{3}, \frac{5\pi}{3}, \frac{7\pi}{3}$$

$$x \rightarrow \frac{\pi}{9}, \frac{5\pi}{9}, \frac{7\pi}{9}$$

$$\text{Sum} \frac{13\pi}{9} \therefore K = \frac{13}{9} \text{ Ans}$$

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(10) A bag contains 4 Red, 6 Black ball - - ? *Prithi*

Total Probability :-

First draw give Red

→ Second draw give Red

→ Second draw give Black

First draw give Black

→ Second draw give Red

→ Second draw give Black

Total probability =

Favourable cases :-

$$\text{Ans} = \frac{6 \times 4 + 4 \times 6}{6 \times 4 + 6 \times 4 + 6 \times 4 + 8 \times 6}$$

$$= \frac{48}{120}$$

$$= \frac{2}{5}$$

$$\text{Ans}$$

$$\frac{4}{10}$$

$$\frac{6}{12} \times \frac{4}{10}$$

$$\frac{6}{12} \times \frac{4}{10}$$

$$\frac{6}{10}$$

$$\frac{4}{12} \times \frac{6}{10}$$

$$\frac{8}{12} \times \frac{6}{10}$$

$$= \frac{6}{12} \times \frac{4}{10} + \frac{6}{12} \times \frac{4}{10} + \frac{4}{12} \times \frac{6}{10} + \frac{8}{12} \times \frac{6}{10}$$

$$= \frac{6}{12} \times \frac{4}{10} + \frac{4}{12} \times \frac{6}{10}$$

$$= \frac{48}{120} = \frac{2}{5}$$

$$\boxed{= 2}$$

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Set D

(11) let the orthocentre and centroid ... ? Page 2

(4) $A \xleftarrow{2} B \xrightarrow{1} C(h, k)$
 $(-3, 5) \quad (3, 3)$

centroid divides AC in ratio 2:1

$$\therefore \frac{2h-3}{3} = 3 \Rightarrow 2h-3=9$$

$$h=6$$

$$\frac{2k+5}{3} = 3 \Rightarrow 2k+5=9$$

$$2k=4$$

$$k=2$$

Circumcentre C(6, 2)

$$\therefore \text{Diameter AC} = \sqrt{(6-(-3))^2 + (2-5)^2}$$

$$= \sqrt{90}$$

$$\text{Radius} = \frac{\sqrt{90}}{2} = \frac{3\sqrt{10}}{2} = 3\sqrt{\frac{5}{2}}$$

Ans

(12) If tangent at (1, 7) ... ? P.T.O.

$$x^2 = y - 6$$

$$2x = \frac{dy}{dx} \Rightarrow m_T = 2$$

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Egⁿ of Tangent $y - 7 = 2(x - 1)$ Set D Page 10

Egⁿ of Tangent $y - 7 = 2(x - 1)$

$$y - 7 = 2(x - 1)$$

$$y - 7 = 2x - 2$$

$$y - 2x - 5 = 0$$

Tangent to Circle $x^2 + y^2 + 16x + 12y + 1 = 0$
& centre $(-8, -6)$

$$radius = \sqrt{100 - c}$$

$$radius = \sqrt{100 - c}$$

$$\left| \frac{-6 - 2(-8) - 5}{\sqrt{5}} \right| = \sqrt{100 - c}$$

$$\left| \frac{-6 + 16 - 5}{\sqrt{5}} \right| = \sqrt{100 - c}$$

$$\left| \frac{16 - 11}{\sqrt{5}} \right| = \sqrt{100 - c}$$

$$\left| \frac{5}{\sqrt{5}} \right| = \sqrt{100 - c}$$

$$5 = 100 - c$$

$$c = 95 \text{ Ans}$$

PTC

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Set - D

(13) If $\alpha, \beta \in \mathbb{C} \dots x^2 - 11x + 1 = 0 \dots$ Page 11

(D)

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

$$\text{roots } \frac{1 \pm \sqrt{3}i}{2} \rightarrow -\omega \rightarrow \alpha \quad -\omega^2 \rightarrow \beta$$

$$(-\omega)^{101} + (-\omega^2)^{107}$$

$$= (\omega^{101} + (\omega^2)^{107})$$

$$= (\omega^{99} \cdot \omega^2 + (\omega^{105})^2 \times (\omega^2)^2)$$

$$= (\omega^2 + \omega^4)$$

$$= (\omega^2 + \omega)$$

$$1 + \omega + \omega^2 = 0$$

$$\omega + \omega^2 = -1$$

\Rightarrow Ans 1

(14) PQR is triangular park... ?
(B) PTO

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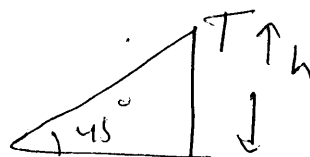
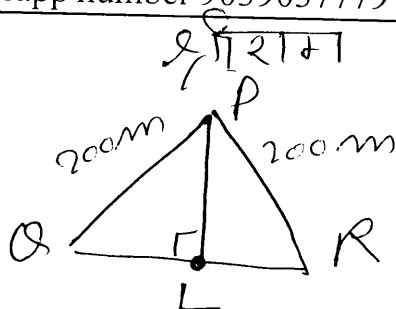
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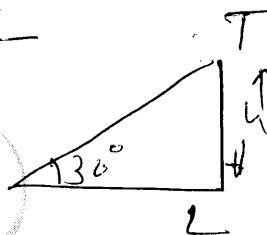
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$PL = h \rightarrow L$
 $PL = h$



