RIGA TECHNICAL UNIVERSITY

Zinātniski – metodiskā konference «Izaicinājumi inženierzinātņu augstākajā izglītībā»

Programma Mathcad drošs rīks studentu rokās

Mathcad is a secure tool in the hands of students

Teorētiskās mehānikas un materiālu pretestības katedra

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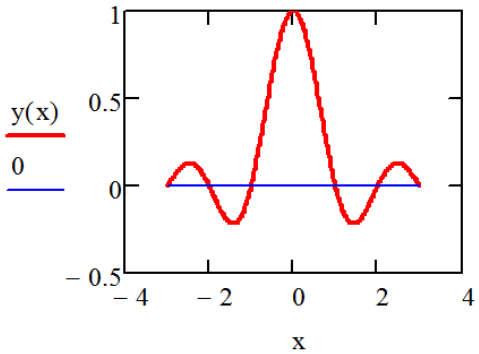
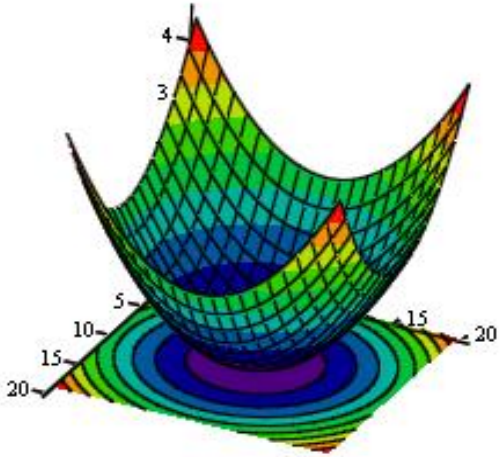
15.04.2021

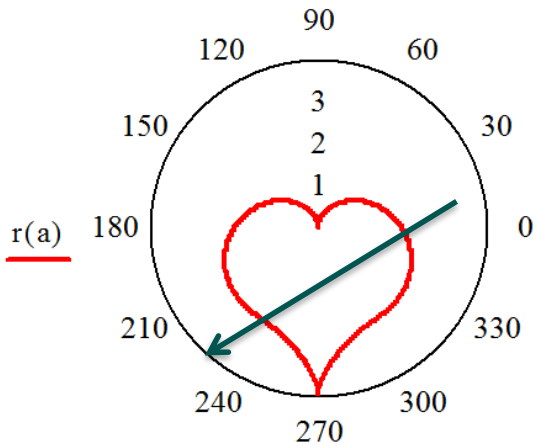
Nice for persentations!



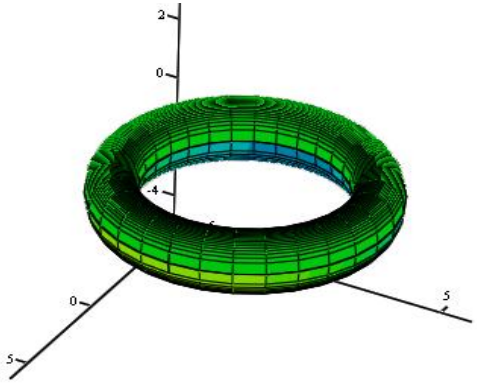
XY Plot



$$r(a) := 2 - 2\cdot\sin(a) + \sin(a)\cdot\frac{\sqrt{|\cos(a)|}}{\sin(a) + 1.4}$$



Polar Plot



3D Plot

Diferenciālvienādojumu vienkāršs atrisinājums

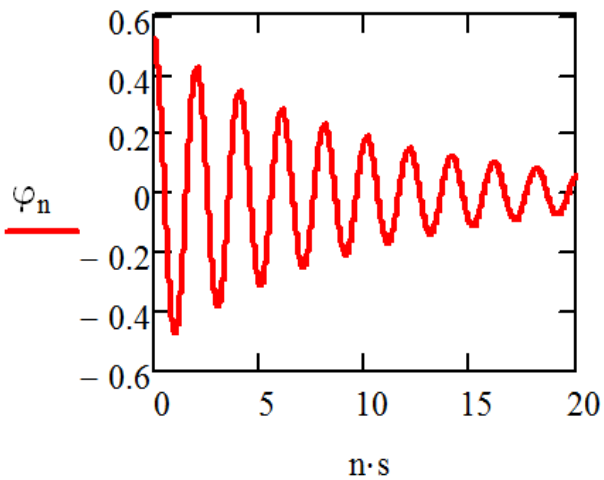
Fiziskā svārsta diferenciālais vienādojums:

