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• • , • •

,

**MathCAD**

“ ”

**2006**

519.6  
22.19  
67

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( 1.4/18- -807 19.09.2006)

-19 · ” , · ” · ” MathCAD.  
« » : ·  
: , 2006. – 108 .  
ISBN 966-379-101-2.

ISBN 966-379-101-2

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MathCad.  
519.6  
22.19  
© · ”  
· ”  
· ”  
· ”, 2006  
© , 2006

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( ) , Windows 2000  
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 MathCad , -  
 , , . Math ad -  
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 , . Math ad -  
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 , , -  
 Math ad.

1.1

MathCad

MathCad

, -  
-  
,

Windows.

MathCad

Windows

- ,  
. ( . 1) (   
, ) (1), , (2). ,  
, - .  
( ) (3,  
4- ).

( . 1):

**File /** -

(2-1);

**Edit /**

-

(2-2);

**View /**

-

(2-3);

**Insert /**

-

(2-4);

**Format /**

-

(2-5);

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(2-6);

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**Help /**

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(2-9).

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,

:

**Calculator Toolbar/**

(3-1);

**Graph Toolbar /**

(3-2);

**Vector and Matrix Toolbar /**

(3-3);

**Evaluation Toolbar/**

(3-4);

**Calculus Toolbar/**

(3-5);

**Boolean Toolbar/**

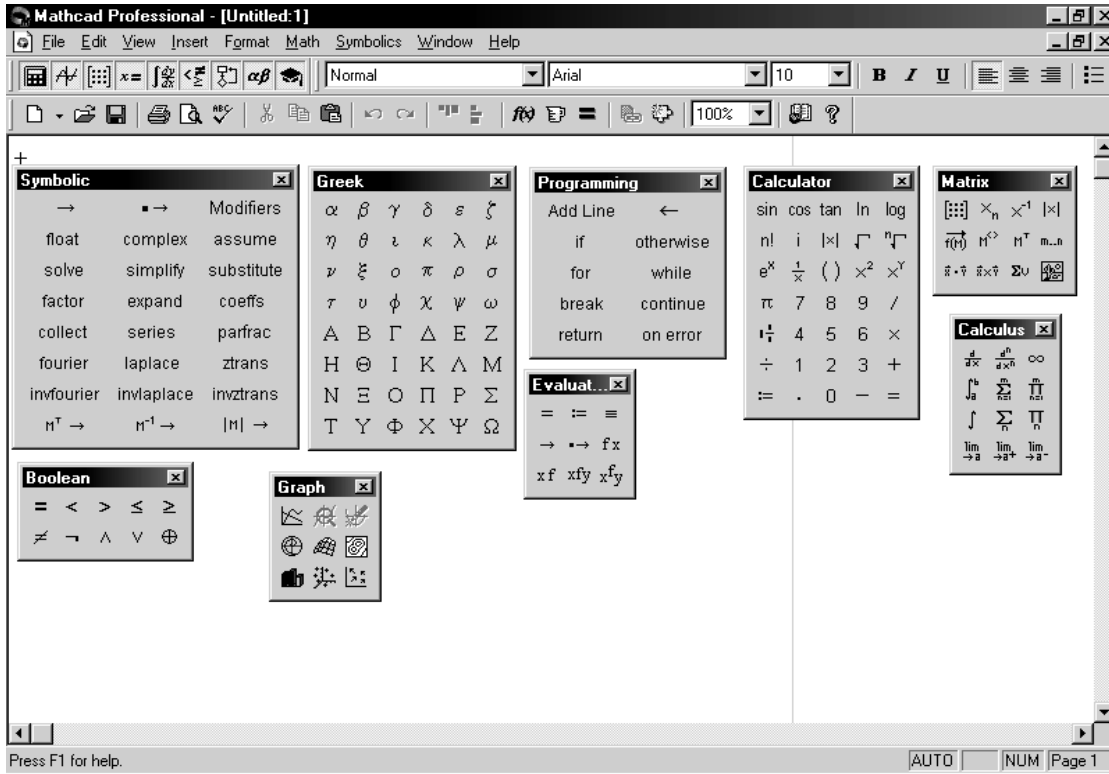
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**Greek symbol Toolbar/** (3-8);  
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**Open /** (4-2);  
**Save /** (4-3);  
**Pr nt /** (4-4);  
**Pr nt Prev ew /** (4-5);  
**Check Spell ng /** (4-6).  
**Cut /** ( ) (4-7);  
**Copy /** ( ) (4-8);  
**Paste /** ( ) (4-9);  
**Undo (Redo) /** ( ) (4-10, 11);  
**Al gn Across (Al gn Down) /** (4-12, 13).  
**Insert Funct on /** ( ) - (4-14);  
**Insert Un t /** (4-15);  
**Calculate /** (4-16);  
**Insert G perl nk /** (4-17);  
**Insert Component /** (4-18);  
**Zoom /** (4-19);  
**Resource Center /** (4-20);  
**Help /** (4-21).

MathCad :  
**Resource Center /** -  
 (4-20) -  
**Help /** (4-21) -

# Shift+F1



1 – *MathCad Professional 2001*

## 1.2

:= ( )

(M), (X), (X X<sub>j</sub>), F(x, y, z).

(4-14) f(x) ( insert Function / ).





1

= 3 ( -

MathCad).

x := 3

$$\sqrt{\frac{4}{e^x}} - \coth(x)^3 \cdot \cos(|x \cdot \sin(x^2) - \ln(x)|) = -0.559$$

1

MathCad.

2

MathCad.

3

/

4

MathCad.

2

2.1

$$y(t) := \sin(t) - \cos(t)$$

t

[-2; 2]

0,5,

:

1

:

t := -2, -1.5 .. 2

-2 -

; -1,5 -

[-2 + 0,5 = -1,5]; ..

Vector and Matrix Toolbar - Range Variable /

/

(  ); 2 -

2  $y(t) := \sin(t) - \cos(t).$   
 3  $t = ($   $t).$   
 4  $y(t) = ($   $y(t)).$   
 , 1 10 ,  
 . 10 -  
 10 -  
 . -

Math ad:

$t := -2, -1.5 \dots 2$   
 $y(t) := \sin(t) - \cos(t)$

t =	y(t) =
-2	-0.493
-1.5	-1.068
-1	-1.382
-0.5	-1.357
0	-1
0.5	-0.398
1	0.301
1.5	0.927
2	1.325

## 2.2

1 , , :

2 **Format – Result /** - .

(Number of decimal places), -

(Exponential threshold) p.


3 **Exponential threshold /**

3. , , 102,

. Math ad .

### 2.3

Math ad

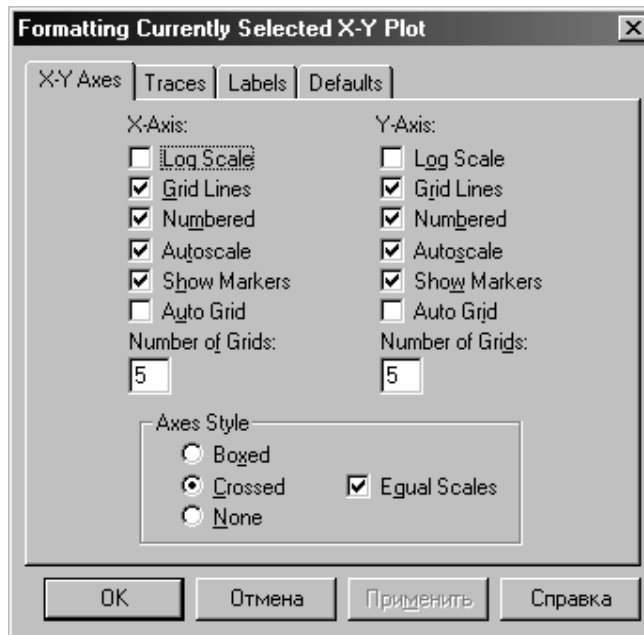
, , ,  
.  
, ,  
: MathCad  
.  
,  
y(t), :  
1 ( ) y(t)  
**Graph Toolbar - X-Y Plot / - X-Y :**   
**Insert - Graph - X-Y Plot/**  
**X-Y** ). ( . 2).



2 -  
2 , t,  
3 , t.  
, y(t),  
(  
, ). , MathCad  
4  
, y (t) '  
**Format - Graph - X-Y Plot /**  
**- X-Y**  
( . 3, 4).

- **Axes** ( . 3):

- Log scale** – ;
- Grid lines** – ;
- Numbered** – ;
- Auto scale** – ;
- Show markers** – ;
- Auto grid** – ;
- Number of grids** – ;
- Boxed** – ;
- Crossed** – ;
- None** – ;
- Equal Scales** – .



3 – . - *Axes*

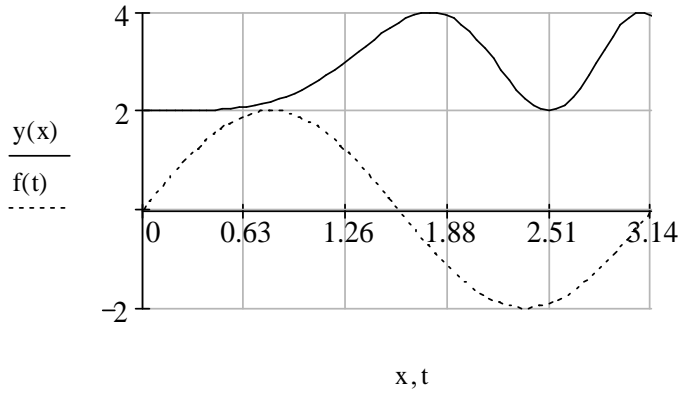
(**Weight**) (Symbol), (Line), (Color),  
**Traces** (Type) ,  
 ( . 4).

( , ) .  
 ( **F9**).



$$x := 0, \frac{\pi}{64} \dots \pi \quad t := 0, \frac{\pi}{64} \dots \pi$$

$$y(x) := 3 - \cos(x^2) \quad f(t) := 2 \cdot \sin(2 \cdot t)$$



5 -

## 2.4

W -


R(w).

Format - Graph - Polar Plot / - -

(Rad al) (Angular), -

(Per meter).

nsert - Graph - Polar Plot / -

 Graph Toolbar

R(w).

:

1

2

MathCad

3 W R(w).

4 R - w.

5 -

R (w).

6

. MathCad

**R(w),**

**w,**

3

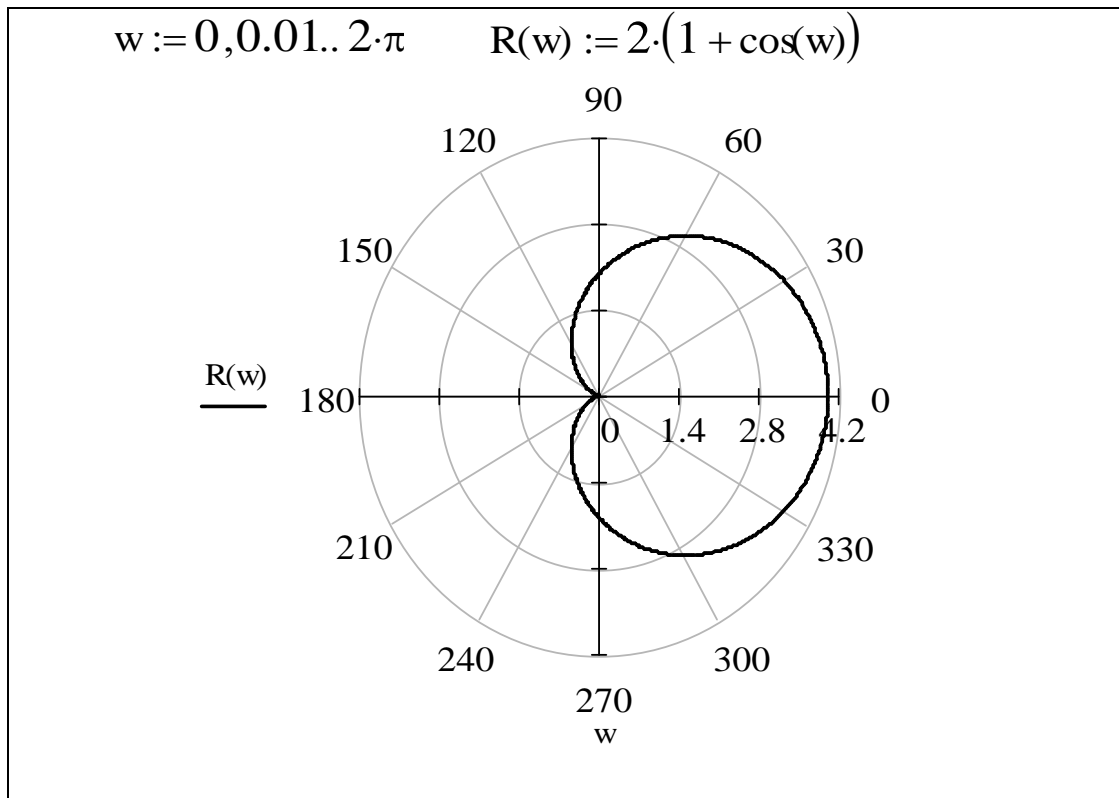
$$R(w) = 2 \cdot (1 + \cos(w))$$

[0; 2]

0,01.

MathCad

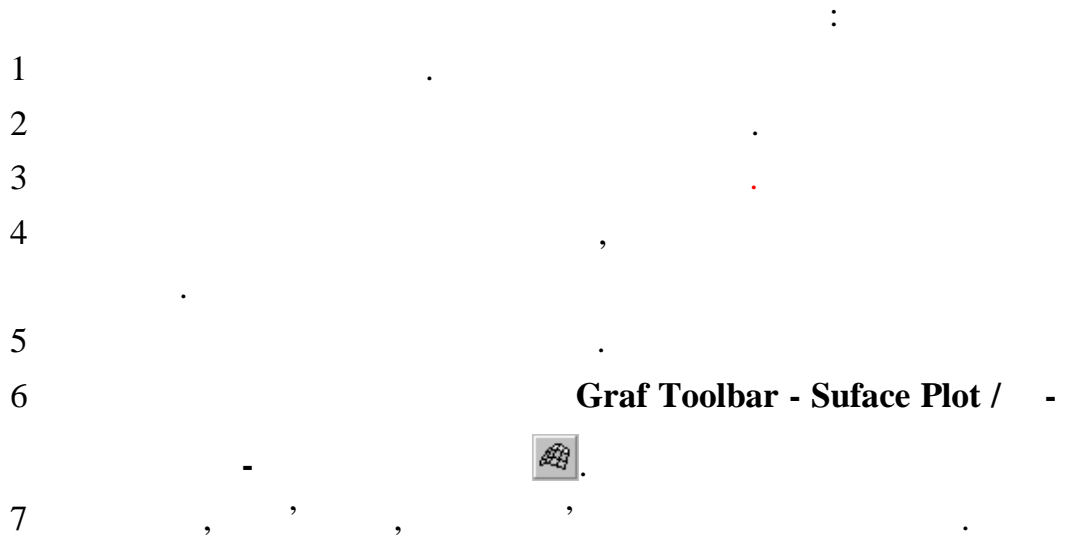
6.



6-



2.5



4

$$f(x,y) = \cos(x) + \sin(y) \quad \in [0; 2]$$

$\in [0; 2]$

MathCad

1

$$f(x,y) := \cos(x) + \sin(y).$$

2

$$x: xlow := 0 \quad xh \quad gh := 2.$$

3

$$: xn := 20.$$

4

$$: ylow := 0,$$

$$yh \quad gh := 2.$$

5

y,

$$: yn := 20.$$

6

$$: i := 0..xn - 1.$$

7

$$x \quad nd := xlow + i \cdot (xh \quad gh - xlow) / (xn - 1).$$

8

$$j: j := 0..yn - 1.$$

9

y:

$$y \quad nd_j := ylow + j \cdot (yh \quad gh - ylow) / (yn - 1).$$

10

$$: M_j := f(x \quad nd, y \quad nd_j).$$

11

MathCad

7.

$$f(x, y) := \cos(x) + \sin(y)$$

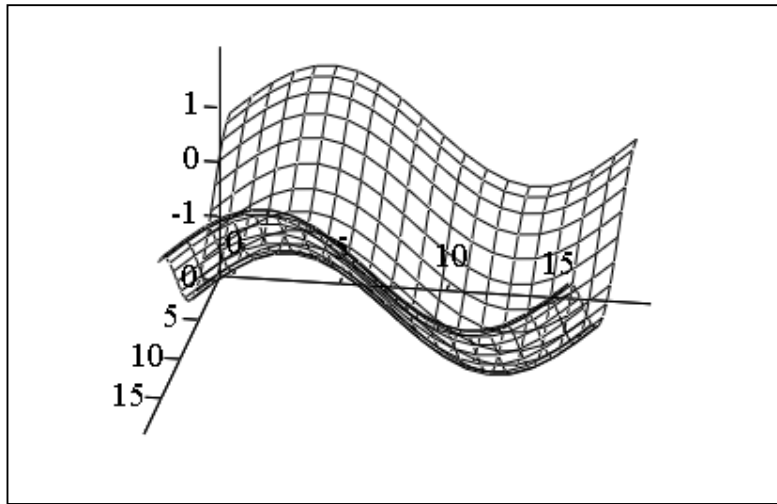
$$xlow := 0 \quad xhigh := 2 \cdot \pi \quad ylow := 0 \quad yhigh := 2 \cdot \pi$$

$$xn := 20 \quad yn := 20$$

$$i := 0..xn - 1 \quad j := 0..yn - 1$$

$$xind_i := xlow + i \cdot \frac{(xhigh - xlow)}{(xn - 1)} \quad yind_j := ylow + j \cdot \frac{(yhigh - ylow)}{(yn - 1)}$$

$$M_{i,j} := f(xind_i, yind_j)$$



M

7 -

4

- |   |         |      |             |
|---|---------|------|-------------|
| 1 | MathCad | Z    | [ -12 ; 4 ] |
|   | 0,005.  |      |             |
| 2 |         | (" " | -           |
| ? |         |      |             |
| 3 |         |      | -           |
| ? |         |      |             |
| 4 | MathCad | ?    |             |
| 5 | MathCad |      | ?           |

$m \times n$ ,  $k = 1..n$ ,  $m \times n$ .



