

Sol. $\cot \left(\sum_{n=1}^{50} \tan^{-1} \left(\frac{1}{1+n(n+1)} \right) \right)$
 $\cot \left(\sum_{n=1}^{50} \tan^{-1} \left(\frac{(n+1)-n}{1+n(n+1)} \right) \right)$
 $\cot \left(\sum_{n=1}^{50} [\tan^{-1}(n+1) - \tan^{-1}n] \right)$
 $\cot \left((\tan^{-1}(2) - \tan^{-1}(1)) + (\tan^{-1}(3) - \tan^{-1}(2)) + \dots + (\tan^{-1}(51) - \tan^{-1}(50)) \right)$
 $\cot [\tan^{-1} 51 - \tan^{-1} 1]$
 $\cot \left[\tan^{-1} \left(\frac{50}{52} \right) \right] = \frac{26}{25}$

2. A and B are two square matrix of order 3. Where $AB = I$ and $|A| = \frac{1}{8}$ then the value of $|\text{adj}(B(\text{adj}2A))|$ is

Ans. 64.00

Sol. $AB = I$

$$|A| |B| = 1$$

$$\text{So } |B| = 8$$

$$|\text{adj}(B(\text{adj}2A))| = |B(\text{adj}2A)|^2$$

$$= |B|^2 |\text{adj} 2A|^2 = 64 \times |2A|^4$$

$$= 64 \times 8^4 \times |A|^4 = 64$$

3. If a_1, a_2, \dots, a_{10} and b_1, b_2, \dots, b_{10} are in A.P. and $a_1 = 2, a_{10} = 3$, also $a_1 b_1 = 1 = a_{10} b_{10}$, then the value of $a_4 b_4$ is

(1) $\frac{14}{27}$

(2) $\frac{28}{27}$

(3) $\frac{7}{27}$

(4) $\frac{15}{27}$

Ans. (2)

Sol. $\frac{a_{10} - a_1}{9} = \frac{3-2}{9} = d$

$$d = \frac{1}{9}$$

$$a_4 = 2 + 3d = 2 + \frac{1}{3} = \frac{7}{3}$$

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PAGE # 1

Also $b_1 = \frac{1}{2}$ and $b_{10} = \frac{1}{3}$

Now $d_1 = \frac{b_{10} - b_1}{9} = \frac{\frac{1}{3} - \frac{1}{2}}{9} = \frac{-1}{54}$

$$b_4 = \frac{1}{2} - \frac{3}{54} = \frac{9-1}{18} = \frac{8}{18} = \frac{4}{9}$$

Now then the value of $a_4 b_4 = \frac{7}{3} \times \frac{4}{9} = \frac{28}{27}$

4. $\sin 36^\circ$ is root of equation whose coefficients are rational is given by

(1) $16x^4 + 20x^2 - 5 = 0$

(2) $16x^4 + 20x^2 + 5 = 0$

(3) $16x^4 - 20x^2 + 5 = 0$

(4) $8x^4 - 20x^2 + 5 = 0$

Ans (3)

Sol. $\sin 36^\circ = x = \frac{\sqrt{10-2\sqrt{5}}}{4}$

$$16x^2 = 10 - 2\sqrt{5}$$

$$(16x^2 - 10)^2 = 20$$

$$(8x^2 - 5)^2 = 5$$

$$64x^4 + 25 - 80x^2 - 5 = 0$$

$$64x^4 - 80x^2 + 20 = 0$$

$$16x^4 - 20x^2 + 5 = 0$$

5. If $S = 2 + \frac{6}{7} + \frac{12}{7^2} + \frac{20}{7^3} + \dots + \infty$, then the value of $4S$ is

- (1) $\left(\frac{7}{3}\right)^2$ (2) $\left(\frac{7}{3}\right)^3$ (3) $\left(\frac{7}{3}\right)^4$ (4) $\left(\frac{7}{3}\right)^5$

Ans. (2)