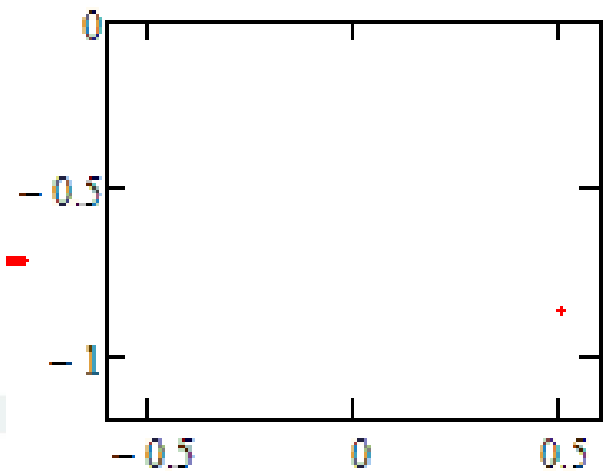
$$\frac{d^2\varphi}{dt^2} = -gL\,sin(\varphi) - b\frac{d\varphi}{dt}$$

$$\ddot{\varphi} = -gL\,sin(\varphi) - b\dot{\varphi}$$

$$\begin{pmatrix} \varphi_0 \\ \omega_0 \end{pmatrix} := \begin{pmatrix} 30deg \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} \varphi_{n+1} \\ \omega_{n+1} \end{pmatrix} := \begin{bmatrix} \varphi_n + s\cdot\omega_n \\ \omega_n + s\cdot\left(-g\cdot L\cdot\sin(\varphi_n) - b\cdot\omega_n\right) \end{bmatrix}$$





Determine the trajectory of the cannon ball

V0=100m/s, m=1kg, g=9.8m/s^2, b=0.1kg/s^2 , $\alpha=\pi/4$

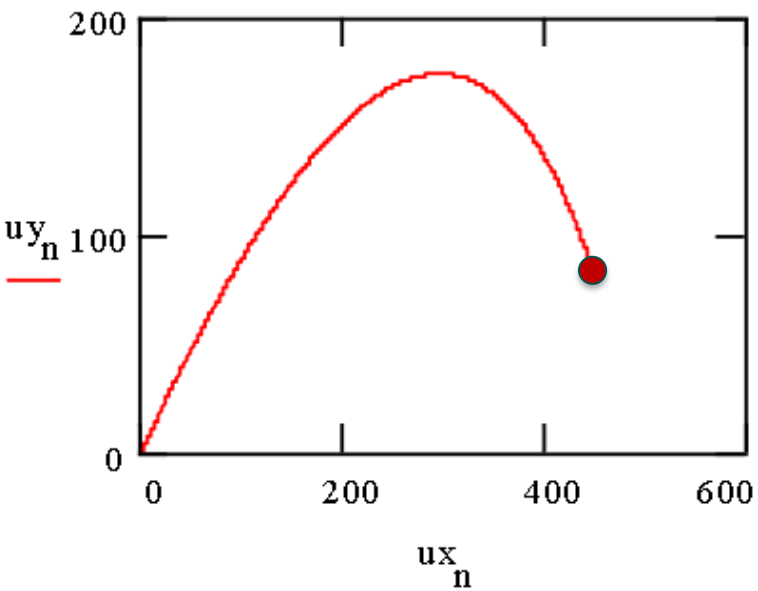
$$m\frac{d^2}{dt^2}u_x + b\frac{d}{dt}u_x = 0$$