Calculator Toolbar /

Vector and  
Matr x Toolbar – Determ nant /



Vector and  
Matr x Toolbar - Matr x Transpose /



Vector and Matr x Toolbar – nverse /



Toolbars – Matr x / View  
Ctrl + ( )

Ctrl +

Matr x or Vector /

(Rows)

(Columns),

$$M := \begin{pmatrix} 0 & 1 & 3 & 5 \\ 2 & 4 & 6 & 8 \\ 7 & 9 & 11 & 10 \end{pmatrix}$$

2

### Vector and Matrix Toolbar /



, M1), M1

$$M1 := \begin{pmatrix} 1 & 2 & 3 \\ 7 & 0 & 9 \\ 4 & 5 & 6 \end{pmatrix} \quad |M1| = 48$$

3



$$M := \begin{pmatrix} 0 & 1 & 3 & 5 \\ 2 & 4 & 6 & 8 \\ 7 & 9 & 11 & 10 \end{pmatrix} \quad M^T = \begin{pmatrix} 0 & 2 & 7 \\ 1 & 4 & 9 \\ 3 & 6 & 11 \\ 5 & 8 & 10 \end{pmatrix}$$

4



1.

$$M1 := \begin{pmatrix} 1 & 2 & 3 \\ 7 & 0 & 9 \\ 4 & 5 & 6 \end{pmatrix} \quad M1^{-1} = \begin{pmatrix} -0.938 & 0.062 & 0.375 \\ -0.125 & -0.125 & 0.25 \\ 0.729 & 0.063 & -0.292 \end{pmatrix}$$

5

$$\begin{pmatrix} 1 & 2 & 3 \\ 7 & 0 & 9 \\ 4 & 5 & 6 \end{pmatrix} \cdot 5 = \begin{pmatrix} 5 & 10 & 15 \\ 35 & 0 & 45 \\ 20 & 25 & 30 \end{pmatrix}$$

6

( )  
 + - ,  
 ( ' ), :





$$A \cdot X = \begin{pmatrix} 180 \\ 255 \\ 200 \end{pmatrix}$$

- 1 MathCad -
- 2 MathCad -
- 3 MathCad ?
- 4

4

**f (n + 1)**

$x_0, x_1, \dots, x_n,$

( . 1).

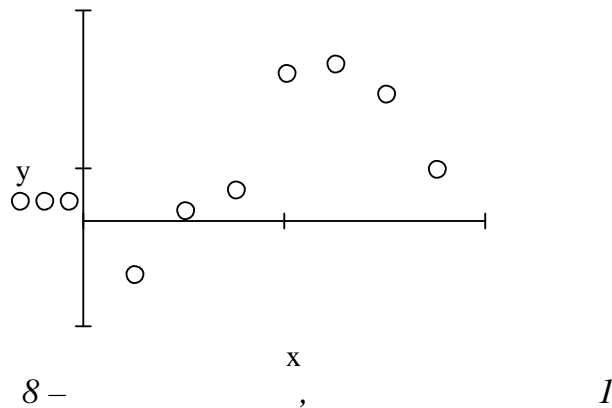
*l*

X	$x_0$	$x_1$	...	$x_n$
Y	$y_0$	$y_1$	...	$y_n$

(.8).  
 $(n + 1)$

**n:**

$$P_n(x) = a_0 + a_1 \cdot x + a_2 \cdot x^2 + \dots + a_n \cdot x^n.$$



$( = 0..n)$   
 $f$   $F(x) \approx P_n(x)$   
 $P_n(x)$ ,  
 $f$   $( = 0..n)$ .

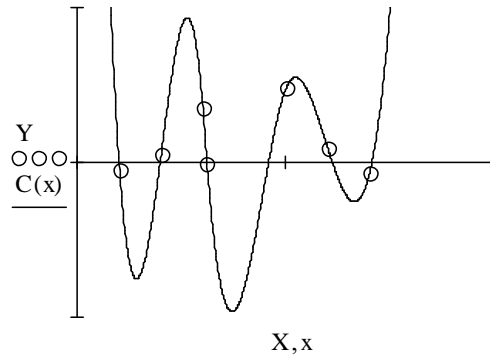
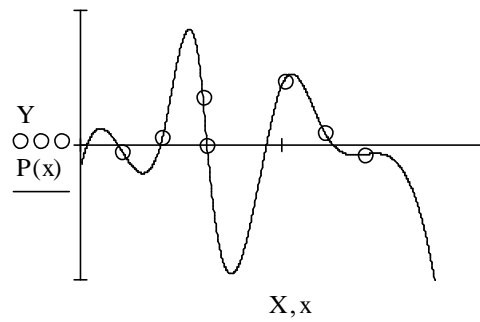
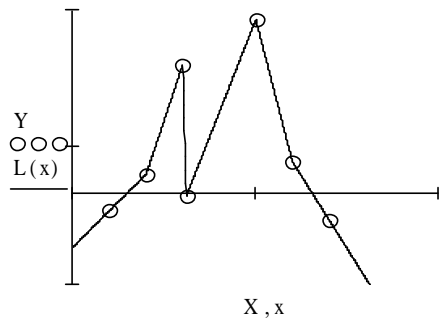
$$F(x) \approx P_n(x) = a_0 + a_1 \cdot x + a_2 \cdot x^2 + \dots + a_n \cdot x^n$$

$n = 1$  ,  $n = 2$  - ,  $n = 3$  -  
 $(.9 ; 9 ; 9)$  ).

$[x_0; x_n]$ ,  
 $[x; x_{+1}]$ .

$[x_0; x_n]$  -





9 -

#### 4.1

: [4; 4], [2; 2], [1; 3], [3; 5].

**VX** ( ), -  
**VY** - .

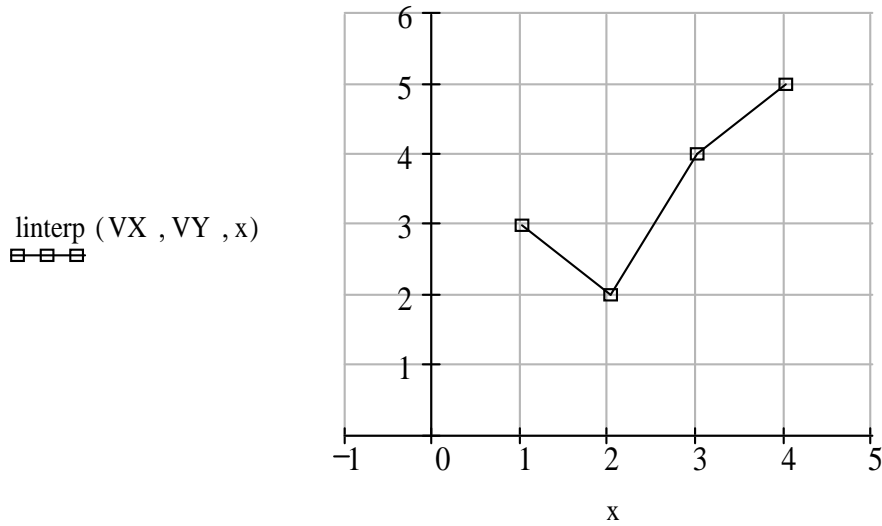
$$VX := \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \end{pmatrix} \quad VY := \begin{pmatrix} 3 \\ 2 \\ 4 \\ 5 \end{pmatrix}$$

, , 2,5 1,2, -  
**L nterp (VX, VY, 2,5) = , : 3.**  
**: L nterp (VX, VY, 1,2) = 2,8.**

(  
 ) ( . 10).

$$\mathbf{VX} := \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \end{pmatrix} \quad \mathbf{VY} := \begin{pmatrix} 3 \\ 2 \\ 4 \\ 5 \end{pmatrix}$$

$$\text{linterp}(\mathbf{VX}, \mathbf{VY}, 1.5) = 2.5 \quad \text{linterp}(\mathbf{VX}, \mathbf{VY}, 2.5) = 3 \quad \text{linterp}(\mathbf{VX}, \mathbf{VY}, 3.5) = 4.5$$



10 -

## 4.2 ( )

nterp. (cspl ne) : VS := cspl ne (VX, VY).

VS (nterp) : f(x) := nterp (VS, VX, VY, x).

VX VY.

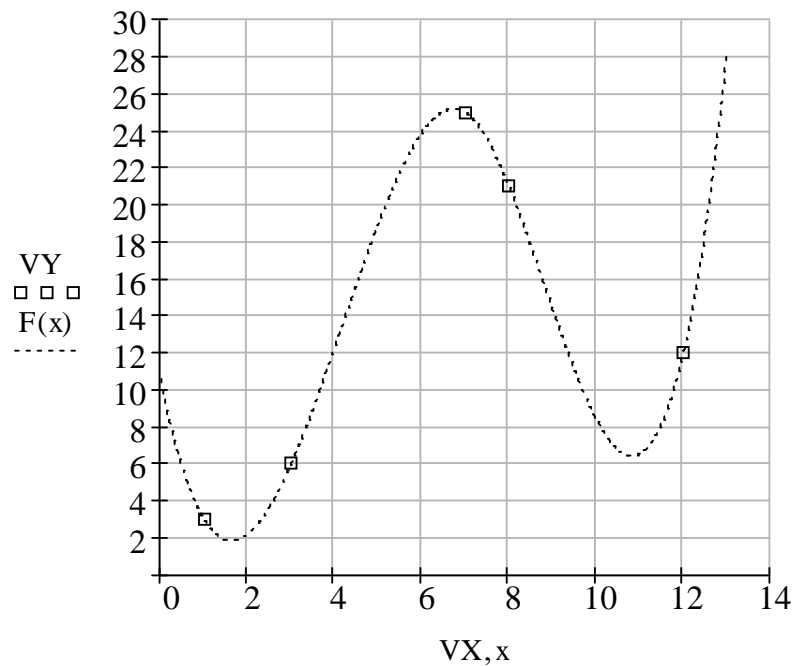
1 [1; 3], [7; 25] [12; 15] [3; 6] [8; 21] VS VY ( ):

$$VX := \begin{pmatrix} 1 \\ 3 \\ 7 \\ 8 \\ 12 \end{pmatrix} \quad VY := \begin{pmatrix} 3 \\ 6 \\ 25 \\ 21 \\ 12 \end{pmatrix}$$

2 : VS := cspline (VX, VY).  
 3 , : F(x) := nterp (VS, VX, VY, x).  
 4 x = 2 -  
 : F(2) =, 2,191.

$$VX := \begin{pmatrix} 1 \\ 3 \\ 7 \\ 8 \\ 12 \end{pmatrix} \quad VY := \begin{pmatrix} 3 \\ 6 \\ 25 \\ 21 \\ 12 \end{pmatrix} \quad x := 0, 0.01 .. 13$$

VS := cspline (VX, VY)    F(x) := nterp (VS, VX, VY, x)    F(2) = 2.191



11 -

( . 11)

[0; 13], 0,01.

1

2

3

4

MathCad,

, , ?

MathCad,

MathCad,

5

5.1

Calculus Toolbar – Summat on /

(  ).

$$\sum_{i=1}^n$$

Ctrl + Shift + 3 ( Calculus Toolbar - iterated Product /



6

$$n := 1 .. 40 \quad x_n := \sin(0.1 \cdot n \cdot \pi)$$

$$\sum_{n=1}^{20} n = 210 \quad \sum_{n=1}^{10} x_n = 6.314 \quad \sum_{n=0}^{40} x_n \cdot n = -126.275$$

$$\prod_{n=0}^{20} (n + 1) = 5.109 \times 10^{19} \quad \sum_{n=0}^5 \sum_{m=0}^{10} n^m = 1.37 \times 10^7$$

1. MathCad

$$1 \quad 3 \quad 0,5, \quad = 1 + 1,5 + 2 + 2,5 + 3.$$

Shift + \$ (

Calculus Toolbar - Range Variable Summation /



Σ

MathCad

7

$$i := 1, 2 \dots 3$$

$$k := 0, 2 \dots 10$$

$$\sum_i i = 22$$

$$\sum_k k^2 = 220$$

### 5.2

1  $( ) = x^3$   $x = 2,$

1

2  $x + \text{Shift} + : 2, x := 2.$

2

Calculus Toolbar



3

$x \cdot \frac{d}{dx}$

3

4

$d / dx \quad x^3$

5

$=,$

$$x := 2$$

$$\frac{d}{dx} x^3 = 12$$

MathCad.

8

1)  $2^5 = 2,$

2)  $2^5 = 2 \cdot 10,$

3)  $2^5 = 2 \cdot 10.$

$$x := 2 \quad y := 10$$

$$\frac{d}{dx}x^5 = 80 \quad \left(\frac{d}{dx}x^5\right) \cdot 10 = 800 \quad \frac{d}{dy}x^5 \cdot y = 32$$

$$3 \cdot x^2, \quad x^3, \quad x = 2, \quad 3 \cdot x^2,$$

### 5.3

(n- )

MathCad

$$() = x^9 \quad x \quad x = 2,$$

1  
2  
x. x:= 2.

### Calculus Toolbar



$$\frac{d^1}{dx^1}$$

3  
x.

$$\frac{d^2}{dx^2}$$

4  
3.

$$\frac{d^3}{dx^3}$$

$d/dx \quad x^9$

=,

$$\frac{d^3}{dx^3} x^9 = 3.226 \cdot 10^4$$

$n = 1$

$n = 0$

### 5.4

MathCad

$$= \sin(x^2) \quad 0 \quad \pi/4$$

1  
Toolbar



Calculus

$$\int_a^b \cdot dx$$

2

0.

$\pi/4$ .

$$\int_0^{\pi/4} \cdot dx$$

3  
 $\sin(x^2)$ .

d.

4

d x.

=




$$\int_0^{\frac{\pi}{4}} \sin(x^2) dx = 0.157$$

- 1 MathCad -  
 , ?
- 2 MathCad -  
 , ?

6

MathCad, ,  
 , ( , ) -  
 , -  
 .

**P: = Minimize** (< , >, < >),  
**P: = Maximize** (< , >, < >),  
 P - ,

**insert - Function - Function Category**  
**(Solving) - Function Name (Minimize, Maximize) /** - -  
 ( , ) - (Minimize, Maximize)  
 , **insert Function** .

9

$x, y,$

$$f(x,y) = x^2 + y^2 + 3$$

:

1

$$f(x,y) := x^2 + y^2 + 3.$$

2

$$x := 1$$

$$y := 1.$$

3

$$P := \text{Minimize}(f, x, y).$$

4

$$P = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$= 1 \quad = 0.$$

MathCad:

$$f(x, y) := (x - 1)^2 + y^2 + 3 \quad x := 1 \quad y := 1$$

$$P := \text{minimize}(f, x, y)$$

$$P = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

10

$$z(x) = x - 5 - x - 7x + 3$$

:

1

$$z(x) := x - 5 - x - 7x + 3$$

2

$$x := 0.$$

3

$$P := \text{Maximize}(z, x).$$

4

$$P = -0,429.$$

5

$$z(P) = 5.$$

6

:

$$\frac{d}{dx}z(P) = 0$$

MathCad:

$$z(x) := |x - 5| - |x| - |7 \cdot x + 3|$$

$$x := 0 \quad P := \text{Maximize} (z, x)$$

$$P = -0.429 \quad z(P) = 5$$

$$\frac{d}{dx}z(P) = 0$$

11

$$f(x, y) = x^2 + y^2 \quad x \in [-10, 10]$$

$y \in [10, 20]$ .

:

1

$$f(x, y) := x^2 + y^2.$$

2

$x := 1; y := 1.$

3

G ven.

4

:

$$x \quad -10 \quad 10;$$

$$y \quad 10 \quad y \quad 20.$$

5

$$P := \text{Minimize} (f, x, y).$$

6

,

:

$$P = \begin{pmatrix} -2.662 \times 10^{-15} \\ 10 \end{pmatrix}$$

$$, \quad = 0 \quad = 10.$$

7

$$: f(0; 10) = 100.$$

MathCad

:

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

given

$$x \geq -10 \quad x \leq 10 \quad y \geq 10 \quad y \leq 20$$

$$P := \text{Minimize} \quad (f, x, y)$$

$$P = \begin{pmatrix} -2.662 \times 10^{-15} \\ 10 \end{pmatrix}$$

$$f(0, 10) = 100$$

, 11

**Solve Block,**

**Given.**

200. **Solve Block**

<, ≤, >, ≥, =

≠.

**1**

MathCad,

?

**2**

MathCad

?

**3**

**(Solve Block)?**

7.1

MathCad root, insert Function - Function Category (Solving) -

Function Name (root) / ( ) - (root) .

: root(f(x), x).

f(x) ( , ) -

root. x -

( , )

), root

( )

. MathCad

, ,

root f(x)

, e<sup>x</sup> = x<sup>3</sup>.

:

1 ,

x<sup>3</sup> - e<sup>x</sup> = 0.

f(x) root.

2 ( ) = x<sup>3</sup> - e<sup>x</sup>.

, - 2

5.

3 1 2 ,

root.

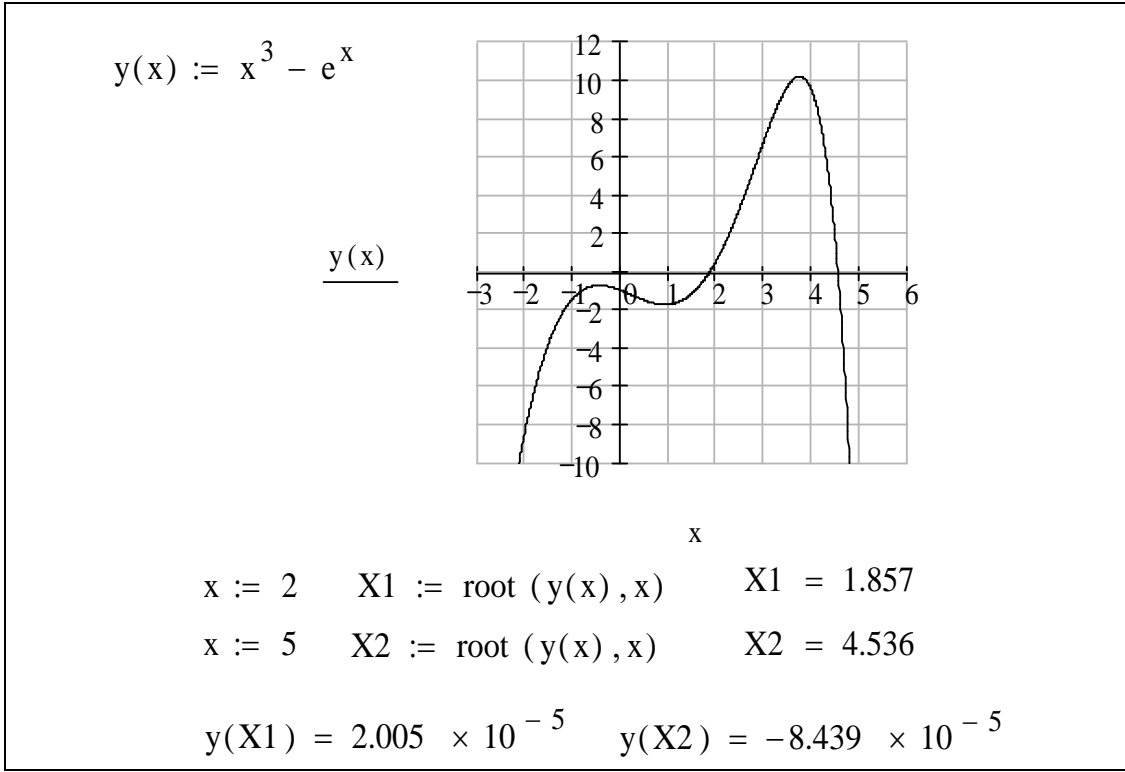
4

5 , -

12.

root :

- ( )  
 - root;  
 - ,  $x^2 - 1 = 0$ ,  
 - ;  
 - root , ;  
 - ,  $f(x) = g(x)$   
 $f(x) - g(x) = 0$  . root  
 : root ( f ( x ) - g ( x ) , x ) .



