Задача 1. а)

■

```
(* a=5 b=7*)
```

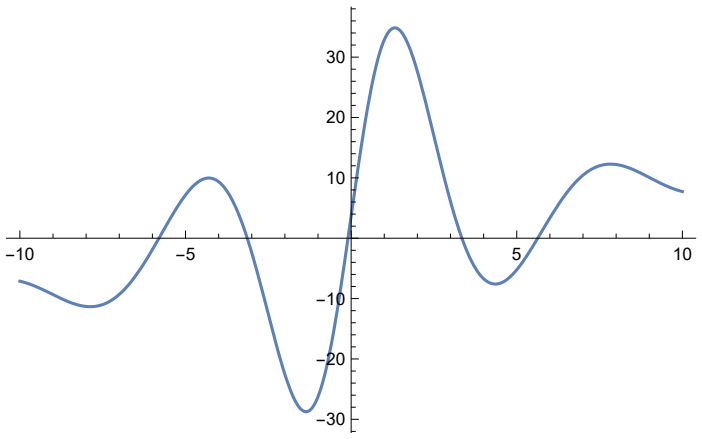
In[•]:=
$$f[x\_] := \frac{50\,(5+2)\,\text{Sin}\,[x] + x^3 + 33}{(7+2) + x^2}$$

```
f[x]
```

Out[•]=
$$\frac{33 + x^3 + 350\,\text{Sin}\,[x]}{9 + x^2}$$

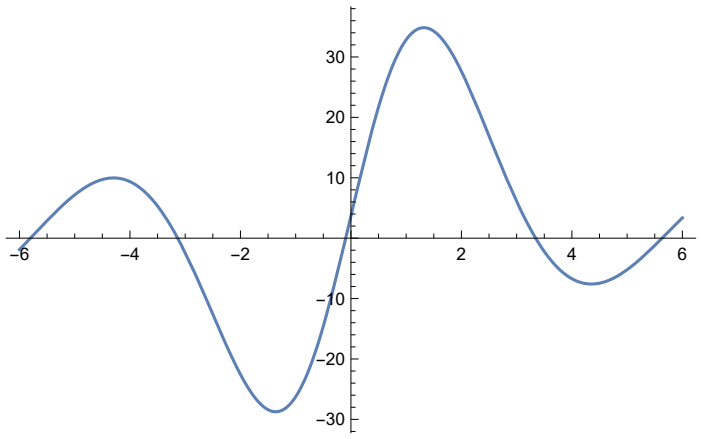
In[•]:=
```
Plot[f[x], {x, -10, 10}]
```

Out[•]=



In[•]:=
```
Plot[f[x], {x, -6, 6}]
```

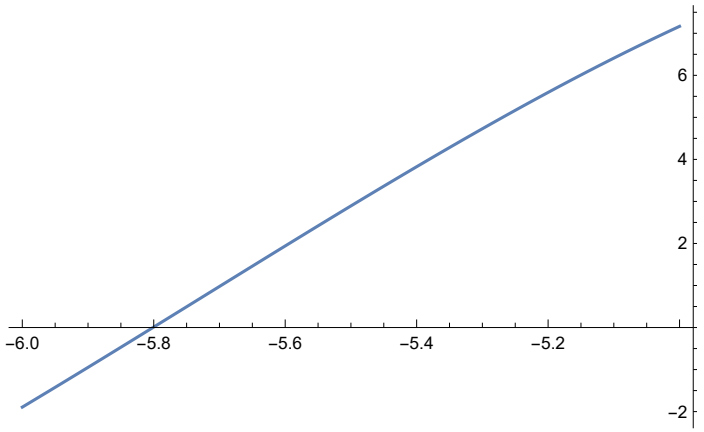
Out[•]=



б)