$$m\frac{d^2}{dt^2}u_y + b\frac{d}{dt}u_y + mg = 0$$

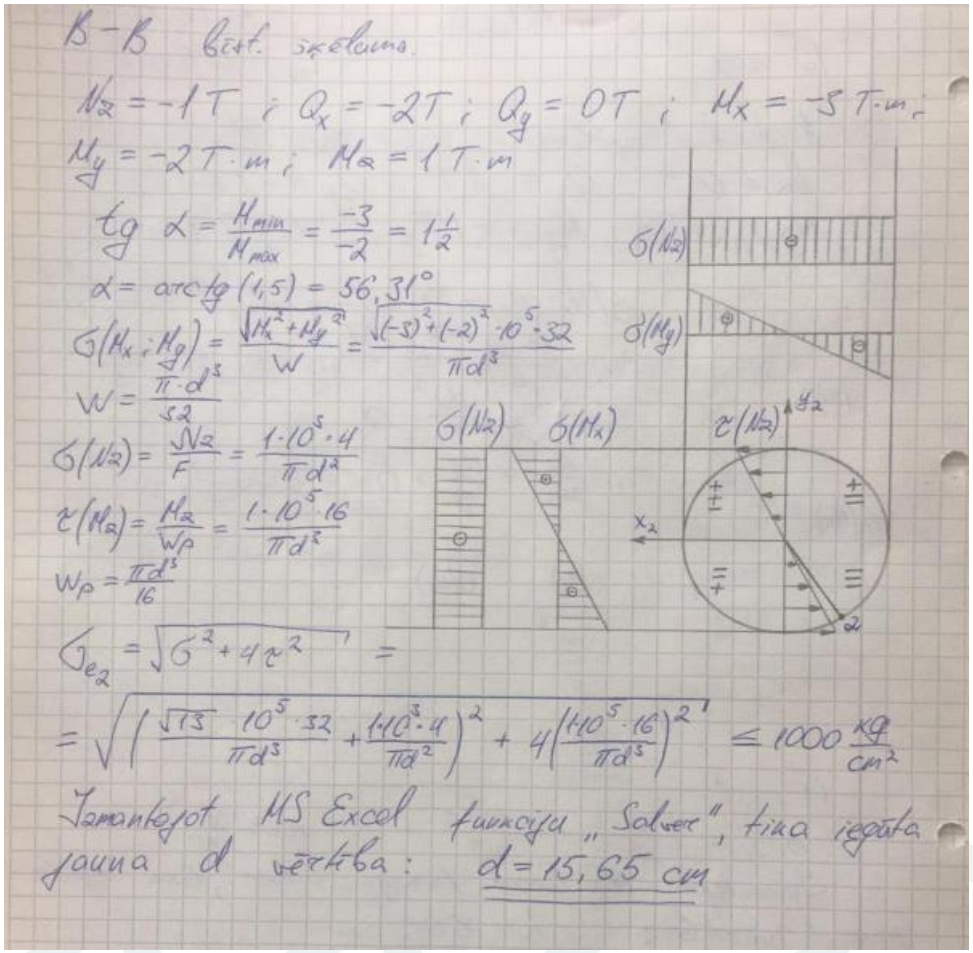
kur **m** ir lielgabala lodes masa;
u ir lielgabala lodes pārvietojums;
g ir brīvās krišanas paātrinājums;
b ir gaisa pretestības koeficients.

$$\begin{bmatrix} ux_0 \\ vx_0 \\ uy_0 \\ vy_0 \end{bmatrix} := \begin{bmatrix} 0 \\ v0\cdot\cos(\alpha) \\ 0 \\ v0\cdot\sin(\alpha) \end{bmatrix}$$

$$\begin{bmatrix} ux_{n+1} \\ vx_{n+1} \\ uy_{n+1} \\ vy_{n+1} \end{bmatrix} := \begin{bmatrix} ux_n + s\cdot vx_n \\ vx_n + s\cdot\frac{1}{m}\cdot\left(-b\cdot vx_n\right) \\ uy_n + s\cdot vy_n \\ vy_n + s\cdot\frac{1}{m}\cdot\left(-b\cdot vy_n - m\cdot g\right) \end{bmatrix}$$