12- , root

### 7.2

$$P_n(x) = a_n X_n + \dots + a_2 X_2 + a_1 X_1 + a_0$$

polyroots,  
 root. root polyroots  
 polyroots

**: polyroots(v), v**

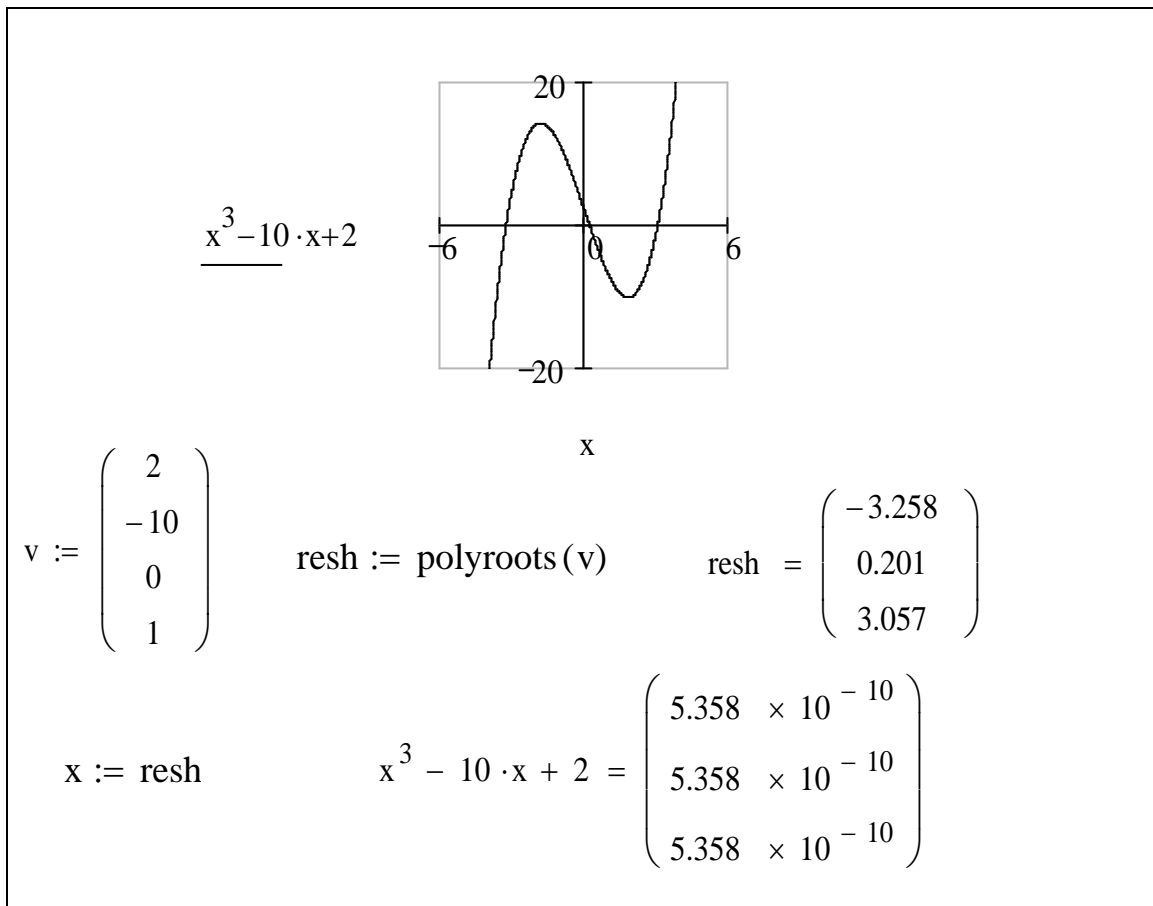
**(n+1):**

$$v := \begin{pmatrix} A_0 \\ A_1 \\ A_2 \\ \dots \\ A_n \end{pmatrix}$$

13

**polyroots**

$$x^3 - 10 \cdot x + 2 \cdot x^0.$$



13 -

**polyroots**

### 7.3

MathCad

1

(MathCad

2

**G ven.**

3

**G ven.**

= ( ).

trl + =

**Boolean Toolbar - Equal to /**

(  ).

: <, >, ≤ ≥..

**F nd.**

**F nd**

**F nd ( z1, z2, z3, ... ) –**

**F nd**

**G ven**

**F nd.**

**F nd**

, **F nd (z1, z2)**

**z1 z2**

**G ven,**

**F nd,**

**G ven**

**F nd (**

**x y**

**z w –**

**- w = z ( =**

**trl + = –**

) 1,

– 0;

**- x > y ( >**

**>) –**

**- x < y ( <**

**<) –**



-  $x \geq y$  ( $\geq$  **trl + 0**) -  
 ;  
 -  $x \leq y$  ( $\leq$  **trl + 9**) -  
 .

-  $\neq$  ( $\neq$  **trl + 3**) - ;

- ;  
 - **a < b < c.**

**F nd** : x y

, athcad , ?

**found /** , **F nd** : **No solut on was**

athcad , **F nd** **Minerr.**

**1** MathCad ,

**2** , ?

**3** MathCad -

, ?

**4** ,

MathCad?

MathCad

13

: rkf xed -

- 4-

$h^5, h -$

**Z: = rkf xed (y, x1, x2, npo nts, D),**

y -

x1 -

x2 -

npo nts -

D -

**rkf xed**

**nsert -**

**Funct on -D fferent al Equat on Solv ng - rkf xed /**

**- rkf xed**

**nsert Funct on /**



MathCad.

12

$$y'' + 3y = 0, y(0) = 1, y'(0) = 0.$$

**D.**

$$\begin{cases} y' = y_1 \\ y'' = -3y_0 \end{cases}$$

$$y' = y_1; y = y_0.$$

$$D = \begin{bmatrix} y_1 \\ -3 \cdot y_0 \end{bmatrix}.$$

$$y = \begin{bmatrix} y(0) \\ y'(0) \end{bmatrix},$$

$$y = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$

**13**

$$y'' + 3y = x^2 + 3, y(0) = 1, y'(0) = 0.$$

$$D = \begin{bmatrix} y_1 \\ x^2 + 3 - 3 \cdot y_0 \end{bmatrix},$$

**14**

$$\mathbf{y}''' + 2 \cdot \mathbf{y}'' + \sin(\mathbf{x}) \cdot \mathbf{y}' - \mathbf{x} \cdot \mathbf{y} = 13,$$

$$\mathbf{y}(0) = 1, \mathbf{y}'(0) = 0, \mathbf{y}''(0) = -1$$

$$\mathbf{D} = \begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ 13 - 2 \cdot \mathbf{y}_2 - \sin(\mathbf{x}) \cdot \mathbf{y}_1 + \mathbf{x} \cdot \mathbf{y}_0 \end{bmatrix},$$

$$: \quad \mathbf{y} = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}.$$

**rkf xed**

+ 1  
, n -

	0	1	2	...
0	0	( 0)	'( 0)	...
1	1	( 1)	'( 1)	...
2	2	( 2)	'( 2)	...
...	...	...	...	...

, - ( ), - : '( ), ''( ) . . .

**15**

$$\mathbf{y}'' = -\mathbf{y}' + 2 \cdot \mathbf{y}$$

$$: \mathbf{y}(0) = 1, \mathbf{y}'(0) = 3.$$

$$\mathbf{y} = \begin{bmatrix} 1 \\ 3 \end{bmatrix} -$$

$$\mathbf{x1} = 0, \mathbf{x2} = 2 -$$

$$\text{npoints} = 400 -$$

$$\mathbf{D}(\mathbf{x}, \mathbf{y}) = \begin{bmatrix} \mathbf{y}_1 \\ -\mathbf{y}_1 + 2 \cdot \mathbf{y}_0 \end{bmatrix} -$$

Matr x Toolbar – Subscr pt /



MathCad:

$$y := \begin{pmatrix} 1 \\ 3 \end{pmatrix}$$

$$D(x, y) := \begin{pmatrix} y_1 \\ -y_1 + 2 \cdot y_0 \end{pmatrix}$$

$$Z := \text{rkfixed}(y, 0, 2, 400, D)$$

[0;2], - 400 -  
( . 14).

$$Z^{<0>}$$

Vector and Matrix Toolbar



$$- Z^{<1>}$$

( . 15).

1

MathCad,

2

3

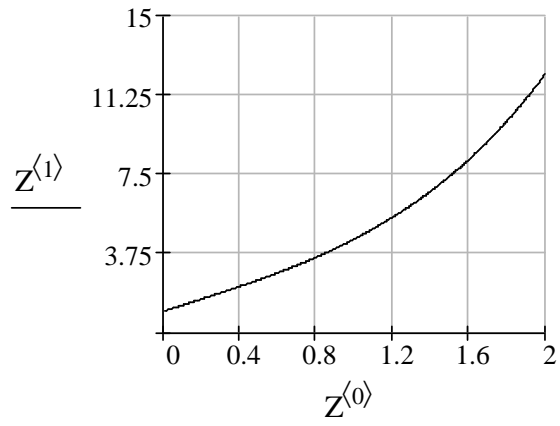
rkf xed

4

?

	0	1	2	
24	0.12	1.355	2.928	
25	0.125	1.369	2.927	
26	0.13	1.384	2.926	
27	0.135	1.399	2.925	
28	0.14	1.413	2.925	
29	0.145	1.428	2.924	
30	0.15	1.443	2.924	
31	0.155	1.457	2.924	
32	0.16	1.472	2.924	
33	0.165	1.486	2.924	
34	0.17	1.501	2.925	
35	0.175	1.516	2.925	
36	0.18	1.53	2.926	
37	0.185	1.545	2.926	
38	0.19	1.56	2.927	
39	0.195	1.574	2.928	

14 -



15 -

,  
 : , ,  
 ,  
 . . .  
 ,  
 .

2.

2

1	,	.
2	,	.
3		,

, ,  
 n :  $x_1, x_2, \dots, x_n$  ( , n).

$$\begin{aligned}
 & : \bar{x}^* = \frac{1}{n} \sum_i x_i, \\
 & : D^* = \frac{1}{n} \sum_i (x_i - \bar{x}^*)^2, \\
 & : \sigma^* = \sqrt{D^*}, \\
 & : Sk = \frac{1}{(\sigma^*)^3} \cdot \frac{1}{n} \sum_i (x_i - \bar{x}^*)^3, \\
 & : Ex = \frac{1}{(\sigma^*)^4} \cdot \frac{1}{n} \sum_i (x_i - \bar{x}^*)^4 - 3.
 \end{aligned}$$

$\bar{x}$

16

( .3)

3

1.67	2.41	0.79	1.41	2.50	2.29	2.58	1.32
3.75	1.94	0.95	3.48	2.39	1.17	1.92	1.04
2.13	1.58	2.18	2.30	3.03	1.50	2.53	1.91
1.31	3.62	1.49	1.98	2.14	3.35	2.89	2.51
2.31	2.34	1.00	2.03	0.64	2.67	0.09	1.78
3.24	1.91	1.20	1.61	2.35	1.73	2.93	2.32
2.84	1.29	2.28	2.54	1.85	2.40	2.22	2.90
2.37	2.68	2.00	2.70	2.33	2.86	0.36	1.98
2.53	0.80	2.89	0.73	1.01	1.85	2.05	1.16
1.76	2.78	2.43	1.85	1.21	1.53	1.54	2.43

1 fio\_2.dat).

2 : n,

mean, R = xmin - xmax,

, Sk, Ex.

3 ,

10. ,

4

: P (2,1 < X < 3,2) = ?.

5 ,

10% ,



```

1                                     dan.dat.
2                                     : ' n, -
mean, R = xmin - xmax, -
, Sk, Ex :
```

```
ORIGIN:= 1
```

```
i:= 1 .. 80
```

```
xi:= READ ("dan.dat")
```

```
xmax:= max( ) xmin:= min( ) xmax = 3.75xmin = 0.09
```

```
xi:= sort( ) n:= length( ) n = 80 R:= xmax - xmin
```

```
mean:= mean( ) mean = 2.03
```

```
disp:= var( ) * n / (n-1) disp = 0.574
```

```
sigma:= sqrt(disp) sigma = 0.758
```

```
mu3:= (1/n) * sum(xi - mean)^3 mu4:= (1/n) * sum(xi - mean)^4
```

```
Sk:= -3/sigma^3 Sk = -0.173
```

```
Ex:= (-4/sigma^4) - 3 Ex = -0.288
```

```

3                                     ,
10.
```

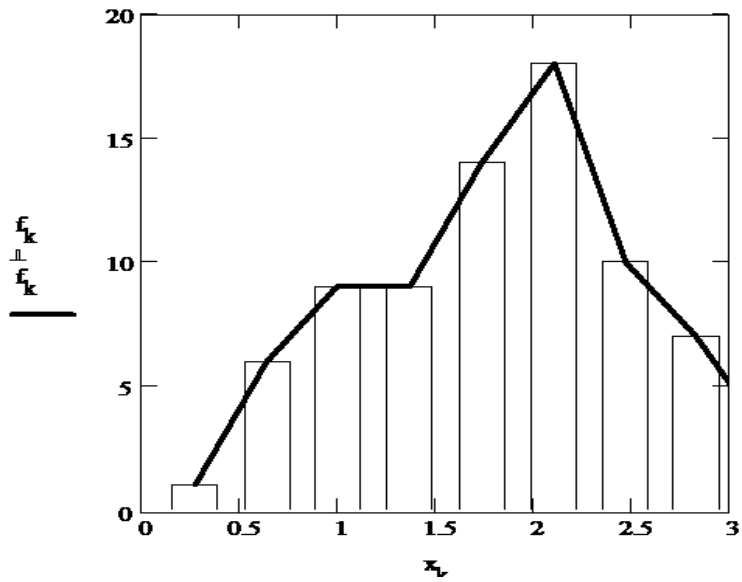
```
m:= 10 h := R / m h = 0.366
```

```
j:= 1 .. m k:= 1 .. m - 1
```

```
xj:= xmin + (h/2) * (2 * j - 1)
```

```
f := hist(x, xi)
```

```
( . 16)
```

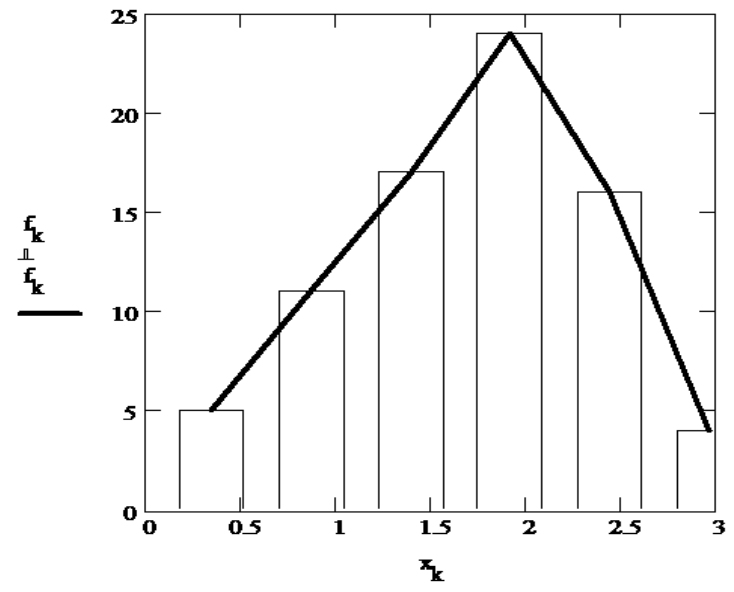


16 -

10

7

( . 17).



17 -

7

4

(a, b)

$$P(a < X < b) = F(b) - F(a),$$

$F(x)$  -

$\text{pnorm}(x, \text{mean}, \sigma)$ .

$$\text{pnorm}(3.2, \text{mean}, \sigma) - \text{pnorm}(2.1, \text{mean}, \sigma) = 0.402;$$

$$P(2.1 < X < 3.2) = F(3.2) - F(2.1) = 0.402.$$

5

$\bar{x}$

$$\delta = 0.1 \cdot \bar{x} = 0.1 \cdot 2.03.$$

$$P(|x - \bar{x}| < \delta) = 2F\left(\frac{\delta}{\sigma}\right).$$

$$\delta := 0.1 \cdot \text{mean}$$

$$\delta = 0.203$$

$$2 \cdot \text{pnorm}\left(\frac{\delta}{\sigma}, \text{mean}, \sigma\right) = 0.02$$

:

$0.1\bar{x}$

$$0.02 \cdot 100\% = 2\%$$

**1**

:

'

**2**

?

**3**

?

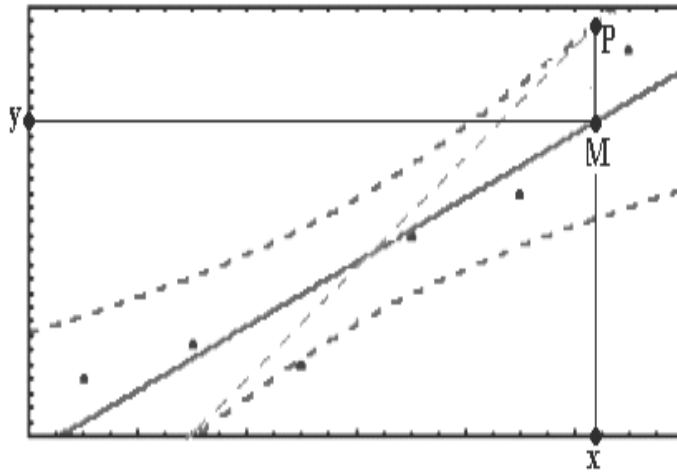
**4**

**5**

$$y = b_0 + b_1x$$

. 19

$$y: y = b_0 + b_1x + \epsilon$$



18 -

$$= 0,95$$

$$= 0,99 \text{ (95\%, 99\%).}$$

$$y = b_0 + b_1x + \epsilon$$

. 18

$$y =$$

$$b_0 + b_1x.$$

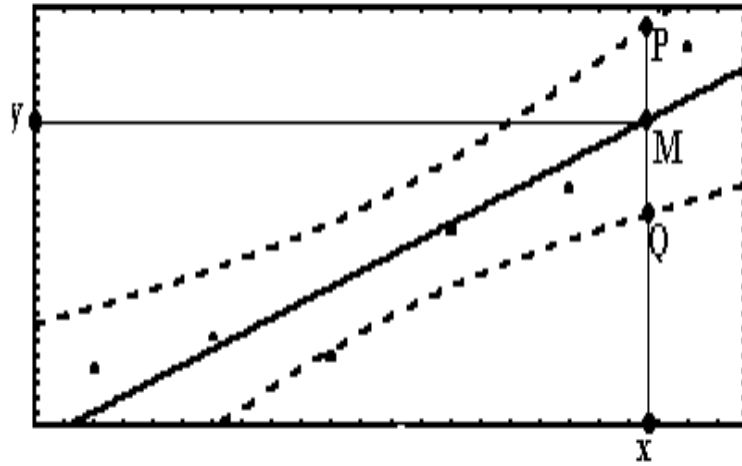
$\gamma$

PQ ( .19).

$$\delta = MP = MQ.$$

:

$$O . . = \left| \frac{\delta}{y} \right| \cdot 100\%.$$



19 -

17

( .4)

4

	X	Y
1	7,89	8,9
2	14,41	4,3
3	6,01	10,2
4	9,17	4,9
5	6,78	8,3
6	8,91	7,8
7	6,17	13,1
8	10,11	4,9
9	5,98	13,3
10	6,10	10,7
11	5,90	13,7
12	8,13	5,6
13	9,01	4,7
14	6,00	11,1
15	6,13	10,8

1

2

80%, 95% 99%

3

4

,  
(80%, 95%, 99%),

5

$\delta_\gamma$ ,

(80%, 95%, 99%):  $\delta_{80}$   $\delta_{95}$   $\delta_{99}$ .