In $\triangle PLO$

$PL^2 + OL^2 = PO^2$

$h^2 + 3h^2 = (200)^2$

$4h^2 = (200)^2$

$h^2 = \left(\frac{200}{2}\right)^2$

$h^2 = (100)^2$

$h = 100$ Ans

$\tan 30^\circ = \frac{h}{OL}$
 $\frac{1}{\sqrt{3}} = \frac{h}{OL}$
 $OL = \sqrt{3}h$

(16) If sum of coeffm --- $(x + \sqrt{x^3 - 1})^5 + (x - \sqrt{x^3 - 1})^5$ --- ?

(A) $(x + \sqrt{x^3 - 1})^5 + (x - \sqrt{x^3 - 1})^5$

$(x + \sqrt{x^3 - 1})^5 = {}^5C_0 x^5 + {}^5C_1 \sqrt{x^3 - 1} x^4 + {}^5C_2 (\sqrt{x^3 - 1})^2 x^3 + {}^5C_3 (\sqrt{x^3 - 1})^3 x^2 + {}^5C_4 (\sqrt{x^3 - 1})^4 x + {}^5C_5 (\sqrt{x^3 - 1})^5$

$(x - \sqrt{x^3 - 1})^5 = {}^5C_0 x^5 - {}^5C_1 (\sqrt{x^3 - 1}) x^4 + {}^5C_2 (\sqrt{x^3 - 1})^2 x^3 - {}^5C_3 (\sqrt{x^3 - 1})^3 x^2 + {}^5C_4 (\sqrt{x^3 - 1})^4 x - {}^5C_5 (\sqrt{x^3 - 1})^5$

P.T.O

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Q.1) $x^2 + 1$ Set D

$$= 2 \left[5C_0 x^5 + 5C_2 x^3 (x^3 - 1) + 5C_4 (x^3 - 1)^2 \right] \text{ Page 13}$$

$$= 2 \left[5C_0 x^5 + 5C_2 x^6 - 5C_2 x^3 + 5C_4 (x^6 + 1 - 2x^3) \right]$$

$$= 2 \left[5C_0 x^5 + 5C_2 x^6 - 5C_2 x^3 + 5C_4 x^6 + 5C_4 - 10C_4 x^3 \right]$$

sum of odd coeffⁿ

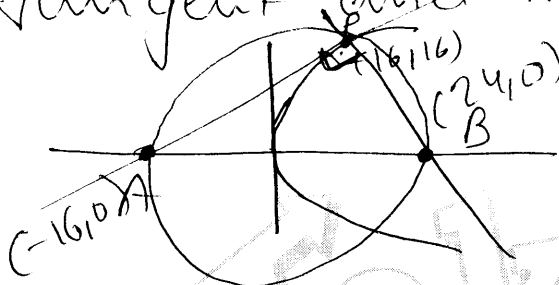
$$2 \left[5C_0 - 5C_2 + 2 \cdot 5C_4 \right]$$

$$2 \left[1 - 10 + 2 \times 5 \right]$$

$$2(1) = 2 \text{ Ans}$$

(22)
(C)

Tangent and Normal $y^2 = 16x$?



$$2y \frac{dy}{dx} = 16$$

$$\frac{dy}{dx} = \frac{8}{y}$$

$$m_T = \frac{8}{16} = \frac{1}{2}$$

$$m_N = -2$$

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सि 21+1 Set-D

Page-14

Tang = $y - 16 = \frac{1}{2}(x - 16)$ Normal
 $(y - 16) = -2(x - 16)$
 $y = 0$
 $x = -16$
 $-16 = -2x + 32$
 $-48 = -2x$
 $x = 24$

$C = (4, 0)$
 slope of CP

$= \frac{16}{12} = \frac{4}{3}$

slope of PB = -2
 $\tan \theta = \left| \frac{\frac{4}{3} + 2}{1 - \frac{8}{3}} \right| = \left| \frac{10}{-5} \right|$

$\tan \theta = 2$ Ans

(23)

(let f(x))

$f(x) = |x - \pi| \cdot (e^{|x|} - 1) \sin |x| \dots ?$

at π RHL ex PTO

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$$f(x) = \begin{cases} -(x-n)(e^{-x}-1)(-\sin x) & x < 0 \\ -(x-n)(e^x-1)(\sin x) & x \geq 0 \end{cases}$$

Set D
Page 15

$$x = 0$$

$$RHL = 0$$

$$x = n$$

Similarly

$$LHL = 0$$

$$LHD \quad f(x) = (x-n)(e^{-x}-1)(\sin x)$$

$$f'(x) = (1-n)(e^{-x}-1)(\cos x) + (x-n)(\sin x)(e^{-x})(-1) + (\sin x)(e^{-x}-1)$$

$$f''(x) = 0$$

$$RHD \quad f''(x) = -[(x-n)(e^x-1)\sin x]$$

$$f''(x) = -[(e^x-1)\sin x + (e^x-1)(\cos x)(x-n) + (\sin x)(e^x-1)]$$

diff at $x = n$

Empty set
Ans