In[•]:=
```
Plot[f[x], {x, -6, -5}]
```

Out[•]=



In[•]:=
```
f[-6.]
```

Out[•]=
```
-1.89344
```

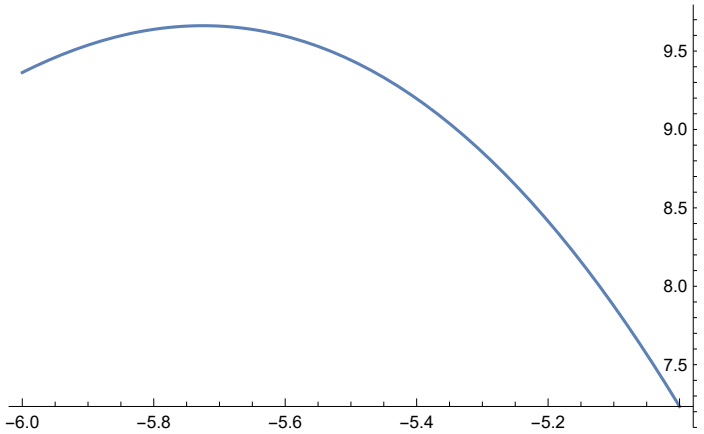
In[•]:=
```
f[-5.]
```

Out[•]=
```
7.1654
```

в).

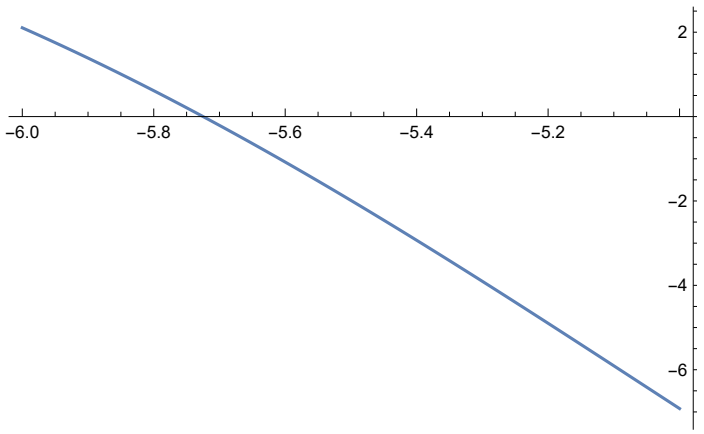
In[•]:=
```
Plot[f'[x], {x, -6, -5}]
```

Out[•]=



In[•]:=
```
Plot[f''[x], {x, -6, -5}]
```

Out[•]=



г).

In[•]:=
```
p = -6.
x0 = -5.
```

Out[•]=
```
-6.
```

Out[•]=
```
-5.
```

д).

In[•]:=
```
For[n = 0, n ≤ 50, n++,
 x1 = x0 - f[x0]/(f[x0] - f[p]) * (x0 - p);
 Print["n = ", n, "x_n = ", x1];
 x0 = x1
]
```

```
n = 0x_n = -5.79098
n = 1x_n = -5.80133
n = 2x_n = -5.80121
n = 3x_n = -5.80121
n = 4x_n = -5.80121
n = 5x_n = -5.80121
n = 6x_n = -5.80121
n = 7x_n = -5.80121
n = 8x_n = -5.80121
n = 9x_n = -5.80121
n = 10x_n = -5.80121
```