Praktiskais pielietojums citos priekšmetos. Materiālu pretestība



B – B bīst. šķēluma

$N_z = -1\,T$; $Q_x = -2\,T$; $Q_y = 0\,T$; $M_x = -3\,T\cdot m$;

$M_y = -2\,T\cdot m$; $M_z = 1\,T\cdot m$

$$tg\,\alpha = \frac{M_{min}}{M_{max}} = \frac{-3}{-2} = 1\frac{1}{2}$$

$$\alpha = arctg\,(1{,}5) = 56{,}31^\circ$$

$$\sigma(M_x; M_y) = \frac{\sqrt{M_x^2 + M_y^2}}{W} = \frac{\sqrt{(-3)^2 + (-2)^2}\cdot 10^5 \cdot 32}{\pi d^3}$$

$$W = \frac{\pi \cdot d^3}{32}$$

$$\sigma(N_z) = \frac{N_z}{F} = \frac{1\cdot 10^5 \cdot 4}{\pi d^2}$$

$$\tau(M_z) = \frac{M_z}{W_p} = \frac{1\cdot 10^5 \cdot 16}{\pi d^3}$$

$$W_p = \frac{\pi d^3}{16}$$

$$\sigma_{e_2} = \sqrt{\sigma^2 + 4\tau^2} =$$

$$= \sqrt{\left(\frac{\sqrt{13}\cdot 10^5 \cdot 32}{\pi d^3} + \frac{1\cdot 10^3 \cdot 4}{\pi d^2}\right)^2 + 4\left(\frac{1\cdot 10^5 \cdot 16}{\pi d^3}\right)^2} \le 1000\,\frac{kg}{cm^2}$$

Izmantojot MS Excel funkciju „Solver", tika iegūta jauna d vērtība: $d = 15{,}65$ cm

$d := 10$

given

$$\sqrt{\left(\frac{\sqrt{13}\cdot 10^5 \cdot 32}{\pi \cdot d^3} + \frac{1\cdot 10^3 \cdot 4}{\pi \cdot d^2}\right)^2 + 4\cdot\left(\frac{1\cdot 10^5 \cdot 16}{\pi \cdot d^3}\right)^2} = 1000$$

$\text{find}(d) = 15.65$

Stiprības aprēķins

Praktiskais pielietojums citos priekšmetos. Materiālu pretestība

$$\Delta B = \frac{1}{EI_x}\left(\int_0^{1,2}(0,85z_1)(0,625\cdot z_1)\,dz_1 + \int_0^{2}(1,02+0,85z_2-z_2^2)(0,75+0,625z_2)\,dz_2 + \int_0^{0,8} 0\,dz_3\right) =$$

$$= \frac{1}{EI_x}\left(\int_0^{1,2}(0,53\cdot z_1^2)\,dz_1 + \int_0^{2}(0,77+0,64z_2+0,64z_2+0,53z_2^2-0,75z_2^2-0,625z_2^3)\,dz_2\right) =$$

$$= \frac{1}{EI_x}\left(\int_0^{1,2}(0,53\cdot z_1^2)\,dz_1 + \int_0^{2}(0,77+1,28z_2-0,22z_2^2-0,625z_2^3)\,dz_2\right) =$$

$$= \frac{1}{EI_x}\left(0,53\cdot\frac{z_1^3}{3}\Big|_0^{1,2} + 0,77z_1\Big|_0^{2} + 1,28\frac{z_2^2}{2}\Big|_0^{2} - 0,22\frac{z_2^3}{3}\Big|_0^{2} - 0,625\frac{z_2^4}{4}\Big|_0^{2}\right) =$$

$$= \frac{1}{EI_x}(0,31+1,54+2,56-0,59-2,5) = \frac{1,32}{EI_x}$$

$$\Delta B = \frac{1,32}{2\cdot10^7\cdot1957\cdot10^{-8}} = \frac{1,32}{391,4} = 0,003\,m = 3\,mm$$