6

( )

(80%, 95%, 99%)

$$\left| \frac{\delta_\gamma}{y} \right| \cdot 100\% (\delta_\gamma (y) \text{ .})$$

7

%

1

dan\_x.dat

dan\_y.dat.

2

MathCad

:

-

ORIGIN := 1      N := 15      i := 1..N

$x_i := \text{READ}(\text{"dan\_x.dat"})$

$$x^T = \begin{array}{|c|c|c|c|c|c|c|c|c|c|c|} \hline & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\ \hline 1 & 7.89 & 14.41 & 6.01 & 9.17 & 6.78 & 8.91 & 6.17 & 10.11 & 5.98 & 6.1 \\ \hline \end{array}$$

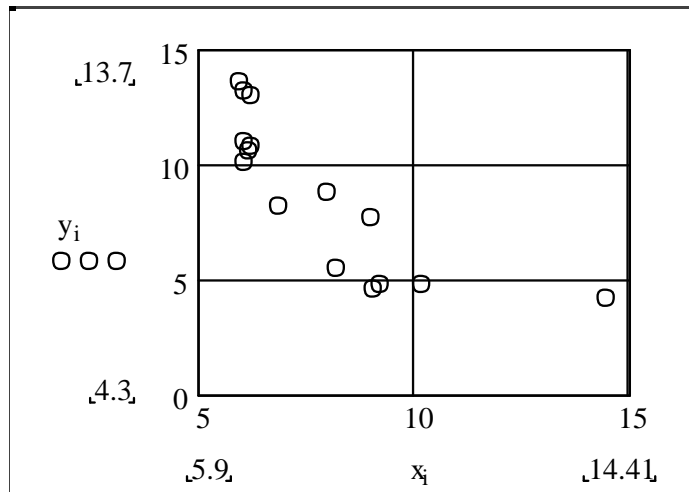
$y_i := \text{READ}(\text{"dan\_y.dat"})$

$$y^T = \begin{array}{|c|c|c|c|c|c|c|c|c|c|c|} \hline & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\ \hline 1 & 8.9 & 4.3 & 10.2 & 4.9 & 8.3 & 7.8 & 13.1 & 4.9 & 13.3 & 10.7 \\ \hline \end{array}$$

( . 20).

y

: corr(x, y) = -0.808 ■



20 -

X Y -0,808.

$0,6 < |-0,808| < 0,9,$

$y = b_0 + b_1x:$

$b_0 := \text{intercept}(x,y) \quad b_0 = 17.818$

$b_1 := \text{slope}(x,y) \quad b_1 = -1.157$

$y_i := b_0 + b_1 \cdot x_i$

:

$X_{\text{mean}} := \text{mean}(x) \quad X_{\text{mean}} = 7.78$

Y:

$Y_{\text{mean}} := \text{mean}(y) \quad Y_{\text{mean}} = 8.82$

(Mean)

$(\bar{x}, \bar{y}) = (7.78, 8.82).$

:

$$S2 := \left( \frac{1}{N-1} \right) \cdot \sum_{k=1}^N (y_k - yr_k)^2 \quad S2 = 3.88$$

$$Xmin \leq X \leq Xmax,$$

:

$$Xmin = \min(x) \quad Xmin = 5.9 \quad Xmax = \max(x) \quad Xmax = 14.41$$

$$(Xmin; Xmax),$$

$$(5.9; 14.41).$$

$$80\%, 95\% \quad 99\%$$

MathCad

$$\gamma = 80\% \quad (.21)$$

$$\alpha := 0.20 \quad t := qt \left[ 1 - \left( \frac{\alpha}{2} \right), N - 2 \right]$$

$$\delta_i := t \cdot \sqrt{S2} \cdot \sqrt{\left( \frac{1}{N} \right) + \frac{(x_i - Xmean)^2}{\sum_{k=1}^N (x_k - Xmean)^2}}$$

$$yleft_i := yr_i - \delta_i \quad yright_i := yr_i + \delta_i$$

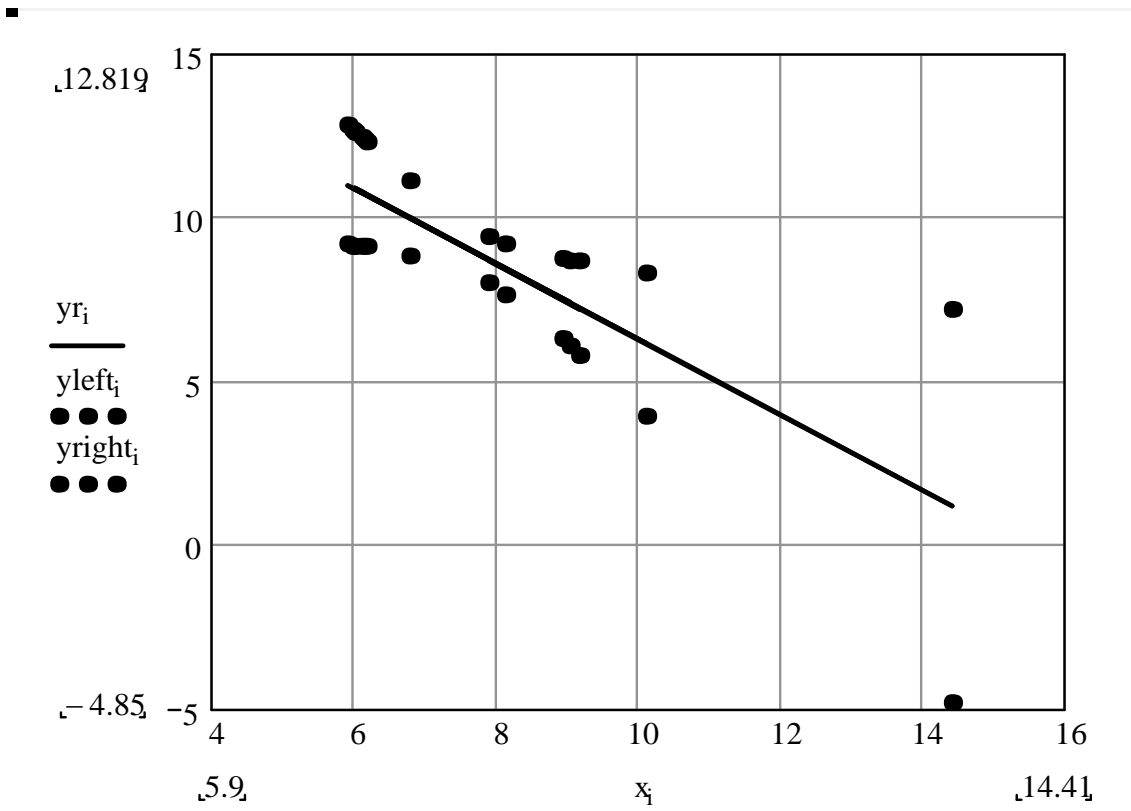
$$\gamma = 95\% \quad (.22).$$

$$\alpha := 0.05 \quad t := qt \left[ 1 - \left( \frac{\alpha}{2} \right), N - 2 \right]$$

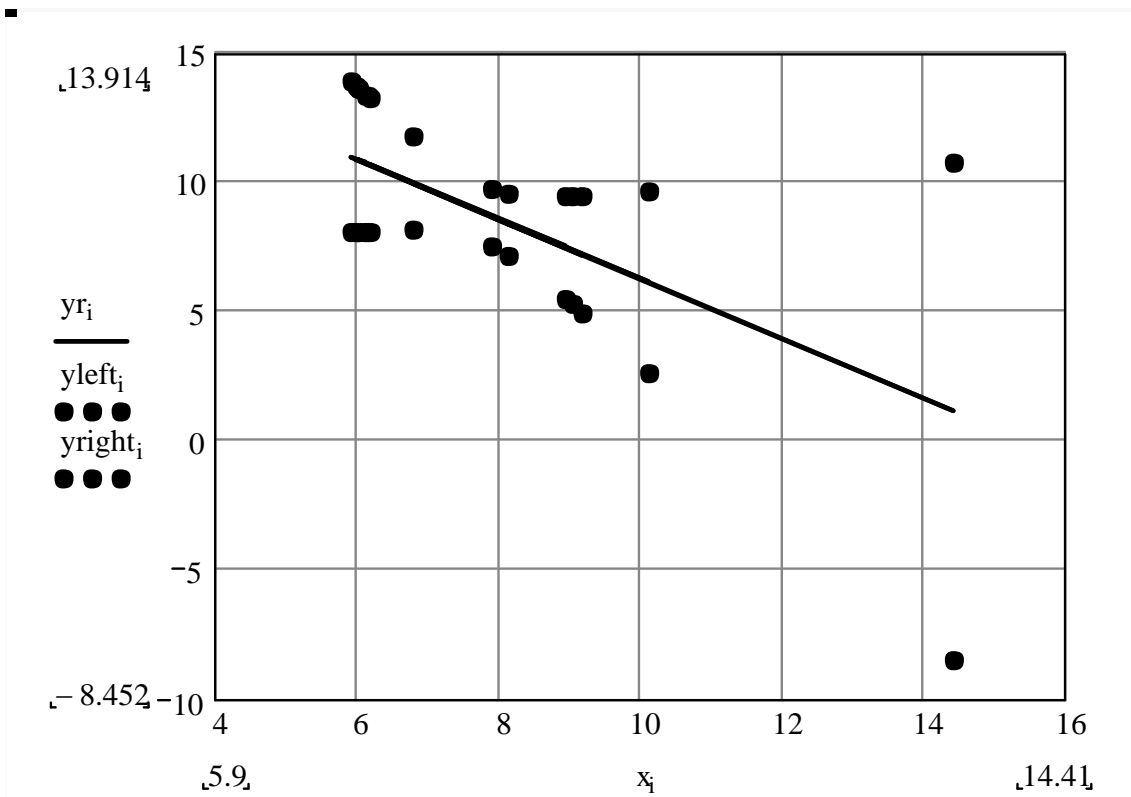
$$\delta_i := t \cdot \sqrt{S2} \cdot \sqrt{\left( \frac{1}{N} \right) + \frac{(x_i - Xmean)^2}{\sum_{k=1}^N (x_k - Xmean)^2}}$$

$$yleft_i := yr_i - \delta_i \quad yright_i := yr_i + \delta_i$$





21



22



2

$\gamma?$

3

y

-

x?

4

?

5

?

6

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-

?

1

$$f(x) = 3 + \sin(4 + x^2)$$

MathCad -

. ,  
(  
). , -  
: , -  
.

1

$$: f(x) := 3 + \sin(4 + x^2).$$

2

:

2.1

(-5;5) -

0,1 ( . ).

Graph /

X-Y Plot /



2.2

- , , ( ) - y(x). -

Auto Gr g

Number of Gr ds

2

99 ( 10).

2.3

( ): -

0,6,

2,4. -

0,8

2,0. -

2.4

: ( ) : f(0,6) = , f(0,8), f(2),

f(2,4)

2.5

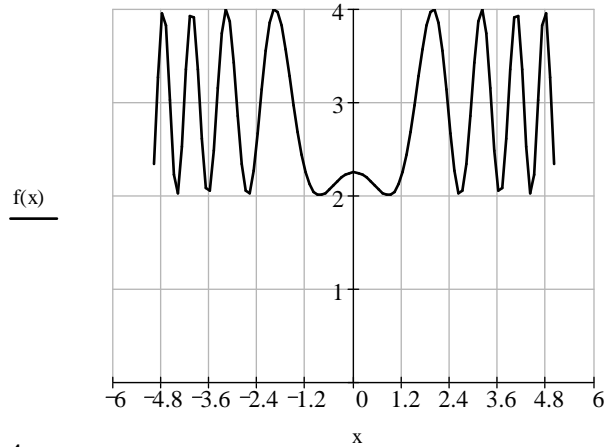
[0,6; 2,4], [0,8; 2,003] [2,0; 3,989],  
[0,6; 2,061] [2,4; 2,671].

MathCad

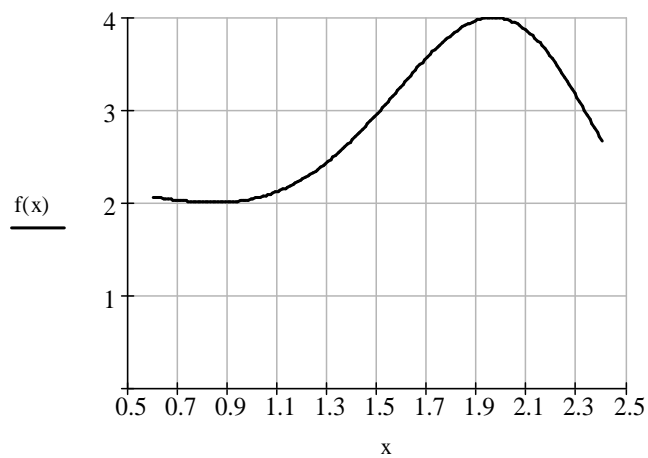
.1.

$$f(x) := 3 + \sin(4 + x^2)$$

$$x := -5, -4.9 \dots 5$$



$$x := 0.6, 0.61 \dots 2.4$$



$$f(0.6) = 2.061$$

$$f(0.8) = 2.003$$

$$f(2) = 3.989$$

$$f(2.4) = 2.671$$

.1 -

1

2

1 :

1 [x1; y1], [x2; y2], [x3; y3], [x4; y4], -

1,

.

.

:

$$. = \frac{\quad - \quad}{100} .$$

2 [x1; y1], [x2; y2], [x3; y3] [x4; y4]. -  
 .1, . -  
 . -  
 3 .

, 1: [0,6; 2,061], [0,8; 2,003], [2,0; 3,989],  
 [2,4; 2,671].

1 f(x) = 3 + sin(4 + x^2)  
 [0,6; 2,4] 0,001.

1.1 :  
 1.1.2 : .  
 1.1.3 : .  
 1.1.4 ' , F(x) := lnterp(X, Y, x).  
 1.1.5 . -

( ' ), -  
 .

1.1 :  
 1.1.1 , -

1,2.

:

$$\text{Otr}_P := |f(1.2) - F(1.2)| \cdot \frac{100}{f(1.2)}$$

1.2.3  
 Otr\_P = 18,274%.

.2.

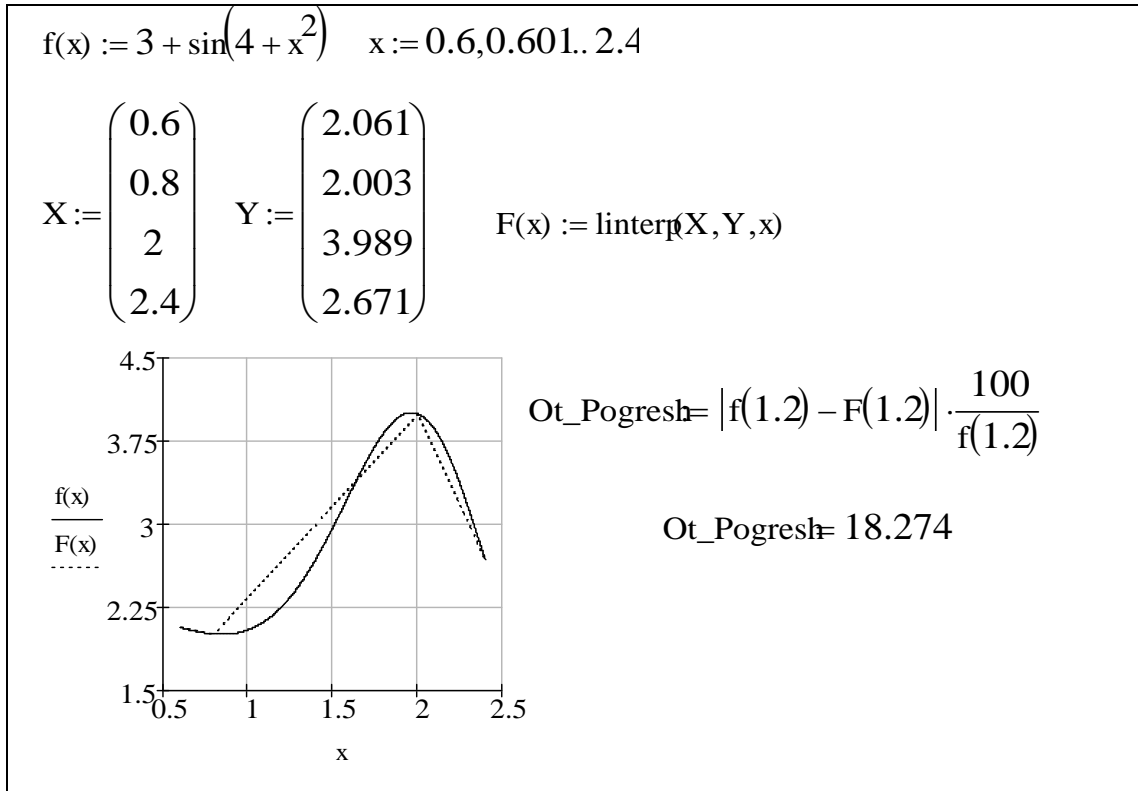
2 :  
 2.1 .  
 2.2 ,

vs := cspline(X, Y) ' F(x) := ninterp(vs, X, Y, x).

2.3 .  
 ( ' ),

2.4

1,5.



.2 -

2.5

$$\text{Ot\_Pogresh} := |f(1.5) - F(1.5)| \cdot \frac{100}{f(1.5)}$$

**16,616%.**

MathCad

.3.

3

$$P(x) = y + q \cdot y_0,$$

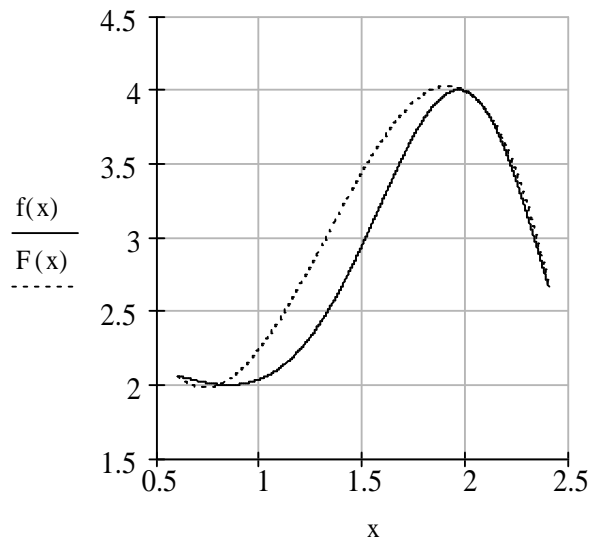
$$P(x) = y + q \cdot \Delta y_0 + \frac{q \cdot (q-1)}{2} \cdot \Delta^2 y_0 + \frac{q \cdot (q-1) \cdot (q-2)}{6} \cdot \Delta^3 y_0.$$

$$f(x) := 3 + \sin(4 + x^2) \quad x := 0.6, 0.601 \dots 2.4$$

$$X := \begin{pmatrix} 0.6 \\ 0.8 \\ 2 \\ 2.4 \end{pmatrix} \quad Y := \begin{pmatrix} 2.061 \\ 2.003 \\ 3.989 \\ 2.671 \end{pmatrix}$$

$$vs := \text{cspline}(X, Y)$$

$$F(x) := \text{interp}(vs, X, Y, x)$$



$$\text{Ot\_Pogresh} := |f(1.5) - F(1.5)| \cdot \frac{100}{f(1.5)} \quad \text{Ot\_Pogresh} = 16.616$$

.3 -

" "

,

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-

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,

,

$N \cdot y_0$

.