Sol. $S = \frac{2}{1} + \frac{6}{7} + \frac{12}{7^2} + \frac{20}{7^3} + \dots + \infty$

$$\frac{S}{7} = \frac{2}{7} + \frac{6}{7^2} + \frac{12}{7^3} + \frac{20}{7^4} + \dots + \infty$$

$$\frac{6S}{7} = 2 + \frac{4}{7} + \frac{6}{7^2} + \frac{8}{7^3} + \frac{10}{7^4} + \dots + \infty$$

$$\frac{6S}{7} \times \frac{1}{7} = \frac{2}{7} + \frac{4}{7^2} + \frac{6}{7^3} + \frac{8}{7^4} + \dots + \infty$$

$$\frac{6S}{7} \left(1 - \frac{1}{7}\right) = 2 + \frac{2}{7} + \frac{2}{7^2} + \dots + \infty = \frac{2}{1 - \frac{1}{7}} = \frac{14}{6} = \frac{7}{3}$$

$$S = \frac{7}{3} \times \frac{49}{36}$$

then the value of $4S = \frac{343}{3 \times 36} \times 4 = \left(\frac{7}{3}\right)^3$

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6. If the mean and variance of observations 4, 5, 6, 6, 7, 8, x, y where $x < y$ are 6 and $\frac{9}{4}$ respectively, then the value of $x^4 + y^2$ is

Ans. 320.00

Sol. $\bar{x} = \frac{4+5+6+6+7+8+x+y}{8} = 6$

$$\Rightarrow x + y = 12 \dots \dots (1)$$

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

$$\Rightarrow \frac{9}{4} = \frac{16+25+36+36+49+64+x^2+y^2}{8} - 36$$

$$\Rightarrow x^2 + y^2 = 80 \dots \dots (2)$$

from (1) and (2) $x = 4, y = 8$

$$x^4 + y^2 = 256 + 64 = 320$$

7. Which of the following is tautology?

(1) $(\sim p \wedge q) \vee (p \vee \sim p)$

(2) $(p \wedge q) \wedge (p \vee \sim p)$

(3) $(\sim p \wedge q) \wedge (p \vee \sim p)$

(4) $(\sim p \wedge \sim q) \vee (p \wedge \sim p)$

Ans. (1)

Sol. $p \vee \sim p$ is tautology with this any 'or' gives tautology so (1) is Answer

8. $y(x) = (x^x)^x$ then the value of $\frac{d^2y}{dx^2} + 20$ at $x = 1$ is

Ans. 24.00

Sol. $y(x) = (x^x)^x$ at $x = 1 \Rightarrow y = 1$

$$\ln y = x^2 \ln x$$

$$\frac{1}{y} y' = x^2 \frac{1}{x} + 2x \ln x$$

$$y' = y(x + 2x \ln x) \dots \dots (1)$$

$$(y')_{x=1} = 1(1+0) = 1$$

$$y'' = y \left(1 + \frac{2x}{x} + 2 \ln x\right) + (x + 2x \ln x) y'$$

$$(y'')_{x=1} = 1(1 + 2 + 0) + (1 \times 1) = 4$$

So, $\frac{d^2y}{dx^2} + 20 = 24$

9. If a curve $y = f(x)$ satisfies the differential equation $(\tan^{-1} y - x)dy = (1 + y^2)dx$ passes through point $(1,0)$, then the value of x at $y = \tan 1$ is
 (1) 2 (2) 3 (3) 3 (4) 4

Ans. (1)

Sol. $(\tan^{-1} y - x)dy = (1 + y^2)dx$

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$$\frac{dx}{dy} + \frac{x}{1+y^2} = \frac{\tan^{-1} y}{1+y^2}$$

$$\text{I.F.} = e^{\int \frac{1}{1+y^2} dy} = e^{\tan^{-1} y}$$

$$x \cdot e^{\tan^{-1} y} = \int e^{\tan^{-1} y} \frac{\tan^{-1} y}{1+y^2} dy$$

$$\text{Let } \tan^{-1} y = t$$

$$\frac{1}{1+y^2} dy = dt$$

$$x \cdot e^{\tan^{-1} y} = \int e^t \cdot t \cdot dt$$

$$x e^{\tan^{-1} y} = t \cdot e^t + \int 1 \cdot e^t dt$$

$$x \cdot e^{\tan^{-1} y} = t \cdot e^t + e^t + C$$

$$x \cdot e^{\tan^{-1} y} = e^t(t+1) + C$$

$$x \cdot e^{\tan^{-1} y} = e^{\tan^{-1} y}(\tan^{-1} y + 1) + C \text{ passes } (1, 0)$$

$$1 = 1(1) + C$$

$$x \cdot e^{\tan^{-1} y} = e^{\tan^{-1} y}(\tan^{-1} y + 1)$$

$$x \cdot e = e(1 + 1)$$

$$x = 2$$

10. The shortest distance between lines $\frac{x-3}{3} = \frac{y-2}{2} = \frac{z-1}{-1}$ and $\frac{x+3}{3} = \frac{y-6}{1} = \frac{z-5}{2}$ is
 (1) $\frac{78}{\sqrt{115}}$ (2) $\frac{79}{\sqrt{115}}$ (3) $\frac{20}{\sqrt{115}}$ (4) $\frac{1}{\sqrt{115}}$

