## Document

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• Let  $x = (x_1, ..., x_n)$ , where the  $x_i$  are non-negative real numbers. Set

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

and

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

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

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

#### Define

$$V_n = \begin{bmatrix} 1 & 1 & 1 & \dots & 1 \\ x_1 & x_2 & x_3 & \dots & x_n \\ x_1^2 & x_2^2 & x_3^2 & \dots & x_n^2 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_1^{n-1} & x_2^{n-1} & x_3^{n-1} & \dots & x_n^{n-1} \end{bmatrix}$$

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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•	$3^3 + 4^3 + 5^3 = 6^3$	
•	$\sqrt{100} = 10$	
•	$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$	
•	$\sum_{k=1}^{n} k = \frac{n(n+1)}{2}$	
•	$\frac{\pi}{4} = \frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \cdots$	

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## Remaining parts of Question 4

۲  $cos\theta = sin(90^{\circ} - \theta)$ ٠  $e^{\iota\theta} = \cos\theta + \iota\sin\theta$ ٠  $\lim_{\theta \to 0} \frac{\sin \theta}{\theta} = 1$ ٠  $\lim_{x\to\infty}\frac{\pi(x)}{x/\log x}=1$ ۵  $\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$ 

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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.

- The volume of a regular 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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• The derivative of a function f, denoted f', is defined by

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

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

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

for all  $a, y \in I$  and  $0 \le \lambda \le 1$ .

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• The general solution to the differential equation

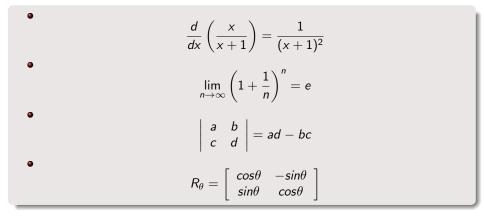
$$y"-3y'+2y=0$$

is

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

• The Fermat number  $F_n$  is defined as

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



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• 
$$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix} = \begin{vmatrix} a_2 & a_3 \\ b_2 & b_3 \end{vmatrix} \mathbf{i} - \begin{vmatrix} a_1 & a_3 \\ b_1 & b_3 \end{vmatrix} \mathbf{j} + \begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix} \mathbf{k}$$
• 
$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} = \begin{bmatrix} a_{11}b_{11} + a_{12}b_{21} & a_{11}b_{12} + a_{12}b_{22} \\ a_{21}b_{11} + a_{22}b_{21} & a_{21}b_{12} + a_{22}b_{22} \end{bmatrix}$$
• 
$$f(x) = \begin{cases} -x^2, & x < 0 \\ x^2, & 0 \le x \ge 2 \\ 4, & x > 2 \end{cases}$$

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٠	1+2	=	3
	4 + 5 + 6	=	7 + 8
	9 + 10 + 11 + 12	=	13 + 14 + 15
16 +	17 + 18 + 19 + 20	=	21 + 22 + 23 + 24
25 + 26 +	27 + 28 + 29 + 30	=	31 + 32 + 33 + 34 + 35

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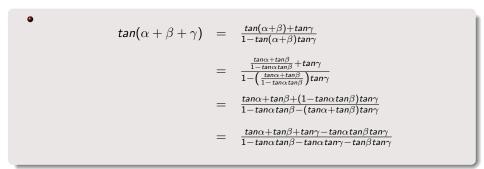
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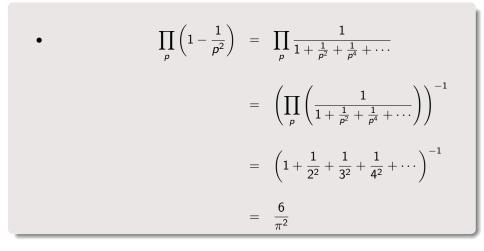
 $(a+b)^2 = (a+b)(a+b)$ = (a+b)a + (a+b)b= a(a+b) + b(a+b) $= a^2 + ab + ba + b^2$  $= a^2 + ab + ab + b^2$  $= a^2 + 2ab + b^2$ 

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## Remaining Parts of Question 7



# Thank you



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