-

,

[18,274%]

[16,616%],

.

-

,

,

.



3

1 **f(x)** 1 ( .2) . -

2 **f(x)** .1 ( .2 ) . -

3 [x1, x4] , -

4 .1, -

5 -

1 I I :

1.1 :

$$f(x) := 3 + \sin(4 + x^2)$$

1.2 . :  
1.2.1 , ' :

$$\frac{d}{dx}(3 + \sin(4 + x^2))$$

1.3 . :

1.3.1 . 1.2.1 ,

**S mpl fy /**

MathCad)

**Symbol cs /**

1.3.2 ( , , -

( , , -

**df(x)** :

$$df(x) := 2 \cdot \cos(4 + x^2) \cdot x$$

1.4  
1.4.1

**d(x):**

$$\begin{aligned} df(0.6) &= -0.414 \\ df(0.8) &= -0.116 \end{aligned}$$

$$\begin{aligned} df(2) &= -0.582 \\ df(2.4) &= -4.533 \end{aligned}$$

1.4.2  
**d(x) := lnterp (X, Y, x).**

1.4.3

1.4.5

**1,6.**

$$\text{Ot\_Pogresh} := |df(1.6) - dF(1.6)| \cdot \frac{100}{f(1.6)}$$

**107,074%.**

MathCad

.4.

2

2.1

2.2

2.3

2.4

2

1.1 - 1.3, 1.4.1

**vs := csplnc (X, Y).**

**dF (x) := nterp (vs, X, Y, x).**

**1,6.**

**69,034 %.**

MathCad

.5.

3

3.1

3.2

3.3

**f (x) := 3 + sin (4 + x<sup>2</sup>).**

**X := Y := .**

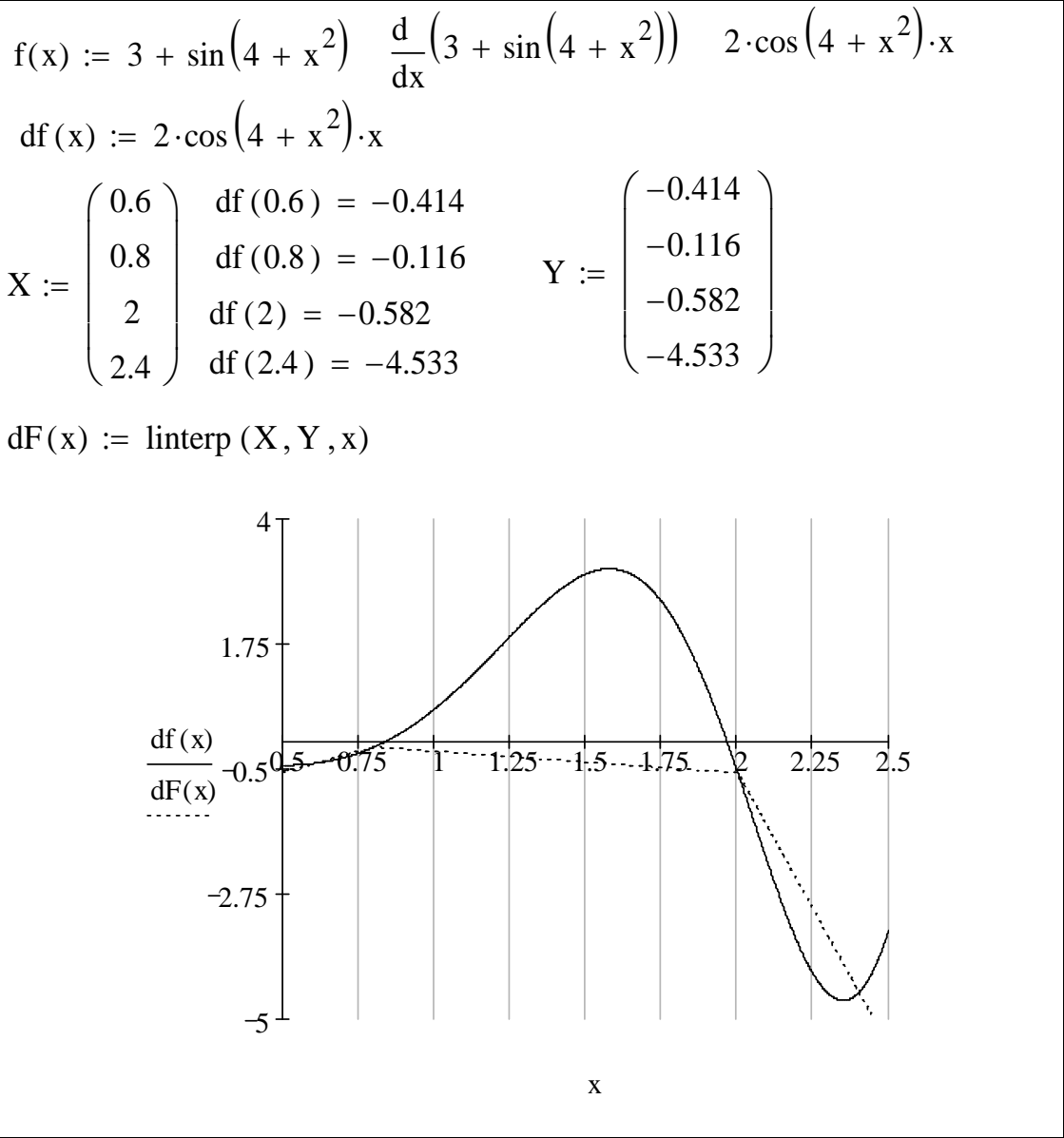
**F1 (x) := lnterp (X, Y, x),**

**vs := csplnc (X, Y)**

**Fk (x) := nterp (vs, X, Y, x).**

3.4

**f (x),**



.4 -

3.4.1

**Calculus Toolbar /  
Def n te ntegral /**



3.4.2

=.

**5,418.**

3.5

**F1(x)**

**Fk(x).**

**5,541 5,786,**

3.6

MathCad

.6.

$$f(x) := 3 + \sin(4 + x^2) \quad \frac{d}{dx}(3 + \sin(4 + x^2)) \quad 2 \cdot \cos(4 + x^2) \cdot x$$

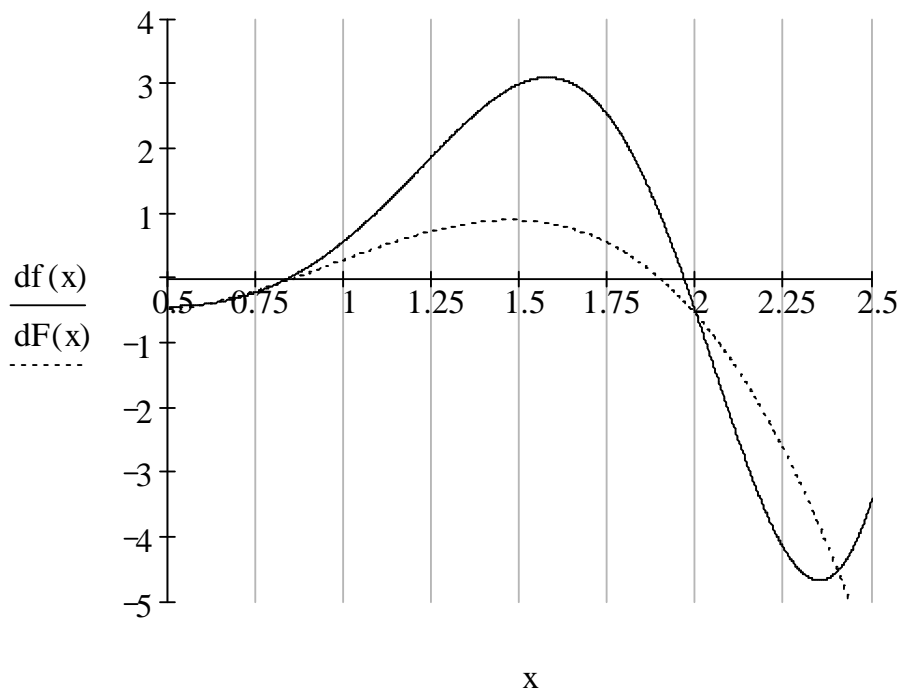
$$df(x) := 2 \cdot \cos(4 + x^2) \cdot x$$

$$X := \begin{pmatrix} 0.6 \\ 0.8 \\ 2 \\ 2.4 \end{pmatrix} \quad \begin{matrix} df(0.6) = -0.414 \\ df(0.8) = -0.116 \\ df(2) = -0.582 \\ df(2.4) = -4.533 \end{matrix} \quad Y := \begin{pmatrix} -0.414 \\ -0.116 \\ -0.582 \\ -4.533 \end{pmatrix}$$

$$vs := \text{cspline}(X, Y) \quad dF(x) := \text{interp}(vs, X, Y, x)$$

$$\text{Ot\_Pogresh} := |df(1.6) - dF(1.6)| \cdot \frac{100}{f(1.6)}$$

$$\text{Ot\_Pogresh} = 69.034$$



.5 -

4

,

( . .1):

.1

	, %		
	18,274	107,074	2,27
	16,616	69,034	6,792

$$f(x) := 3 + \sin(4 + x^2)$$

$$X := \begin{pmatrix} 0.6 \\ 0.8 \\ 2 \\ 2.4 \end{pmatrix} \quad Y := \begin{pmatrix} 2.061 \\ 2.003 \\ 3.989 \\ 2.671 \end{pmatrix}$$

$$Fl(x) := \text{linterp}(X, Y, x)$$

$$vs := \text{cspline}(X, Y) \quad Fk(x) := \text{interp}(vs, X, Y, x)$$

$$\int_{0.5}^{2.4} f(x) dx = 5.418 \quad \int_{0.5}^{2.4} Fl(x) dx = 5.541 \quad \int_{0.5}^{2.4} Fk(x) dx = 5.786$$

$$\text{Ot\_Pogresh\_Fl} := |5.418 - 5.541| \cdot \frac{100}{5.418} \quad \text{Ot\_Pogresh\_Fl} = 2.27$$

$$\text{Ot\_Pogresh\_Fk} := |5.418 - 5.786| \cdot \frac{100}{5.418} \quad \text{Ot\_Pogresh\_Fk} = 6.792$$

.6 -

5 . , , 4 , -  
, . , N·y0 -  
**18,274%**      **- 16,616%** . -  
. -  
**4**  
1      **f<sub>1</sub>(x)**, , -  
; , .  
2      **f<sub>2</sub>(x)**, , -  
; , .  
3      **f<sub>1</sub>(x), f<sub>2</sub>(x)** -

$$f_1(x) = \frac{x}{1+x^4}; \quad f_2(x) = e^{\sqrt{1+\cos(x)}}.$$

1

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1.1

$$f(x) = \frac{x}{1+x^4}.$$

1.2

.

1.3

,

-2,

-

:= -2.

1.4

:

**P\_min := Min m ze (f, x).**

1.5

**: P = -0,76**

-

**f(x)**

**: f (-0,76) = -0,57.**

1.6

**: P\_max := Max m ze (f, x).**

1.7

**P: = 0,76**

-

**f(x)**

**f (0,76) = 0,57.**

MathCad

.7.

2

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2

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2.1

**f (x): = .**

2.2

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,

,

, [-5; 2],

-

:= -2.

**G ven**

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(

**G ven**

-

,

);

(

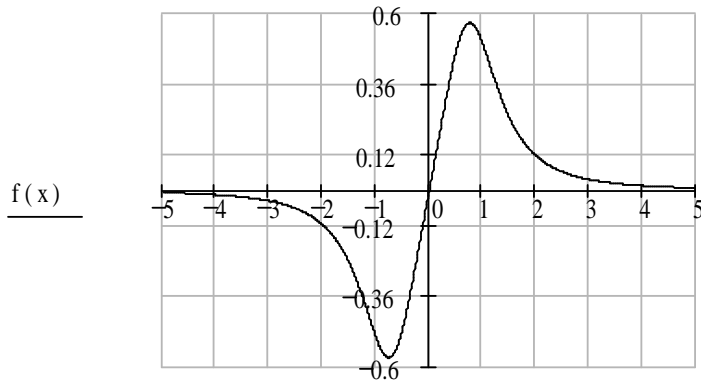
),

**Boolean Toolbar /**

-

**: x ≥ -5 ≤ 2.**

$$f(x) := \frac{x}{1 + x^4}$$



x

$$x := -2$$

$$P_{\min} := \text{minimize}(f, x)$$

$$P_{\min} = -0.76$$

$$P_{\max} := \text{maximize}(f, x)$$

$$P_{\max} = 0.76$$

$$f(P_{\min}) = -0.57$$

$$f(P_{\max}) = 0.57$$

.7 -

2.3

1.4-1.7

3

-

MathCad

.8.

3

3

:

3.1

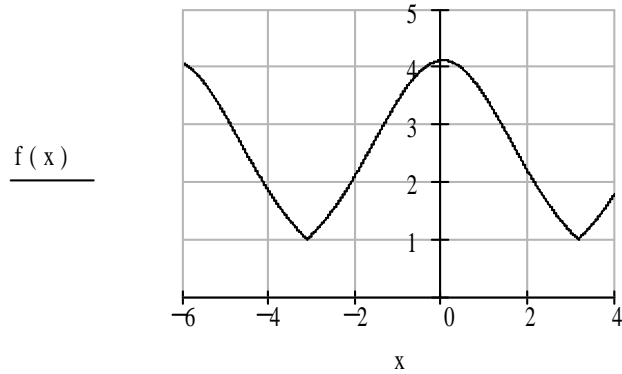
**f1(x) f2(x).**

3.2

MathCad

.9.

$$f(x) := e^{\sqrt{1 + \cos(x)}}$$



$$x := -2$$

given

$$x \leq 2 \quad x \geq -5$$

$$P_{\min} := \text{Minimize} \quad (f, x) \quad P_{\min} = -3.142$$

$$P_{\max} := \text{Maximize} \quad (f, x) \quad P_{\max} = 0$$

$$f(P_{\min}) = 1$$

$$f(P_{\max}) = 4.113$$

.8-

5

0,00001.

MathCad

1

$$\mathbf{x} := \mathbf{0}, \mathbf{y} := \mathbf{2}, \mathbf{TOL} := \mathbf{1 \cdot 10^{-5}}.$$

2

**G ven.**

3

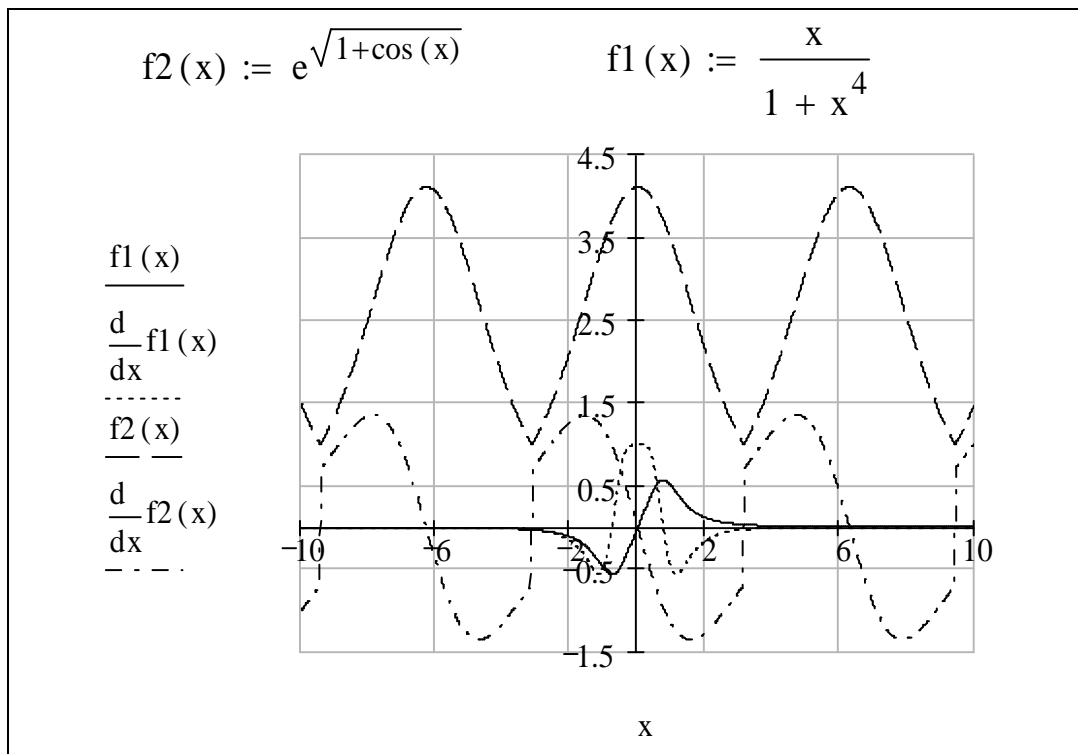
4

**F nd (x, )**

=

$$\text{find}(x, y) = \begin{pmatrix} 0.331441665257368 \\ -0.662858829250469 \end{pmatrix}$$





.9-

, MathCad :

```

x := 0      y := 2

given

x7·√(4·x2 - y2) = 0

x - y + √(4·x2 - y2) = 1

find(x, y) = ( 0.331441665257368
              -0.662858829250469 )

x := 0.331441665257368

y := -0.662858829250469

x - y + √(4·x2 - y2) = 1

x7·√(4·x2 - y2) = 2.504 × 10-6