n = 11 x_n = −5.80121

n = 12 x_n = −5.80121

n = 13 x_n = −5.80121

n = 14 x_n = −5.80121

n = 15 x_n = −5.80121

n = 16 x_n = −5.80121

n = 17 x_n = −5.80121

n = 18 x_n = −5.80121

n = 19 x_n = −5.80121

n = 20 x_n = −5.80121

n = 21 x_n = −5.80121

n = 22 x_n = −5.80121

n = 23 x_n = −5.80121

n = 24 x_n = −5.80121

n = 25 x_n = −5.80121

n = 26 x_n = −5.80121

n = 27 x_n = −5.80121

n = 28 x_n = −5.80121

n = 29 x_n = −5.80121

n = 30 x_n = −5.80121

n = 31 x_n = −5.80121

n = 32 x_n = −5.80121

n = 33 x_n = −5.80121

n = 34 x_n = −5.80121

n = 35 x_n = −5.80121

n = 36 x_n = −5.80121

n = 37 x_n = −5.80121

n = 38 x_n = −5.80121

n = 39 x_n = −5.80121

n = 40 x_n = −5.80121

n = 41 x_n = −5.80121

n = 42 x_n = −5.80121

n = 43 x_n = −5.80121

n = 44 x_n = −5.80121

n = 45 x_n = −5.80121

n = 46 x_n = −5.80121

n = 47 x_n = −5.80121

n = 48 x_n = −5.80121

n = 49 x_n = −5.80121

$n = 50 x_n = -5.80121$

In[•]:=
```
m1 = Abs[f'[-5.]]
```
Out[•]=

7.2334

In[•]:=
```
M1 = Abs[f'[-6.]]
```
Out[•]=

9.36308

In[•]:=
$$R = \frac{M1 - m1}{m1}$$
Out[•]=

0.294422

In[•]:=
$$f[x\_] := \frac{33 + x^3 + 350\,\text{Sin}[x]}{9 + x^2}$$
```
x0 = -5.; p = -6.;
M1 = Abs[f'[-6.]];
m1 = Abs[f'[-5.]];
R = (M1 - m1)/m1;
For[n = 0, n ≤ 10, n++,
 x1 = x0 - f[x0]/(f[x0] - f[p]) * (x0 - p);
 Print["n = ", n, "x_n = ", x1, "f(x_n) = ", f[x1], "ϵ_n = ", eps = R * Abs[x1 - x0]];
 x0 = x1
]
```

$n = 0 x_n = -5.79098 f(x_n) = 0.098616 \epsilon_n = 0.232883$

$n = 1 x_n = -5.80133 f(x_n) = -0.0011399 \epsilon_n = 0.00304646$

$n = 2 x_n = -5.80121 f(x_n) = 0.0000135054 \epsilon_n = 0.000035235$

$n = 3 x_n = -5.80121 f(x_n) = -1.59965 \times 10^{-7} \epsilon_n = 4.17458 \times 10^{-7}$

$n = 4 x_n = -5.80121 f(x_n) = 1.89472 \times 10^{-9} \epsilon_n = 4.9446 \times 10^{-9}$

$n = 5 x_n = -5.80121 f(x_n) = -2.24467 \times 10^{-11} \epsilon_n = 5.85669 \times 10^{-11}$

$n = 6 x_n = -5.80121 f(x_n) = 2.63201 \times 10^{-13} \epsilon_n = 6.93757 \times 10^{-13}$

$n = 7 x_n = -5.80121 f(x_n) = -1.99899 \times 10^{-15} \epsilon_n = 8.10647 \times 10^{-15}$

$n = 8 x_n = -5.80121 f(x_n) = -1.99899 \times 10^{-15} \epsilon_n = 0.$

$n = 9 x_n = -5.80121 f(x_n) = -1.99899 \times 10^{-15} \epsilon_n = 0.$

$n = 10 x_n = -5.80121 f(x_n) = -1.99899 \times 10^{-15} \epsilon_n = 0.$

е).

In[•]:=
```
f[x_] := (33 + x^3 + 350 Sin[x])/(9 + x^2)
a = -6.; b = -5.;
For[n = 0, n ≤ 20, n++,
 Print["n = ", n, "a_n = ", a, "b_n = ",
  b, "m_n = ", m = (a + b)/2, "f(m_n) = ", f[m], "ϵ_n = ", (b - a)/2];
 If[f[m] > 0, b = m, a = m]
]
```

n = 0a_n = −6.b_n = −5.m_n = −5.5f(m_n) = 2.89335ϵ_n = 0.5

n = 1a_n = −6.b_n = −5.5m_n = −5.75f(m_n) = 0.494224ϵ_n = 0.25

n = 2a_n = −6.b_n = −5.75m_n = −5.875f(m_n) = −0.708912ϵ_n = 0.125

n = 3a_n = −5.875b_n = −5.75m_n = −5.8125f(m_n) = −0.108734ϵ_n = 0.0625

n = 4a_n = −5.8125b_n = −5.75m_n = −5.78125f(m_n) = 0.192519ϵ_n = 0.03125

n = 5a_n = −5.8125b_n = −5.78125m_n = −5.79688f(m_n) = 0.0418205ϵ_n = 0.015625

n = 6a_n = −5.8125b_n = −5.79688m_n = −5.80469f(m_n) = −0.0334767ϵ_n = 0.0078125

n = 7a_n = −5.80469b_n = −5.79688m_n = −5.80078f(m_n) = 0.00416714ϵ_n = 0.00390625

