Mata Sundri College for Women, University of Delhi

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Q - 1....

Let x = (x<sub>1</sub>,..., x<sub>n</sub>) ,where the x<sub>i</sub> are nonnegative real numbers. Set

$$M_r(x) = \left(\frac{x_1^r + x_2^r + \dots + x_n^r}{n}\right)^{1/r}$$
,  $r \in \mathbb{R} \setminus \{0\}$ ,

and

$$M_0(x) = (x_1 x_2 \dots x_n)^{1/n}$$

We call  $M_r(x)$  the *r* th power mean of *x*. Claim:

$$\lim_{r\to 0}M_r(x)=M_0(x)$$

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#### Define

We call  $V_n$  the Vandermonde matrix of order n. Claim:

$$\det V_n = \prod_{1 \le i < j \le n} (x_j - x_i)$$

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#### **QUESTION NO. 4**

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$$3^3 + 4^3 + 5^3 = 6^3$$

$$\sqrt{100} = 10$$

$$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

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$$\sum_{k=1}^{n} = \frac{n(n+1)}{2}$$

$$\frac{\pi}{4} = \frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \cdots$$

$$|\cos\theta = \sin(90^\circ - \theta)|$$

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$$\bullet \quad e^{i\theta} = \cos\theta + i\sin\theta$$

$$\blacksquare \quad \lim_{\theta \to 0} \frac{\sin \theta}{\theta} = 1$$

$$\Box \lim_{x \to \infty} \frac{\pi(x)}{x/\log x} = 1$$

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### **QUESTION NO. 5**

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Positive numbers a, b, and c are the side lengths of a triangle if and only if a + b > c, b + c > a and c + a > b.

The area of a triangle with side lengths a, b, c is given by *Heron's* formula:

$$A=\sqrt{s(s-a)(s-b)(s-c)},$$

where s is the semiperimeter (a + b + c)/2.

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Q - 5.....

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### The volume of rectangular tetrahedron of edge length 1 is $\sqrt{2}/12$

#### The quadratic equation $ax^2 + bx + c = 0$ has roots

$$r_1, r_2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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### Q - 5.....

#### The derivative of the function f, denoted f', is defined by

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

A real-valued function f is convex on an interval I if

$$f(\lambda x + (1 - \lambda)y) \le \lambda f(x) + (1 - \lambda)f(y),$$

for all  $x, y \in Iand0 \le \lambda \le 1$ .

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### Q - 5.....

is

#### The general solution to the differential equation

$$y'' - 3y'^{+3y=0}$$

$$y=C_1e^x+C_2e^{2x}.$$

#### The *Fermat number* $F_n$ is defined as

$$F_n=2^{2^n}, n\geq 0.$$

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### QUESTION NO. 6

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### Q - 6.....

$$\blacksquare \quad \frac{d}{dx} \left( \frac{x}{x+1} \right) = \frac{1}{(x+1)^2}$$

$$\square \left| \lim_{n \to \infty} \left( 1 + \frac{1}{n} \right)^n = e \right|$$

$$\left| \begin{array}{c} a & b \\ c & d \end{array} \right| = ad - bc$$

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# Q - 6.....

$$\mathbf{R}_{\theta} = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$

$$\blacksquare \left| \begin{array}{ccc|c} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{array} \right| = \left| \begin{array}{ccc|c} a_1 & a_3 \\ b_1 & b_3 \end{array} \right| \mathbf{i} - \left| \begin{array}{ccc|c} a_1 & a_3 \\ b_1 & b_3 \end{array} \right| \mathbf{j} + \left| \begin{array}{ccc|c} a_1 & a_2 \\ b_1 & b_2 \end{array} \right| \mathbf{k} \right|$$

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# Q - 6....

$$\begin{bmatrix}
a_{11} & a_{12} \\
a_{21} & a_{22}
\end{bmatrix}
\begin{bmatrix}
b_{11} & b_{12} \\
b_{21} & b_{22}
\end{bmatrix} =
\begin{bmatrix}
a_{11}b_{11} + a_{12}b_{21} & a_{11}b_{12} + a_{12}b_{22} \\
a_{21}b_{11} + a_{22}b_{21} & a_{21}b_{12} + a_{22}b_{22}
\end{bmatrix}$$

$$f(x) = \begin{cases} -x^2, & x < 0 \\ x^2, & 0 \le x \le 2 \\ 4, & x > 2 \end{cases}$$

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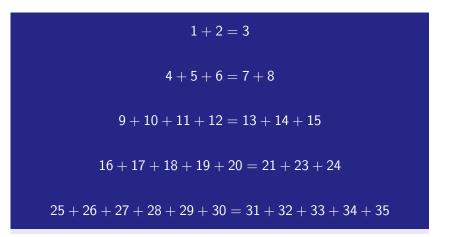
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### **QUESTION NO. 7**

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Q - 7.....



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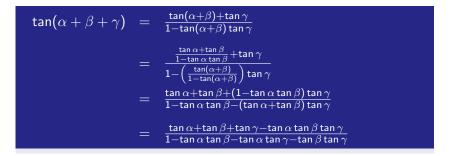
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# Q - 7.....

$$(a+b)^{2} = (a+b)(a-b)$$
  
=  $(a+b)a + (a+b)b$   
=  $a(a+b) + b(a+b)$   
=  $a^{2} + ab + ba + b^{2}$   
=  $a^{2} + ab + ab + b^{2}$   
=  $a^{2} + 2ab + b^{2}$ 

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### Q - 7....



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$$\begin{split} \prod_{\rho} (1 - \frac{1}{\rho^2}) &= \prod_{\rho} \frac{1}{1 + \frac{1}{\rho^2} + \frac{1}{\rho^4} + \dots} \\ &= (\prod_{\rho} (1 + \frac{1}{\rho^2} + \frac{1}{\rho^4} + \dots))^{-1} \\ &= (1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \dots)^{-1} \\ &= \frac{6}{\pi^2} \end{split}$$

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