Stinguma aprēķins

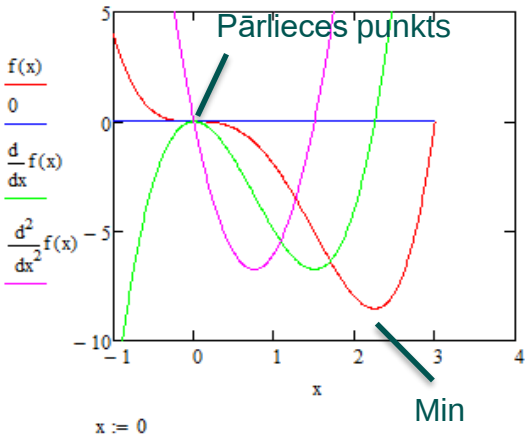
$$\Delta B := \int_0^{1.2} 0.85\cdot z1\cdot 0.625\cdot z1\,dz1 + \int_0^{2}\left(1.02 + 0.85\cdot z2 - z2^2\right)\cdot(0.75 + 0.625\cdot z2)\,dz2$$

$$\Delta B = 1.303$$

Praktiskais pielietojums citos priekšmetos. Optimizācijas metodes

$x := -1, -0.99 .. 3$

$f(x) := x^4 - 3 \cdot x^3$



$x := 0$

Given

$\frac{d}{dx} f(x) = 0$

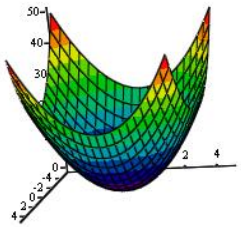
$\text{Find}(x) = 1 \times 10^{-15}$

$f(0) = 0$

$x := 0$

$\frac{d^2}{dx^2} f(x) = 0$ inflection

$f(x,y) = x^2 + y^2 \quad a = 1 \quad b = 1$

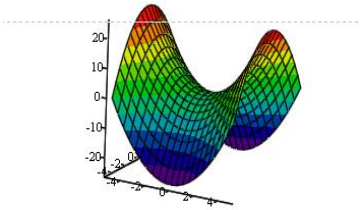


$A1 := \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$

$|A1| = 4$

Minimum
Stationary point
x=0;
y=0;
f=0

$f(x,y) = x^2 - y^2 \quad a = 1 \quad b = -1$

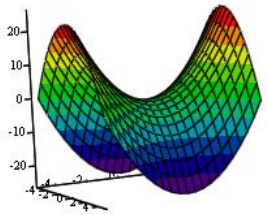


$A1 := \begin{pmatrix} 2 & 0 \\ 0 & -2 \end{pmatrix}$

$|A1| = -4$

Saddle point
x=0;
y=0;
f=0

$f(x,y) = -x^2 + y^2 \quad a = -1 \quad b = 1$

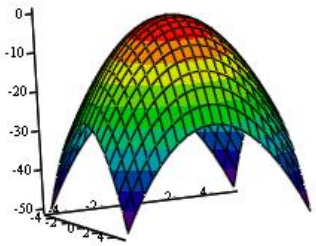


$A1 := \begin{pmatrix} -2 & 0 \\ 0 & 2 \end{pmatrix}$

$|A1| = -4$

Saddle point
x=0;
y=0;
f=0

$f(x,y) = -x^2 - y^2 \quad a = -1 \quad b = -1$



$A1 := \begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$

$|A1| = 4$

Maximum
Stationary point
x=0;
y=0;
f=0

Labs instruments pašpārbaudei. Simboliskā matemātika

$$\frac{\tan(x)\cdot\cos(x)}{\sin(x)^2+\cos(x)^2}\ \text{simplify}\ \rightarrow \sin(x)$$

Vienkāršošana

$$x^2-10\cdot x+5 \qquad \begin{pmatrix} 5+2\cdot 5^{\frac{1}{2}} \\ 5-2\cdot 5^{\frac{1}{2}} \end{pmatrix}$$