```

6

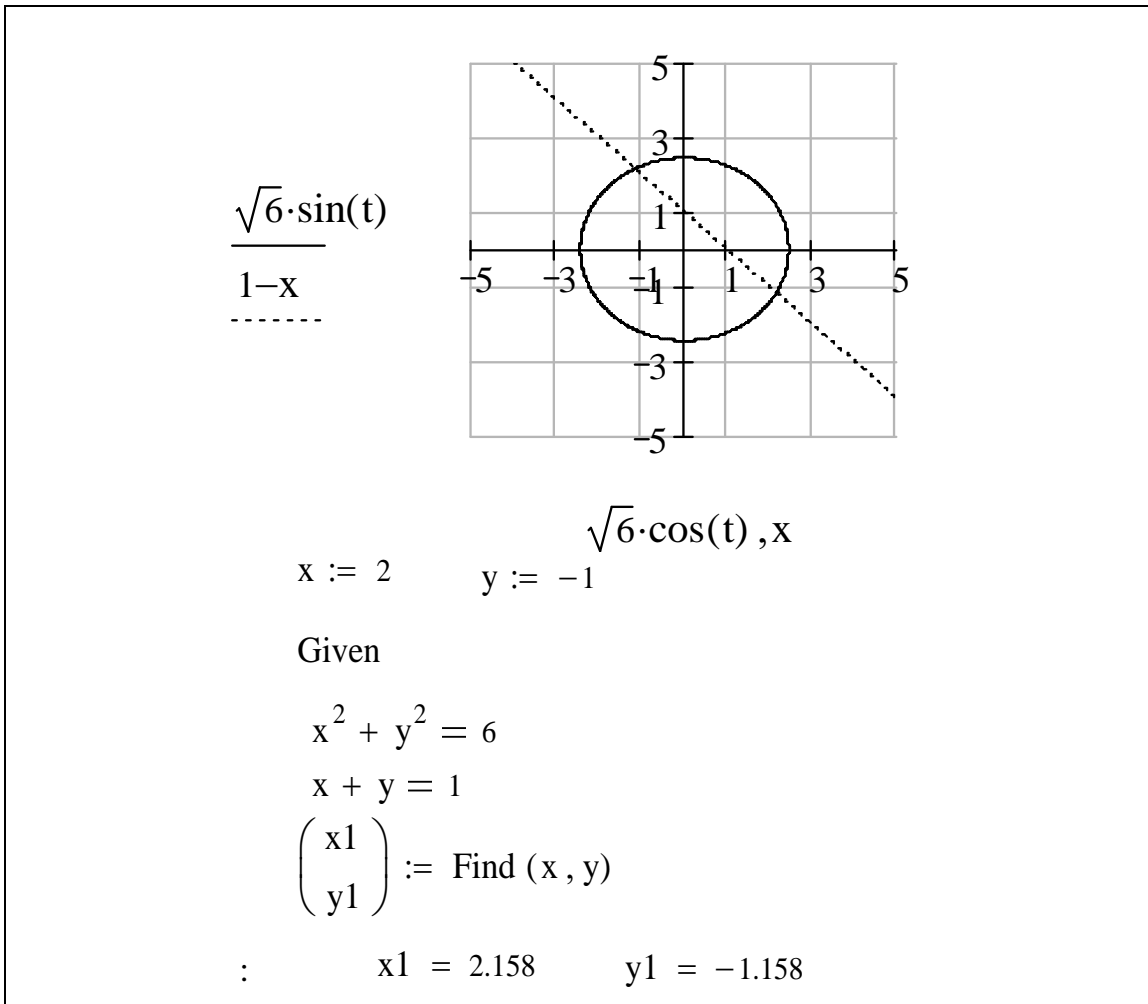
$$x^2 + y^2 = 6 \quad x + y = 1$$

( ).

$$y(t) = a \cdot \sin(t) \quad x(t) = a \cdot \cos(t), x-1 -$$

.10

$$x_1 = -1.158 \quad x_2 = 2.158.$$



.10 -

Find

7

f1, f2  
 [x\_n, x\_k]

	f1	f2	(x_n)	y (x_k)	x_n	x_k
y + 9y	0	5 (x + 2) <sup>2</sup>	0	3	0	5

( rkf xed).

1

f1

1.1

$$: y := \begin{bmatrix} 0 \\ 3 \end{bmatrix}.$$

1.2

$$: \mathbf{1} := \mathbf{0},$$

2: = 5.

1.3

$$: \text{npoints} := 400.$$

1.4

$$: \mathbf{D}(\mathbf{x}, \mathbf{y}) := \begin{bmatrix} y_1 \\ -9 \cdot y_0 \end{bmatrix}.$$

1.5

$$\mathbf{Z} := \text{rkf xed} (y, x_1, x_2, \text{npoints}, \mathbf{D}).$$

$\mathbf{Z}^{<0>}$ ,

$-\mathbf{Z}^{<1>}$ .

2

f2

2.1

$$\mathbf{D}(\mathbf{x}, \mathbf{y}) := \begin{bmatrix} y_1 \\ 5 \cdot (\mathbf{x} + 2)^2 - 9 \cdot y_0 \end{bmatrix}.$$

2.2

$$: \mathbf{Z} := \text{rkf xed} (y, x_1, x_2, \text{npoints}, \mathbf{D}).$$

2.3

$\mathbf{Z}^{<0>}$ ,

$-\mathbf{Z}^{<1>}$ .

MathCad

.11.

$$y := \begin{pmatrix} 0 \\ 3 \end{pmatrix} \quad x1 := 0 \quad x2 := 5 \quad npoints := 400$$

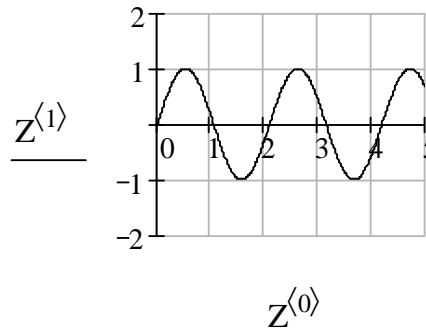
$$D(x, y) := \begin{pmatrix} y_1 \\ -9 \cdot y_0 \end{pmatrix} \quad Z := \text{rkfixed}(y, x1, x2, npoints, D)$$

$$Z^{(0)} =$$

	0
0	0
1	0.013
2	0.025
3	0.038
4	0.05
5	0.063
6	0.075
7	0.088
8	0.1
9	0.113
10	0.125
11	0.137
12	0.15
13	0.163
14	0.175
15	0.188

$$Z^{(1)} =$$

	0
0	0
1	0.037
2	0.075
3	0.112
4	0.149
5	0.186
6	0.223
7	0.259
8	0.296
9	0.331
10	0.366
11	0.401
12	0.435
13	0.468
14	0.501
15	0.533



$$D(x, y) := \begin{bmatrix} y_1 \\ -9 \cdot y_0 + 5 \cdot (x + 2)^2 \end{bmatrix} \quad Z := \text{rkfixed}(y, x1, x2, npoints, D)$$

$$Z^{(0)} =$$

	0
0	0
1	0.013
2	0.025
3	0.038
4	0.05
5	0.063
6	0.075
7	0.088
8	0.1
9	0.113
10	0.125
11	0.137
12	0.15
13	0.163
14	0.175
15	0.188

$$Z^{(1)} =$$

	0
0	0
1	0.039
2	0.081
3	0.126
4	0.175
5	0.226
6	0.281
7	0.338
8	0.398
9	0.461
10	0.527
11	0.596
12	0.668
13	0.742
14	0.819
15	0.898

.11 - ,

y

$$y := \begin{pmatrix} 9 \\ 16 \\ 25 \\ 36 \\ 49 \end{pmatrix} \quad h := 0.25$$

$$m := \text{length}(y) - 1 \\ m = 4$$

1.

$$i := 0..m-1 \quad I := \left(\frac{h}{2}\right) \cdot \sum_i (y_i + y_{i+1}) \quad I = 26.5$$

2.

$$i := 1,3..m-1 \quad j := 2,4..m-2 \\ I := \left(\frac{h}{3}\right) \cdot \left( y_0 + y_m + 4 \cdot \sum_i y_i + 2 \cdot \sum_j y_j \right) \quad I = 26.333$$

3.

$$i := 0..m \quad t_i := i \cdot h \\ I := \int_0^{m \cdot h} \text{linterp}(t, y, x) \, dx \quad I = 26.5$$

4.

$$s := \text{cspline}(t, y) \\ I := \int_0^{m \cdot h} \text{interp}(s, t, y, x) \, dx \quad I = 26.5$$

5.

$$I := h \cdot \int_3^7 x^2 \, dx \quad I = 26.333$$

1

: ( . .1)

.1

	$y(x) =$		$y(x) =$
1	$3 - \cos(x^2)$	14	$\text{Ln}(4 - \cos x)$
2	$e^{\sin(x+4)}$	15	$2,5 + \cos(x^2)$
3	$e^{\cos 2x}$	16	$\sin 2x + \cos^2 2x$
4	$2 + \ln(3 + \sin x)$	17	$e^{\cos(2+x)}$
5	$3 + \sin(4 + x^2)$	18	$2 - \sin(2x)$
6	$\ln(5 - \cos x)$	19	$e^{(1 + \sin \frac{x}{2})}$
7	$e^{\sin(2x)}$	20	$\ln(3 + \sin \frac{x}{2})$
8	$1,5 + \cos(1 + 2x)$	21	$e^{\sin \frac{x}{2}}$
9	$\ln(4 + \sin(2x))$	22	$\ln(3 - \cos x^2)$
10	$2 + \cos(x)$	23	$2 - \sin \frac{x^2}{2}$
11	$3 \sin(e^x)$	24	$\sin 3x + \cos(x + 5)$
12	$1,1 + \cos(e^x)$	25	$2 + \sin x$
13	$2 + \sin(x^2)$	26	$\sin(2x + 2) - 1$

## 2

1 ( . .2) ,  
 2 ( . .2).  
 3 , 10-5  
 ( . .3).

.2

1	2	3
1	$e^x + x = 0$	$x^2 - 12x - 4 = 0$
2	$\sin x - \frac{1}{x} = 0$	$x^3 - 24x + 11 = 0$
3	$\cos x - \frac{1}{x+2} = 0$	$x^3 + 2x - 7 = 0$
4	$\cos x + \frac{1}{x+2} = 0$	$x^3 - 21x + 7 = 0$
5	$x = e^{-x+20}$	$x^3 - 5x + 1 = 0$
6	$\cos x^2 - x = 0$	$x^3 - 12x + 5 = 0$
7	$e^{-x} - 2x = 0$	$x^3 + 3x^2 - 4x - 1 = 0$
8	$\cos x - \frac{1}{x^2 + 3} = 0.5$	$x^3 - 9x^2 + 20x - 11 = 0$
9	$\cos x - \frac{1}{x^2 + 3} = 0.5$	$x^3 - 12x + 5 = 0$
10	$5 \cdot \cos x - x = \cos^2 x$	$x^3 + 6x^2 + 6x - 7 = 0$
11	$x^2 - \cos x^3 = 0$	$x^3 - 3x^2 - x + 2 = 0$
12	$e^x + 2 \sin x = 0$	$x^3 - 10x^2 + 4x + 9 = 0$
13	$\sin x - \frac{1}{x-5} = 3x$	$x^4 + x - 1 = 0$
14	$\cos x - \frac{1}{x} = 0$	$x^3 - 3x^2 - 4x + 1 = 0$
15	$5 \cos x - x = \cos x$	$x^3 - 34x^2 + 4x + 1 = 0$
16	$\sqrt[4]{2 x } + x^3 = 0$	$x^3 - 27x - 17 = 0$
17	$\ln(x) + \sqrt{x} = 0$	$x^4 - 2x^3 + 2x^2 - 2x + 1 = 0$

.2

1	2	3
18	$3^x - 21 + 8x^3 = 9x$	$x^4 - 3x^3 + 3x^2 - 3x + 2 = 0$
19	$4 - x - \frac{4}{x^2} = 0$	$x^4 - 3x^3 + 5x^2 - 3x + 8 = 0$
20	$2\sqrt{x} - x - 0,5 = 0$	$x^4 - 4x^3 + 8x^2 - 4x + 16 = 0$
21	$x - 4\sqrt{x} + 3 = 0$	$x^4 - 4x^3 + 4x^2 - 4x + 3 = 0$
22	$2x^2 + \frac{108}{x^2} - 59 = 0$	$x^4 - 4x^3 + 12x^2 - 4x + 27 = 0$
23	$x^2 + \frac{16}{x} - 16 = 0$	$x^4 - 6x^3 + 18x^2 - 6x + 81 = 0$
24	$2\sqrt{x} - x - 0,5 = 0$	$x^4 - 5x^3 + 10x^2 - 5x + 24 = 0$
25	$\frac{10x}{x^2 + 1} = 3$	$x^4 - 5x^3 + 15x^2 - 5x + 54 = 0$

.3

1	2	1	2
1	$\begin{cases} x^2 - y^3 = 2 \\ x^2 + y = 0 \end{cases}$	14	$\begin{cases} x^2 + y^3 = 0 \\ x^2 - y = 0 \end{cases}$
2	$\begin{cases} x^2 + \cos x = 12 \\ x^2 + y = 0 \end{cases}$	15	$\begin{cases} x^2 - \cos x - 2 = 9 \\ x^2 + y^3 = 9 \end{cases}$
3	$\begin{cases} y^2 - \operatorname{tg} x^2 = 2 \\ x + y^3 = 9 \end{cases}$	16	$\begin{cases} x^2 - y^3 = 2 \\ x^2 + y = 0 \end{cases}$
4	$\begin{cases} x^2 + y^3 = 0 \\ x^2 - y = 0 \end{cases}$	17	$\begin{cases} x^2 + \cos x = 12 \\ x^2 + y = 0 \end{cases}$
5	$\begin{cases} 1,5y = 1,3 \ln(x+2) \\ \frac{1,3}{3^{2x}} = y \end{cases}$	18	$\begin{cases} 1,5y = 1,3 \ln(x+2) \\ 2y = 1,3(x-1,3)^3 \end{cases}$
6	$\begin{cases} 1,5y = 1,3 \ln(x+2) \\ y = 2 \operatorname{tg}(x+1,3) \end{cases}$	19	$\begin{cases} y = \frac{1,3}{3^{2x}} \\ 2y = 1,3(x-1,3)^3 \end{cases}$



1	2	1	2
7	$\begin{cases} y = \frac{1,3}{3^{2x}} \\ y = 2 \operatorname{arctg} (x+1,3) \end{cases}$	20	$\begin{cases} 2y = 1,3(x-1,3)^3 \\ y = 2 \operatorname{tg} (x+1,3) \end{cases}$
8	$\begin{cases} x^2 + y^2 = 4 \\ 3x+1 = y \end{cases}$	21	$\begin{cases} x^2 + y^2 = 16 \\ y - 3x - 1 = 0 \end{cases}$
9	$\begin{cases} x^3 + y = 9 \\ y = 3x + 5 \end{cases}$	22	$\begin{cases} x^2 + y^2 = 16 \\ y = 3x + 5 \end{cases}$
10	$\begin{cases} x^3 + y = 9 \\ y = 3,5x - 5 \end{cases}$	23	$\begin{cases} x^2 + y^3 = 16 \\ y = 3x + 5 \end{cases}$
11	$\begin{cases} x^3 - y^{-x} = 9 \\ y - 3,5x + 5 = 0 \end{cases}$	24	$\begin{cases} x^3 + y = 16 \\ y - 3x = 5 \end{cases}$
12	$\begin{cases} x^2 - y^{-x} = 1 \\ y = 3,5x - 5 \end{cases}$	25	$\begin{cases} x^2 + \cos x = 12 \\ x^2 + y = 0 \end{cases}$
13	$\begin{cases} x^2 + y^{-x} = \cos x \\ y = 3,5x - 5 \end{cases}$	26	$\begin{cases} x^2 + \cos x = 12 \\ x^2 + y = 0 \end{cases}$

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1

( . .4) -

$$A \cdot X = B.$$

2

$$\Delta = \det A$$

3

:

)

$$: X = A^{-1} \cdot B;$$

)

**Isolve (A, B).**

4

1	2
1	$\begin{cases} 0,005x_1 + 0,004x_2 + 0,150x_3 = 0,057 \\ -0,090x_1 - 0,033x_2 + 0,0067x_3 - 0,098x_4 = -0,098 \\ 0,150x_1 + 0,033x_2 + 0,050x_3 + 0x_4 = 0,183 \\ 2,857x_1 + 0,100x_2 - 0,300x_3 + 0,025x_4 = -0,041 \end{cases}$
2	$\begin{cases} 0,010x_1 + 0,008x_2 + 0,200x_3 + 0,050x_4 = 0,186 \\ -0,080x_1 + 0,013x_3 - 0,050x_4 = -0,126 \\ 0,250x_1 + 0,067x_2 + 0,067x_3 + 0,069x_4 = 0,646 \\ 0,057x_1 + 0,150x_2 - 0,267x_3 + 0,050x_4 = 0,0086 \end{cases}$
3	$\begin{cases} 0,015x_1 + 0,012x_2 + 0,250x_3 + 0,100x_4 = 0,388 \\ -0,070x_1 - 0,033x_2 + 0,020x_3 - 0,075x_4 = -0,084 \\ 0,350x_1 + 0,100x_2 + 0,075x_3 + 0,110x_4 = 1,357 \\ 0,0086x_1 + 0,200x_2 - 0,233x_3 + 0,075x_4 = 0,149 \end{cases}$
4	$\begin{cases} 0,020x_1 + 0,016x_2 + 0,300x_3 + 0,150x_4 = 0,662 \\ -0,060x_1 + 0,067x_2 + 0,027x_3 - 0,100x_4 = 0,029 \\ 0,450x_1 + 0,133x_2 + 0,080x_3 + 0,139x_4 = 2,312 \\ 0,011x_1 + 0,250x_2 - 0,200x_3 + 0,100x_4 = 0,379 \end{cases}$
6	$\begin{cases} 0,030x_1 + 0,024x_2 + 0,400x_3 + 0,250x_4 = 1,427 \\ -0,040x_1 + 0,133x_2 + 0,040x_3 + 0,150x_4 = 0,465 \\ 0,650x_1 + 0,200x_2 + 0,086x_3 + 0,179x_4 = 4,940 \\ 0,017x_1 + 0,350x_2 - 0,133x_3 + 0,150x_4 = 1,111 \end{cases}$
7	$\begin{cases} 0,035x_1 + 0,028x_2 + 0,450x_3 + 0,300x_4 = 1,918 \\ -0,030x_1 + 0,167x_2 + 0,047x_3 + 0,175x_4 = 0,788 \\ 0,750x_1 + 0,233x_2 + 0,088x_3 + 0,195x_4 = 6,611 \\ 0,020x_1 + 0,400x_2 - 0,100x_3 + 0,175x_4 = 1,613 \end{cases}$
8	$\begin{cases} 0,040x_1 + 0,032x_2 + 0,500x_3 + 0,350x_4 = 2,481 \\ -0,020x_1 + 0,200x_2 + 0,053x_3 + 0,200x_4 = 1,182 \\ 0,850x_1 + 0,267x_2 + 0,089x_3 + 0,208x_4 = 8,520 \\ 0,023x_1 + 0,450x_2 - 0,067x_3 + 0,200x_4 = 2,205 \end{cases}$