n = 8a_n = −5.80469b_n = −5.80078m_n = −5.80273f(m_n) = −0.014656ϵ_n = 0.00195313

n = 9a_n = −5.80273b_n = −5.80078m_n = −5.80176f(m_n) = −0.00524473ϵ_n = 0.000976563

n = 10a_n = −5.80176b_n = −5.80078m_n = −5.80127f(m_n) = −0.000538872ϵ_n = 0.000488281

n = 11a_n = −5.80127b_n = −5.80078m_n = −5.80103f(m_n) = 0.00181412ϵ_n = 0.000244141

n = 12a_n = −5.80127b_n = −5.80103m_n = −5.80115f(m_n) = 0.000637617ϵ_n = 0.00012207

n = 13a_n = −5.80127b_n = −5.80115m_n = −5.80121f(m_n) = 0.0000493716ϵ_n = 0.0000610352

n = 14a_n = −5.80127b_n = −5.80121m_n = −5.80124f(m_n) = −0.00024475ϵ_n = 0.0000305176

n = 15a_n = −5.80124b_n = −5.80121m_n = −5.80122f(m_n) = −0.0000976895ϵ_n = 0.0000152588

n = 16a_n = −5.80122b_n = −5.80121m_n = −5.80122f(m_n) = $-0.000024159\epsilon_n = 7.62939\times10^{-6}$

n = 17a_n = −5.80122b_n = −5.80121m_n = −5.80121f(m_n) = $0.0000126063\epsilon_n = 3.8147\times10^{-6}$

n = 18a_n = −5.80122b_n = −5.80121m_n = −5.80121f(m_n) = $-5.77633\times10^{-6}\epsilon_n = 1.90735\times10^{-6}$

n = 19a_n = −5.80121b_n = −5.80121m_n = −5.80121f(m_n) = $3.41498\times10^{-6}\epsilon_n = 9.53674\times10^{-7}$

n = 20a_n = −5.80121b_n = −5.80121m_n = −5.80121f(m_n) = $-1.18067\times10^{-6}\epsilon_n = 4.76837\times10^{-7}$

ж).

```
(*Сравнение на двата метода*)
```

In[•]:=
```
Log2[(-5 - (-6))/0.0001] - 1
```

Out[•]=

12.2877

```
(*По метода на разполовяването са необходими 16
  итерации за достигане на истинската точност. По метода на хордите
  са необходими 3 итерации.Метода на хордите е по-ефективен*)
```

Задача 2.

In[•]:=
$$A = \begin{pmatrix} 1 & 5-1 & 3 & 0 \\ 4 & 2 & 7 & -2 \\ 0 & 1 & 1 & 4 \\ -(7+2) & 2 & 3 & 5 \end{pmatrix}$$

Out[•]=
```
{{1, 4, 3, 0}, {4, 2, 7, -2}, {0, 1, 1, 4}, {-9, 2, 3, 5}}
```

In[•]:=
```
Length[A]
```
Out[•]=
```
4
```

In[•]:=
```
A[[1]] = A[[1]] / A[[1, 1]]
```
Out[•]=
```
{1, 4, 3, 0}
```

In[•]:=
```
A[[2]] = A[[2]] - A[[2, 1]] * A[[1]]
```
Out[•]=
```
{0, -14, -5, -2}
```

In[•]:=
```
A[[3]] = A[[3]] - A[[3, 1]] * A[[1]]
```
Out[•]=
```
{0, 1, 1, 4}
```