Ans. (1)

Sol. Normal vector of both lines

$$\vec{n} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & -1 \\ 3 & 1 & 2 \end{vmatrix} = \hat{i}(5) - \hat{j}(9) + \hat{k}(-3)$$

$$= 5\hat{i} - 9\hat{j} - 3\hat{k}$$

Now vector joining $(3, 2, 1)$ and $(-3, 6, 5)$ is $(-6\hat{i} + 4\hat{j} + 4\hat{k})$

Now, shortest distance

$$= \frac{|(5\hat{i} - 9\hat{j} - 3\hat{k}) \cdot (-6\hat{i} + 4\hat{j} + 4\hat{k})|}{|5\hat{i} - 9\hat{j} - 3\hat{k}|}$$

$$= \frac{|-30 - 36 - 12|}{\sqrt{25 + 81 + 9}}$$

$$= \frac{78}{\sqrt{115}}$$

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11. A matrix $[a_{ij}]_{2 \times 2}$ where $a_{ij} \in \{0, 1, 2, 3, 4, 5\}$ is formed such that sum of its elements is prime number p and $p \in (2, 8)$, then number of possible matrices
 (1) 187 (2) 180 (3) 185 (4) 182

Ans (2)

Sol. Let matrix is $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ then $a + b + c + d = 3$ or 5 or 7

for $3 \Rightarrow {}^4+3-1C_3 = 20$

For $5 \Rightarrow {}^5+4-1C_3 = 56$

for $7 \Rightarrow$ coeff $x^7 (1 + x + x^2 + \dots + x^5)^4$

$= (1-x^6)^4 (1-x)^{-4}$

$= ({}^4C_0 - {}^4C_1 x^6) (1-x)^{-4}$

$= {}^{4+7-1}C_7 - {}^4C_1 \times {}^{4+1-1}C_1$

$= \frac{10.9.8}{3.2} - 4 \times 4 = 120 - 16$

So total matrix = $20 + 56 + 104 = 180$

12. If vertex of parabola $x^2 + ay^2 + bxy + cx + dy + e = 0$ is at $(5,4)$ and its directrix is $3x + y - 29 = 0$ then the value of $a + b + c + d + e$ is

(1) 576 (2) -576 (3) -575 (4) 575

Ans (2)

Sol. Tangent at vertex is $3x + y + p = 0$, It passes through $(5, 4)$, then $p = -19$

So tangent at vertex $3x + y - 19 = 0$

Equation of Axis parabola $\Rightarrow x - 3y + q = 0$, It passes through $(5,4)$,

$5 - 12 + q = 0$

$q = 7$

distance between vertex and directrix = $a = \left| \frac{15 + 4 - 29}{\sqrt{10}} \right|$

$4a = 4\sqrt{10}$

Now equation of parabola is

$\left(\frac{x - 3y + 7}{\sqrt{10}} \right)^2 = -4\sqrt{10} \left(\frac{3x + y - 19}{\sqrt{10}} \right)$

$(x - 3y + 7)^2 + 40(3x + y - 19) = 0$

Sum of coefficient for $x = y = 1$

$= 25 + 40(-15)$

So $a + b + c + d + e = -575 - 1 = -576$

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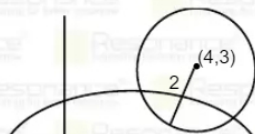
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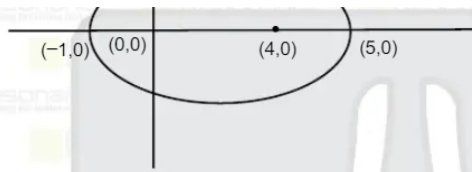
13. The number of complex numbers z satisfying $|z - (4 + 3i)| = 2$ and $|z| + |z - 4| = 6$ is

(1) 2 (2) 3 (3) 4 (4) 5

Ans. (1)

Sol.





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