9	$\begin{cases} 0,045x_1 + 0,036x_2 + 0,550x_3 + 0,400x_4 = 3,117 \\ -0,010x_1 + 0,233x_2 + 0,060x_3 + 0,225x_4 = 1,646 \\ 0,950x_1 + 0,300x_2 + 0,090x_3 + 0,220x_4 = 10,664 \\ 0,026x_1 + 0,500x_2 - 0,033x_3 + 0,225x_4 = 2,888 \end{cases}$
10	$\begin{cases} 0,050x_1 + 0,040x_2 + 0,600x_3 + 0,450x_4 = 3,825 \\ 0,267x_2 + 0,067x_3 + 0,250x_4 = 2,181 \\ 1,050x_1 + 0,333x_2 + 0,091x_3 + 0,230x_4 = 13,045 \\ 0,029x_1 + 0,550x_2 + 0,250x_4 = 3,661 \end{cases}$
11	$\begin{cases} 0,055x_1 + 0,044x_2 + 0,065x_3 + 0,500x_4 = 4,605 \\ 0,010x_1 + 0,300x_2 + 0,073x_3 + 0,275x_4 = 2,785 \\ 1,150x_1 + 0,367x_2 + 0,092x_3 + 0,240x_4 = 15,662 \\ 0,031x_1 + 0,600x_2 + 0,033x_3 + 0,750x_4 = 4,524 \end{cases}$
12	$\begin{cases} 0,060x_1 + 0,048x_2 + 0,700x_3 + 0,550x_4 = 5,458 \\ 0,020x_1 + 0,333x_2 + 0,080x_3 + 0,300x_4 = 3,460 \\ 1,250x_1 + 0,400x_2 + 0,092x_3 + 0,248x_4 = 18,515 \\ 0,034x_1 + 0,650x_2 + 0,067x_3 + 0,300x_4 = 5,478 \end{cases}$
13	$\begin{cases} 0,065x_1 + 0,052x_2 + 0,750x_3 + 0,600x_4 = 6,383 \\ 0,030x_1 + 0,367x_2 + 0,087x_3 + 0,325x_4 = 4,205 \\ 1,350x_1 + 0,433x_2 + 0,093x_3 + 0,256x_4 = 21,603 \\ 0,037x_1 + 0,700x_2 + 0,100x_3 + 0,325x_4 = 6,522 \end{cases}$
14	$\begin{cases} 0,070x_1 + 0,056x_2 + 0,800x_3 + 0,650x_4 = 7,380 \\ 0,040x_1 + 0,400x_2 + 0,093x_3 + 0,350x_4 = 5,021 \\ 1,450x_1 + 0,467x_2 + 0,093x_3 + 0,264x_4 = 24,926 \\ 0,040x_1 + 0,750x_2 + 0,133x_3 + 0,350x_4 = 7,657 \end{cases}$
15	$\begin{cases} 0,075x_1 + 0,060x_2 + 0,850x_3 + 0,700x_4 = 8,450 \\ 0,050x_1 + 0,433x_2 + 0,100x_3 + 0,375x_4 = 5,906 \\ 1,550x_1 + 0,500x_2 + 0,094x_3 + 0,248x_4 = 28,484 \\ 0,043x_1 + 0,800x_2 + 0,167x_3 + 0,375x_4 = 8,882 \end{cases}$

16	$\begin{cases} 0,080x_1 + 0,064x_2 + 0,900x_3 + 0,750x_4 = 9,592 \\ 0,060x_1 + 0,467x_2 + 0,107x_3 + 0,400x_4 = 6,862 \\ 1,650x_1 + 0,533x_2 + 0,094x_3 + 0,277x_4 = 32,278 \\ 0,046x_1 + 0,850x_2 + 0,200x_3 + 0,400x_4 = 10,198 \end{cases}$
17	$\begin{cases} 0,085x_1 + 0,068x_2 + 0,950x_3 + 0,800x_4 = 10,806 \\ 0,070x_1 + 0,500x_2 + 0,113x_3 + 0,425x_4 = 7,888 \\ 1,750x_1 + 0,567x_2 + 0,094x_3 + 0,283x_4 = 36,306 \\ 0,049x_1 + 0,900x_2 + 0,233x_3 + 0,425x_4 = 11,604 \end{cases}$
18	$\begin{cases} 0,090x_1 + 0,072x_2 + 1,000x_3 + 0,850x_4 = 12,093 \\ 0,080x_1 + 0,533x_2 + 0,120x_3 + 0,450x_4 = 8,985 \\ 1,850x_1 + 0,600x_2 + 0,095x_3 + 0,289x_4 = 40,569 \\ 0,051x_1 + 0,950x_2 + 0,267x_3 + 0,450x_4 = 13,101 \end{cases}$
19	$\begin{cases} 0,095x_1 + 0,076x_2 + 1,050x_3 + 0,900x_4 = 13,452 \\ 0,090x_1 + 0,567x_2 + 0,127x_3 + 0,475x_4 = 10,152 \\ 1,950x_1 + 0,633x_2 + 0,095x_3 + 0,294x_4 = 45,067 \\ 0,054x_1 + 1,000x_2 + 0,300x_3 + 0,475x_4 = 14,688 \end{cases}$
20	$\begin{cases} 0,100x_1 + 0,080x_2 + 1,100x_3 + 0,950x_4 = 14,883 \\ 0,100x_1 + 0,600x_2 + 0,133x_3 + 0,500x_4 = 11,389 \\ 2,050x_1 + 0,667x_2 + 0,095x_3 + 0,300x_4 = 49,799 \\ 0,057x_1 + 1,050x_2 + 0,333x_3 + 0,500x_4 = 16,365 \end{cases}$

4

:

- 1  $f(x)$  ( . .5)  $x$ .
- 2 ( ) -
- n** .
- 3  $f(x)$   $[a, b]$  ( . .6).
- 4 ( ) .

.5

	$f(x) =$	$x =$	$n =$		$f(x) =$	$x =$	$n =$
<b>1</b>	$e^{-x^2}$	2	3	<b>9</b>	$\frac{x}{x^2-1}$	2	4
<b>2</b>	$\sin 2x$	5	2	<b>10</b>	$x e^{5x}$	1	3
<b>3</b>	$e^{3x}$	8	4	<b>11</b>	$\ln 3x$	3	4
<b>4</b>	$\sqrt{x}$	4	2	<b>12</b>	$\sqrt{2x+3}$	4	3
<b>5</b>	$\frac{x^2}{x-1}$	7	6	<b>13</b>	$\frac{2x+3}{4x+7}$	5	3
<b>6</b>	$x^2 \sin 2x$	3	2	<b>14</b>	$\sin^2 x$	6	3
<b>7</b>	$x^3 \cos 5x$	1	3	<b>15</b>	$\cos^2 x$	7	3
<b>8</b>	$\frac{x-1}{x+1}$	9	4	<b>16</b>	$\cos^3 x$	8	3

.6

	$f(x)$	<b>a</b>	<b>b</b>		$f(x)$	<b>a</b>	<b>b</b>
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>1</b>	$\frac{x+1}{\sqrt{x}}$	1	6	<b>10</b>	$\sqrt{1+\sin 2x}$	0	4
<b>2</b>	$(x^4+1)x^3$	2	5	<b>11</b>	$(2x-3)^{10}$	2	6
<b>3</b>	$\frac{x^2}{1-x^2}$	2	5	<b>12</b>	$\frac{1}{\sqrt{2-5x}}$	1	3
<b>4</b>	$t g^2 x$	-1	1	<b>13</b>	$\frac{1}{2+3x^2}$	-1	1
<b>5</b>	$\frac{2x+3}{3x+2}$	0	4	<b>14</b>	$\frac{1}{\sqrt{3x^2-2}}$	2	3
<b>6</b>	$\sqrt{1-\sin 2x}$	4	6	<b>15</b>	$\frac{1}{\sin^2(2x+\frac{\pi}{4})}$	1,5	2,7
<b>7</b>	$(3-x^2)^3$	2	3	<b>16</b>	$\frac{1}{1+\cos x}$	1	3
<b>8</b>	$(1-\frac{1}{x^2})\sqrt{x\sqrt{x}}$	1	5	<b>17</b>	$\frac{1}{1+\sin x}$	1	3
<b>9</b>	$\frac{\sqrt{x^4+x^{-4}+2}}{x^3}$	2	3	<b>18</b>	$\frac{1}{\sqrt{1+x^2}}$	2	4

.6

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>19</b>	$\frac{x^2+3}{x^2-1}$	2	3	<b>23</b>	$\frac{x^3}{x^8-2}$	7	8
<b>20</b>	$\frac{2^{x+1}-5^{x-1}}{10^x}$	-2	-1	<b>24</b>	$\frac{1}{x\sqrt{x^2+1}}$	4	5
<b>21</b>	$\frac{\sqrt{1+x^2}+\sqrt{1-x^2}}{\sqrt{1-x^4}}$	-3	-1	<b>25</b>	$\frac{1}{x\sqrt{x^2-1}}$	2	3
<b>22</b>	$(2^x+3^x)^2$	1	2	<b>26</b>	tgx	-1	1

5

:

1

( . .7).

2

( . .8).

.7

<b>1</b>	$3\sqrt[3]{(x+4)^2-2x-8}$	<b>6</b>	$3\sqrt[3]{(x-1)x}$
<b>2</b>	$1-\sqrt[3]{x^2-2x}$	<b>7</b>	$\frac{6\sqrt[3]{6x^2}}{(x+2)^2+8}$
<b>3</b>	$12\sqrt[3]{(x+2)^2-8x-16}$	<b>8</b>	$2x-2-3\sqrt[3]{(x-1)^2}$
<b>4</b>	$\frac{12\sqrt[3]{6(x-2)^2}}{x^2+8}$	<b>9</b>	$2+\sqrt[3]{8x(x+2)}$
<b>5</b>	$8x-16-12\sqrt[3]{(x+4)^2}$	<b>10</b>	$\frac{3\sqrt[3]{6(x-4)^2}}{x^2-4x+12}$

.7

1	2	1	2
11	$\frac{12\sqrt[3]{6(x-1)^2}}{(x+1)^2+8}$	12	$3\sqrt[3]{(x-2)^2}-2x+4$
12	$9\sqrt[3]{(x+1)^2}-6x-6$	13	$-\frac{3\sqrt[3]{6(x+1)^2}}{(x+3)^2+8}$
13	$1-\sqrt[3]{(x-2)^2-1}$	14	$\sqrt[3]{(x+2)^2-1}$
14	$\sqrt[3]{(x+4)x}$	15	$\sqrt[3]{(x+4)(x-4)}$
11	$\frac{6\sqrt[3]{6(x-3)^2}}{(x-1)^2+8}$	16	$\frac{3\sqrt[3]{6(x-5)^2}}{(x-3)^2+8}$

.8

1	2	3	1	2	3
1	$\sqrt[3]{2(x-2)^2(8-x)-1}$	[0; 6]	11	$2-x-\frac{4}{(x+2)^2}$	[-1; 2]
2	$4-x-\frac{4}{x^2}$	[1; 4]	12	$\sqrt[3]{2x^2(x-3)}$	[-1; 6]
3	$x^2+\frac{16}{x}-16$	[1; 4]	13	$\frac{2(-x^2+7x-7)}{x^2-2x+2}-1$	[1; 4]
4	$2\sqrt{x}-x-0,5$	[0; 4]	15	$1-\sqrt[3]{2(x-2)^2(5-x)}$	[1; 5]
5	$1+\sqrt[3]{2(x-1)^2(x-7)}$	[-1; 5]	16	$\frac{4x}{x^2+4}$	[-4; 2]
6	$x-4\sqrt{x}+3$	[1; 9]	17	$8+\frac{8}{x}-\frac{x^2}{2}$	[-4; -1]
7	$\frac{10x}{x^2+1}-3$	[0; 3]	18	$1+\sqrt[3]{2x^2(x-6)}$	[-2; 4]
8	$-2+\sqrt[3]{2(x+1)^2(5-x)}$	[-3; 3]	19	$\frac{2x(2x+3)}{x^2+4x+5}$	[-2; 1]
9	$2x^2+\frac{108}{x^2}-59$	[2; 4]	20	$-\frac{2(x^2+3)}{x^2+2x+5}+2$	[-5; -2,8]
10	$\frac{2(x^2+3)}{x^2-2x+5}-1$	[-3; 3]	14	$x-4\sqrt{x+2}+5,5$	[-1; 7]

6

:

1 ( .  
 .9).  
 2 f(x) ( . .10) n -  
 x<sub>0</sub> . -

.9

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>1</b>	X	0,8	0,9	1	1,5	2
	Y	2,5	2,22	2	1,333	1
<b>2</b>	X	0,8	0,9	1	1,5	2
	Y	-0,223	-0,105	0	0,405	0,693
<b>3</b>	X	0,8	0,9	1	1,5	2
	Y	0,928	0,965	1	1,145	1,26
<b>4</b>	X	1	1,5	2	2,5	3
	Y	0,707	0,924	1	0,924	0,707
<b>5</b>	X	4	4,5	5	5,5	6
	Y	2	1,2	0,833	0,629	0,5
<b>6</b>	X	1	1,5	2	2,5	3
	Y	0,25	0,333	0,4	0,455	0,5
<b>7</b>	X	0,8	0,9	1	1,5	2
	Y	0,527	0,445	0,368	0,105	0,018



<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>8</b>	<b>X</b>	0,8	0,9	1	1,5	2
	<b>Y</b>	1,17	1,216	1,26	1,442	1,587
<b>9</b>	<b>X</b>	0,8	0,9	2	2,5	3
	<b>Y</b>	3,75	3,333	3	2	1,5
<b>10</b>	<b>X</b>	0,8	0,9	1	1,5	2
	<b>Y</b>	0,247	0,482	0,693	1,504	2,079
<b>11</b>	<b>X</b>	1	1,5	2	2,5	3
	<b>Y</b>	0,368	0,223	0,135	0,082	0,05
<b>12</b>	<b>X</b>	0,8	0,9	1	1,5	2
	<b>Y</b>	-0,14	-0,07	0	0,27	0,462
<b>13</b>	<b>X</b>	1,2	1,5	2	2,2	2,3
	<b>Y</b>	0,667	1	2	2,75	3,286
<b>14</b>	<b>X</b>	0	0,5	1	1,5	2
	<b>Y</b>	1	1,125	2	4,375	9
<b>15</b>	<b>X</b>	1	1,5	2	2,5	3
	<b>Y</b>	0,707	0,583	1	0,383	0,77
<b>16</b>	<b>X</b>	0,5	0,7	0,8	1,3	1,8
	<b>Y</b>	-3	-2,44	-2,2	-1,076	0,053
<b>17</b>	<b>X</b>	0	0,5	1	1,5	2
	<b>Y</b>	-0,736	-0,963	-1	-1,047	-1,437

.9

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>18</b>	<b>X</b>	1,2	1,7	2	2,5	3
	<b>Y</b>	-4,64	-4,017	-4	-3,953	-3,693
<b>19</b>	<b>X</b>	0,1	0,5	1	1,5	2
	<b>Y</b>	-2,262	-1,097	-1	-0,881	-0,266
<b>20</b>	<b>X</b>	0	0,5	1	1,5	2
	<b>Y</b>	0,708	0,98	1	0,98	0,708
<b>21</b>	<b>X</b>	0	0,5	1	1,5	2
	<b>Y</b>	-0,736	-1,463	-3	-5,547	-9,437
<b>22</b>	<b>X</b>	-0,9	-0,5	0	1	1,5
	<b>Y</b>	-0,995	0,864	1	1,386	2,083
<b>23</b>	<b>X</b>	0,5	1	2	3	3,5
	<b>Y</b>	-1,255	-0,292	0	-0,292	-1,255
<b>24</b>	<b>X</b>	-3	-2,5	-2	-1,5	-1
	<b>Y</b>	14,987	11,228	7,963	5,19	2,9

.10

	<b>f(x)</b>	<b>x<sub>0</sub></b>	<b>n</b>		<b>f(x)</b>	<b>x<sub>0</sub></b>	<b>n</b>
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>1</b>	$\frac{2}{x}$	1	3	<b>5</b>	$\frac{x}{3-x}$	2	3
<b>2</b>	$\ln x$	1	4	<b>6</b>	$x^3 + 1$	1	4
<b>3</b>	$\sqrt[3]{x}$	1	3	<b>7</b>	$\cos \frac{\pi}{4}x$	2	3
<b>4</b>	$\sin \frac{\pi}{4}x$	2	4	<b>8</b>	$(x - \frac{\pi}{4}) \sin x$	$\frac{\pi}{4}$	4

<b>1</b>	2	3	4	<b>1</b>	2	3	4
<b>9</b>	$\frac{x}{x^2 - 5x + 6}$	5	3	<b>17</b>	$x^2 - 2e^{x-1}$	1	5
<b>10</b>	$\frac{x}{3+x}$	2	4	<b>18</b>	$x^2 - 4x - (x-2)\ln(x-1)$	2	4
<b>11</b>	$e^{-x^2}$	1	3	<b>19</b>	$x^2 - 2x - (x-1)\ln x$	1	4
<b>12</b>	$\sqrt[3]{2x}$	1	4	<b>20</b>	$\sin^2(x-1) - x^2 + 2x$	1	5
<b>13</b>	$\frac{3}{x}$	2	3	<b>21</b>	$-x^2 - 2e^{x-1}$	1	5
<b>14</b>	$\ln(2x^2)$	1	4	<b>22</b>	$x^2 - 2x + 1 + 2\ln(x+1)$	0	4
<b>15</b>	$e^{-x}$	2	3	<b>23</b>	$\sin^2(x-2) - x^2 + 4x - 4$	2	5
<b>16</b>	$\cos^2(x-1) - x^2$	1	4	<b>24</b>	$x^2 - 2x - 2e^{x-2}$	-2	5

7 ,  
:

.11

[xn, xk] f1, f2.

.11

		f1	f2	y(0)	y'(0)	xn	xk
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
<b>1</b>	$y'' + \pi y$	0	$1 - x^2 \sin x$	1	0	1	6
<b>2</b>	$y'' + 6y' + 8y$	0	$6x^2 + 3 \cos x$	-1	0	-1	3
<b>3</b>	$y'' + \frac{y}{4}$	0	$(1 - 2x)e^x$	0	1	0	3
<b>4</b>	$y'' + 3y'$	0	$e^x \cos 2x$	0	-1	0	5
<b>5</b>	$y'' + 9y$	0	$5(x+2)^2$	0	3	0	5

1	2	3	4	5	6	7	8
6	$y'' - 3y' + 2y$	0	$(3x + 7)e^{2x}$	0	-3	0	2
7	$y'' + 4y$	0	$x^2 + x - 1$	3	0	3	10
8	$y'' + 9y$	0	$\cos 4x + 1$	-3	0	-3	3
9	$y'' + 3y' + 2y$	0	$(2x + 5)e^{2x}$	2	0	-2	2
10	$y'' - 6y' + 8y$	0	$4x^2 \sin x$	-2	0	-2	-1
11	$y'' - y'$	0	$(16 - 2x)e^{-x}$	0	2	3	6
12	$y'' + 4y$	0	$5x^2 - 1$	0	-2	0	9
13	$y'' - 9y' + 18y$	0	$4(1 - x)e^{-x}$	4	0	4	5
14	$y'' + 4y$	0	$x - x^2 + 2 \cos x$	-4	0	-4	4
15	$y'' + 6y$	0	$e^{x+2} \cos x$	0	4	0	5
16	$y'' + \pi^2 y$	0	$3x^2 + 2x$	1	0	1	6
17	$y'' - 3y' + 2y$	0	$(12 - 16x)e^x$	-1	0	2	3
18	$y'' + y'$	0	$3x^2 + 2\sqrt{x} + 1$	0	1	0	5
19	$y'' + 5y$	0	$(20x + 14)e^{2x}$	0	-1	0	1
20	$y'' + 16y$	0	$x \cos x + 2$	0	3	0	6
21	$y'' + y$	0	$1 + \cos^3 x$	0	-3	0	7
22	$y'' - 3y'$	0	$(20x + 14)e^{2x}$	3	0	0	1
23	$y'' - 6y' + 8y$	0	$12x^2 - 6x$	-3	0	0.5	1,5
24	$y'' - 3y' + 2y$	0	$49 - 24x^2$	2	0	3	4
25	$y'' + y$	0	$3x^2 + x - 4$	-2	0	2	7

8

- :
- 1) fio\_2.dat);
- 2) lab2.mcd  
- fio\_2.mcd;
- 3) mean, R=xmin-xmax,  
Sk, Ex.
- 4) 10.
- 5)
- 6) 10%
- %.  
I

1.67	2.41	0.79	1.41	2.50	2.29	2.58	1.32
3.75	1.94	0.95	3.48	2.39	1.17	1.92	1.04
2.13	1.58	2.18	2.30	3.03	1.50	2.53	1.91
1.31	3.62	1.49	1.98	2.14	3.35	2.89	2.51
2.31	2.34	1.00	2.03	0.64	2.67	0.09	1.78
3.24	1.91	1.20	1.61	2.35	1.73	2.93	2.32
2.84	1.29	2.28	2.54	1.85	2.40	2.22	2.90
2.37	2.68	2.00	2.70	2.33	2.86	0.36	1.98
2.53	0.80	2.89	0.73	1.01	1.85	2.05	1.16
1.76	2.78	2.43	1.85	1.21	1.53	1.54	2.43

P (0.93 < X < 1.52) = ?