Polinoma saknes

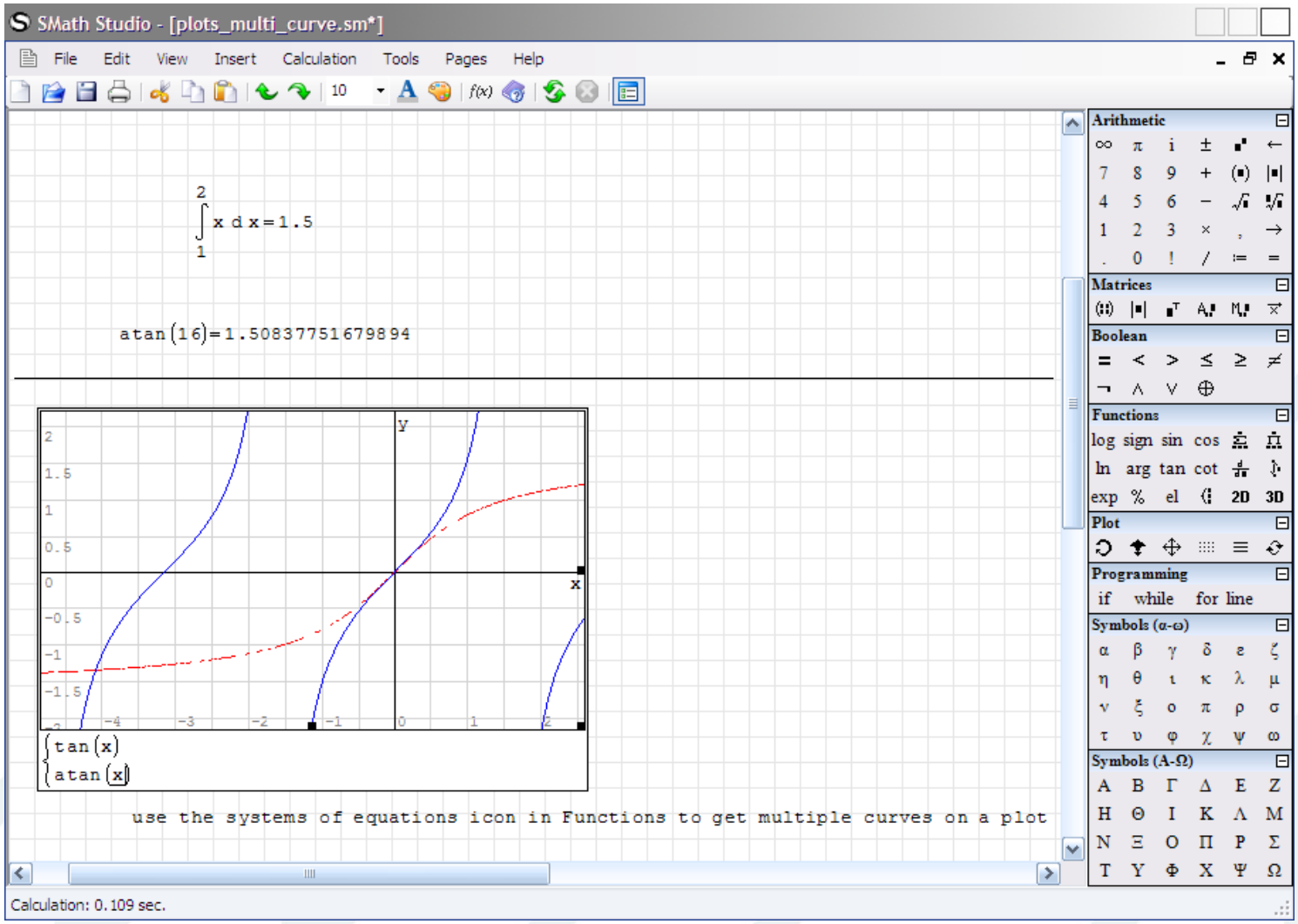
$$\sin(x)^2 \qquad 2\cdot\sin(x)\cdot\cos(x)$$

Diferencēšana

$$\left|\begin{pmatrix} a & b \\ c & d \end{pmatrix}\right| \rightarrow a\cdot d-b\cdot c$$

Matricas determinants

Bezmaksas analogs. SMath Studio



Paldies!