2

2.46	1.70	2.44	0.82	1.50	2.53	2.32	2.61
1.35	3.78	1.97	0.98	3.51	2.42	1.20	1.95
1.07	2.16	1.61	2.21	2.33	3.06	1.53	2.56
1.94	1.34	3.63	1.52	2.01	2.17	3.38	2.92
2.54	2.34	2.37	1.03	2.06	0.67	2.70	1.12
1.81	3.27	1.94	1.23	1.64	2.38	1.76	2.96
2.35	2.87	1.32	2.31	2.57	1.88	2.43	1.88
2.93	2.40	2.71	2.03	2.76	2.36	2.89	0.39
2.01	2.56	0.83	2.92	0.76	1.04	1.88	2.08
1.19	1.79	2.81	2.46	1.88	1.24	1.56	1.57

P (0.92 &lt; X &lt; 1.54) = ?

3

1.60	2.49	1.73	2.47	0.85	1.53	2.56	2.35
2.64	1.38	3.81	2.00	1.01	3.54	2.45	1.23
1.98	1.10	2.19	1.64	2.24	2.36	3.09	1.56
2.59	1.97	1.37	3.68	1.55	2.04	2.20	3.41
2.95	2.57	2.37	2.40	1.06	2.09	0.70	2.73
0.45	1.84	3.30	1.97	1.26	1.67	2.41	1.79
2.99	2.38	2.90	1.35	2.34	2.60	1.91	2.46
2.28	2.96	2.43	2.74	2.06	2.76	2.39	2.92
0.42	2.04	2.59	0.86	2.95	0.79	1.07	1.91
2.11	1.22	1.82	2.84	2.49	1.91	1.27	1.59

P (0.91 &lt; X &lt; 1.55) = ?

4

1.62	1.63	2.52	1.76	2.50	0.88	1.56	2.59
2.38	2.67	1.14	3.84	2.03	1.04	3.57	2.48
1.86	2.01	1.13	2.22	1.67	2.27	2.38	3.12
1.59	2.62	2.00	1.40	3.71	1.58	2.07	2.23
3.44	2.98	2.60	2.40	2.43	1.09	2.12	0.73
2.76	0.18	1.87	3.32	2.00	1.29	1.70	2.44
1.82	3.02	2.41	2.93	1.38	2.37	2.63	1.94
2.49	2.31	2.99	2.46	2.77	2.09	2.79	2.42
2.95	0.45	2.07	2.62	0.89	2.98	0.82	1.10
1.94	2.14	1.25	1.83	2.87	2.52	1.94	1.30

P (0.90 &lt; X &lt; 1.56) = ?

5

3.31	1.15	1.43	2.27	2.47	1.58	2.18	3.20
2.85	2.27	1.63	1.95	1.96	2.85	2.09	2.83
1.21	1.89	2.92	2.71	3.00	1.74	4.17	2.36
1.37	3.90	2.81	1.59	2.34	1.46	2.55	2.00
2.60	2.78	3.45	1.92	2.95	2.33	1.73	4.04
1.91	2.40	2.56	3.77	3.31	2.93	2.73	2.76
1.42	2.45	1.06	3.09	0.31	2.20	3.66	2.33
1.62	2.03	2.77	2.15	3.35	2.74	3.26	1.71
2.70	2.96	2.27	2.82	2.64	3.32	2.79	3.10
2.42	3.12	2.75	3.28	0.78	2.40	2.95	1.22

P (0.89 &lt; X &lt; 1.57) = ?

6

2.46	1.70	2.44	0.82	1.50	2.53	2.32	2.61
1.35	3.78	1.97	0.98	3.51	2.42	1.20	1.95
1.07	2.16	1.61	2.21	2.33	3.06	1.53	2.56
1.94	1.34	3.63	1.52	2.01	2.17	3.38	2.92
2.54	2.34	2.37	1.03	2.06	0.67	2.70	1.12
3.24	1.91	1.20	1.61	2.35	1.73	2.93	2.32
2.84	1.29	2.28	2.54	1.85	2.40	2.22	2.90
2.37	2.68	2.00	2.70	2.33	2.86	0.36	1.98
2.53	0.80	2.89	0.73	1.01	1.85	2.05	1.16
1.76	2.78	2.43	1.85	1.21	1.53	1.54	2.43

P (1.08 &lt; X &lt; 1.68) = ?

7

1.67	2.41	0.79	1.41	2.50	2.29	2.58	1.32
3.75	1.94	0.95	3.48	2.39	1.17	1.92	1.04
2.13	1.58	2.18	2.30	3.03	1.50	2.53	1.91
1.31	3.62	1.49	1.98	2.14	3.35	2.89	2.51
2.31	2.34	1.00	2.03	0.64	2.67	0.09	1.78
1.81	3.27	1.94	1.23	1.64	2.38	1.76	2.96
2.35	2.87	1.32	2.31	2.57	1.88	2.43	1.88
2.93	2.40	2.71	2.03	2.76	2.36	2.89	0.39
2.01	2.56	0.83	2.92	0.76	1.04	1.88	2.08
1.19	1.79	2.81	2.46	1.88	1.24	1.56	1.57

P (1.07 &lt; X &lt; 1.69) = ?

8

1.62	1.63	2.52	1.76	2.50	0.88	1.56	2.59
2.38	2.67	1.14	3.84	2.03	1.04	3.57	2.48
1.86	2.01	1.13	2.22	1.67	2.27	2.38	3.12
1.59	2.62	2.00	1.40	3.71	1.58	2.07	2.23
3.44	2.98	2.60	2.40	2.43	1.09	2.12	0.73
0.45	1.84	3.30	1.97	1.26	1.67	2.41	1.79
2.99	2.38	2.90	1.35	2.34	2.60	1.91	2.46
2.28	2.96	2.43	2.74	2.06	2.76	2.39	2.92
0.42	2.04	2.59	0.86	2.95	0.79	1.07	1.91
2.11	1.22	1.82	2.84	2.49	1.91	1.27	1.59

P (1.06 &lt; X &lt; 1.70) = ?

9

1.60	2.49	1.73	2.47	0.85	1.53	2.56	2.35
2.64	1.38	3.81	2.00	1.01	3.54	2.45	1.23
1.98	1.10	2.19	1.64	2.24	2.36	3.09	1.56
2.59	1.97	1.37	3.68	1.55	2.04	2.20	3.41
2.95	2.57	2.37	2.40	1.06	2.09	0.70	2.73
2.76	0.18	1.87	3.32	2.00	1.29	1.70	2.44
1.82	3.02	2.41	2.93	1.38	2.37	2.63	1.94
2.49	2.31	2.99	2.46	2.77	2.09	2.79	2.42
2.95	0.45	2.07	2.62	0.89	2.98	0.82	1.10
1.94	2.14	1.25	1.83	2.87	2.52	1.94	1.30

P (1.05 &lt; X &lt; 1.71) = ?

10

1.43	2.03	3.05	2.70	2.13	1.48	1.80	1.81
2.70	1.94	3.63	1.06	1.74	2.77	2.56	2.85
1.59	3.08	2.21	1.22	3.75	2.66	1.44	3.19
1.81	2.40	1.85	2.45	2.57	3.30	1.77	2.80
3.18	1.58	2.89	1.76	2.25	2.41	3.62	2.13
1.95	0.45	2.07	2.62	0.89	2.98	0.82	1.10
1.94	2.14	1.25	1.83	2.87	2.52	1.94	1.30
1.62	1.03	2.77	2.15	2.35	2.74	3.26	1.71
2.70	2.96	2.27	1.82	2.64	3.32	2.79	3.10
2.42	1.12	2.75	1.28	0.78	2.40	2.95	1.22

P (1.04 &lt; X &lt; 1.72) = ?



11

2.46	1.70	1.43	2.27	2.47	1.58	2.32	2.61
1.35	3.78	1.63	1.95	1.96	2.85	1.20	1.95
1.07	2.16	1.87	3.32	2.00	1.29	1.53	2.56
1.94	1.34	2.41	2.93	1.38	2.37	3.38	2.92
2.54	2.34	2.99	2.46	2.77	2.09	2.70	1.12
3.24	1.91	2.07	2.62	0.89	2.98	2.93	2.32
2.84	1.29	1.25	1.83	2.87	2.52	2.22	2.90
2.37	2.68	2.77	2.15	3.35	2.74	0.36	1.98
2.53	0.80	2.27	2.82	2.64	3.32	2.05	1.16
1.76	2.78	2.75	3.28	0.78	2.40	1.54	2.43

$P(1.23 < X < 1.83) = ?$

12

3.31	1.15	2.44	0.82	1.50	2.53	2.18	3.20
2.85	2.27	1.97	0.98	3.51	2.42	2.09	2.83
2.76	0.18	1.61	2.21	2.33	3.06	1.70	2.44
1.82	3.02	3.63	1.52	2.01	2.17	2.63	1.94
2.49	2.31	2.37	1.03	2.06	0.67	2.79	2.42
2.95	0.45	1.20	1.61	2.35	1.73	0.82	1.10
1.94	2.14	2.28	2.54	1.85	2.40	1.94	1.30
1.62	2.03	2.00	2.70	2.33	2.86	3.26	1.71
2.70	2.96	2.89	0.73	1.01	1.85	2.79	3.10
2.42	3.12	2.43	1.85	1.21	1.53	2.95	1.22

$P(1.22 < X < 1.84) = ?$

13

1.60	2.49	0.79	1.41	2.50	2.29	2.56	2.35
2.64	1.38	0.95	3.48	2.39	1.17	2.45	1.23
1.98	1.10	2.18	2.30	3.03	1.50	3.09	1.56
2.59	1.97	1.49	1.98	2.14	3.35	2.20	3.41
2.95	2.57	1.00	2.03	0.64	2.67	0.70	2.73
2.76	0.18	1.94	1.23	1.64	2.38	1.70	2.44
1.82	3.02	1.32	2.31	2.57	1.88	2.63	1.94
2.49	2.31	2.71	2.03	2.76	2.36	2.79	2.42
2.95	0.45	0.83	2.92	0.76	1.04	0.82	1.10
1.94	2.14	2.81	2.46	1.88	1.24	1.94	1.30

$P(1.21 < X < 1.85) = ?$

14

0.67	2.41	1.73	2.47	0.85	1.53	1.58	1.32
0.75	1.94	3.81	2.00	1.01	3.54	1.92	1.04
2.13	1.58	2.19	1.64	2.24	2.36	2.53	1.91
1.31	3.62	1.37	3.68	1.55	2.04	2.89	2.51
2.31	0.34	2.37	2.40	1.06	2.09	0.09	1.78
1.81	2.27	1.87	3.32	2.00	1.29	1.76	2.96
2.35	2.87	2.41	2.93	1.38	2.37	2.43	1.88
2.93	2.40	2.99	2.46	1.77	2.09	2.89	0.39
2.01	2.56	2.07	2.62	0.89	2.98	1.88	2.08
1.19	1.79	1.25	1.83	2.87	2.52	1.56	1.57

$P(1.20 < X < 1.86) = ?$

15

1.62	1.63	2.52	1.76	2.50	0.88	1.56	2.59
2.38	2.67	3.14	3.84	2.03	1.04	3.57	2.48
2.86	2.01	3.13	2.22	1.67	2.27	2.38	3.12
1.59	2.62	2.00	1.40	3.71	1.58	2.07	2.23
0.42	2.04	2.59	0.86	2.95	0.79	1.07	1.91
2.11	3.22	1.82	2.84	2.49	2.91	3.27	1.59
1.76	2.50	1.88	3.08	2.47	2.99	1.44	2.43
2.69	2.00	2.55	2.37	3.05	2.52	1.83	2.15
2.85	3.48	3.01	0.51	2.13	2.68	0.95	3.04
0.88	1.16	2.00	3.20	1.31	1.91	2.93	2.58

$P(1.19 < X < 1.87) = ?$

9

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:

:

1)

, ;

2)

80%, 95% 99%

-

;

3)

;

4) , -  
 (80%, 95%, 99%), -  
 - ;

5)  $\delta_\gamma$  ,

(80%, 95%, 99%):  $\delta_{80}$ ,  $\delta_{95}$ ,  $\delta_{99}$ ;

6) ( )  
 (80%, 95%, 99%)

$$\left| \frac{\delta_\gamma}{y} \right| \cdot 100\% (\delta_\gamma \text{ y } ) ;$$

7) ,  $\gamma$

1

:

		, %
1	1,24	39,4
2	0,63	23,2
3	1,18	37,2
4	1,12	35,1
5	0,44	20,0
6	1,19	37,9
7	0,48	20,1
8	0,65	23,4
9	0,26	13,4
10	0,75	24,8
11	1,03	32,2
12	0,89	30,2
13	0,16	10,3
14	0,67	23,7
15	0,90	31,3

2

:

	,	, %
1	38,9	10,7
2	33,3	11,3
3	37,7	12,2
4	31,1	12,4
5	29,4	10,9
6	37,2	11,3
7	35,6	11,1
8	34,1	14,0
9	0,26	6,8
10	22,8	7,1
11	21,7	8,9
12	26,	4,2
13	23,3	7,4
14	24,5	11,4
15	29,9	4,8

3

:

	,	, %
1	5,46	27,6
2	5,53	24,9
3	7,05	32,1
4	7,29	37,1
5	7,40	36,9
6	7,10	33,4
7	6,25	31,3
8	8,64	39,3
9	5,18	24,8
10	1,81	20,0
11	2,30	25,5
12	5,53	26,4
13	2,22	20,3
14	3,54	29,1
15	3,23	27,7

4

:

	,	, %
1	20,1	12,2
2	64,2	17,6
3	61,1	17,5
4	13,3	10,3
5	10,8	12,8
6	17,2	13,1
7	34,1	16,9
8	32,3	14,4
9	27,8	16,0
10	24,2	16,4
11	55,5	18,3
12	17,1	10,8
13	11,1	10,0
14	25,5	14,0
15	31,1	16,1

5

:

	,	, %
1	1,25	9,2
2	2,32	14,7
3	1,71	10,3
4	1,64	10,0
5	1,38	9,9
6	1,18	9,1
7	1,44	9,8
8	1,17	6,4
9	1,72	13,0
10	2,21	11,8
11	1,64	13,2
12	1,73	11,4
13	1,17	8,1
14	1,39	9,0
15	1,07	11,1

6

:

	,	, %
1	1,08	20,1
2	1,05	12,9
3	0,99	18,0
4	1,02	11,7
5	0,98	17,9
6	1,04	16,8
7	1,03	15,6
8	1,10	14,3
9	1,03	18,1
10	0,89	17,8
11	0,78	13,0
12	0,99	14,2
13	1,43	24,2
14	1,03	20,0
15	1,05	19,3

7

:

	,	, %
1	33,4	12,3
2	29,1	14,7
3	25,3	10,9
4	27,1	16,1
5	43,3	22,3
6	47,2	21,1
7	49,3	24,3
8	35,7	13,3
9	45,8	27,6
10	43,4	28,3
11	42,1	25,1
12	40,1	20,2
13	33,3	13,7
14	41,2	19,9
15	34,0	14,2

8

:

	, %	,
1	84	4300
2	83	4150
3	67	3000
4	63	3420
5	69	3300
6	70	4300
7	73	3420
8	81	4100
9	77	3700
10	72	3500
11	80	4000
12	85	4450
13	83	4270
14	70	3300
15	87	4500

9

:

	, %	%
1	18,1	9,5
2	7,8	19,4
3	7,4	8,7
4	6,4	18,3
5	7,8	16,4
6	17,1	8,8
7	10,2	17,8
8	14,1	13,7
9	20,0	7,0
10	16,7	10,2
11	16,0	10,4
12	20,4	7,3
13	16,2	10,7
14	16,0	14,0
15	20,1	7,3

:

	, %	,
1	40	142,20
2	33	152,33
3	37	154,20
4	39	149,95
5	37	154,37
6	41	149,80
7	49	170,11
8	38	168,33
9	55	193,30
10	43	172,72
11	56	189,39
12	47	187,01
13	44	173,40
14	55	187,87
15	54	184,20

:

	,	, %
1	20,0	2,0
2	12,8	1,8
3	9,2	1,1
4	5,3	3,5
5	18,6	10,1
6	10,8	3,3
7	28,7	24,2
8	13,8	1,9
9	28,6	20,8
10	22,9	19,2
11	14,0	3,4
12	13,0	2,7
13	12,8	1,4
14	25,0	20,1
15	13,8	7,8



:

	,	, %
1	80,0	20,0
2	87,2	37,5
3	90,8	43,4
4	94,7	45,6
5	81,4	23,4
6	89,2	25,0
7	71,3	17,2
8	86,2	33,3
9	71,4	15,0
10	77,7	18,7
11	86,0	24,8
12	87,0	34,5
13	87,2	33,1
14	75,0	19,2
15	86,2	31,8

:

	, %	%
1	25,2	9,5
2	58,2	9,4
3	42,2	8,7
4	46,8	8,3
5	60,5	6,4
6	66,1	8,8
7	26,5	7,8
8	59,9	13,7
9	43,2	7,0
10	47,8	6,7
11	61,8	10,4
12	68,1	7,3
13	32,0	8,9
14	60,2	9,4
15	44,2	7,3

:

	, %	, %
1	7,89	8,9
2	14,41	4,3
3	6,01	10,2
4	9,17	4,9
5	6,78	8,3
6	8,91	7,8
7	6,17	13,1
8	10,11	4,9
9	5,98	13,3
10	6,10	10,7
11	5,90	13,7
12	8,13	5,6
13	9,01	4,7
14	6,00	11,1
15	6,13	10,8

:

	, %	,
1	84	4300
2	83	4150
3	67	3000
4	63	3420
5	69	3300
6	70	4300
7	73	3420
8	81	4100
9	77	3700
10	72	3500
11	80	4000
12	85	4450
13	83	4270
14	70	3300
15	87	4500

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