In[•]:=
```
A // MatrixForm
```
Out[•]//MatrixForm=
$$\begin{pmatrix} 1 & 4 & 3 & 0 \\ 0 & -14 & -5 & -2 \\ 0 & 1 & 1 & 4 \\ -9 & 2 & 3 & 5 \end{pmatrix}$$

```
(*първи етап-получаваме единица на мястото на главния елемент a22=1)
```

In[•]:=
```
A[[2]] = A[[2]] / A[[2, 2]]
```
Out[•]=
$$\left\{0, 1, \frac{5}{14}, \frac{1}{7}\right\}$$

In[•]:=
```
A // MatrixForm
```
Out[•]//MatrixForm=
$$\begin{pmatrix} 1 & 4 & 3 & 0 \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} \\ 0 & 1 & 1 & 4 \\ -9 & 2 & 3 & 5 \end{pmatrix}$$

(*втори етап-получаване на нули във всички останали елементи от стълба*)

In[•]:= A[[1]] = A[[1]] - A[[1, 2]] * A[[2]]

Out[•]=

$$\left\{1, 0, \frac{11}{7}, -\frac{4}{7}\right\}$$

In[•]:= A[[3]] = A[[3]] - A[[3, 2]] * A[[2]]

Out[•]=

$$\left\{0, 0, \frac{9}{14}, \frac{27}{7}\right\}$$

In[•]:= A // MatrixForm

Out[•]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & \frac{11}{7} & -\frac{4}{7} \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} \\ 0 & 0 & \frac{9}{14} & \frac{27}{7} \\ -9 & 2 & 3 & 5 \end{pmatrix}$$

(*първи етап-получаваме единица на мястото на главния елемент a33=1*)

In[•]:= $\mathbf{A[[3]] = \frac{A[[3]]}{A[[3, 3]]}}$

Out[•]=

{0, 0, 1, 6}

In[•]:= A // MatrixForm

Out[•]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & \frac{11}{7} & -\frac{4}{7} \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} \\ 0 & 0 & 1 & 6 \\ -9 & 2 & 3 & 5 \end{pmatrix}$$

(*втори етап-получаване на нули във всички останали елементи от стълба*)

In[•]:= A[[1]] = A[[1]] - A[[1, 3]] * A[[3]]

Out[•]=

{1, 0, 0, -10}

In[•]:= A // MatrixForm

Out[•]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & -10 \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} \\ 0 & 0 & 1 & 6 \\ -9 & 2 & 3 & 5 \end{pmatrix}$$

In[•]:= A[[2]] = A[[2]] - A[[2, 3]] * A[[3]]

Out[•]=

{0, 1, 0, -2}

In[•]:=
```
A // MatrixForm
```

Out[•]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & -10 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & 6 \\ -9 & 2 & 3 & 5 \end{pmatrix}$$

Съставяне на програмен код

In[•]:=
```
A = {{1, 5 - 1, 3, 0}, {4, 2, 7, -2}, {0, 1, 1, 4}, {-(7 + 2), 2, 3, 5}}; c = {{5}, {5 - 7}, {7 + 1}, {2}}

n = Length[A];
For[col = 1, col ≤ n, col++,

 A[[col]] = A[[col]] / A[[col, col]];

 For[row = 1, row ≤ n, row++,
  If[row ≠ col, A[[row]] = A[[row]] - A[[row, col]] * A[[col]]]
 ];
 Print[A // MatrixForm]
]
```

Out[•]=

```
{{5}, {-2}, {8}, {2}}
```

$$\begin{pmatrix} 1 & 4 & 3 & 0 \\ 0 & -14 & -5 & -2 \\ 0 & 1 & 1 & 4 \\ 0 & 38 & 30 & 5 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & \frac{11}{7} & -\frac{4}{7} \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} \\ 0 & 0 & \frac{9}{14} & \frac{27}{7} \\ 0 & 0 & \frac{115}{7} & -\frac{3}{7} \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & -10 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & -99 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

```
In[•]:= LinearSolve[A = {{1, 5 - 1, 3, 0}, {4, 2, 7, -2}, {0, 1, 1, 4}, {-(7 + 2), 2, 3, 5}}, {5, 5 - 7, 7 + 1, 2}]
```

Out[•]=

$$\left\{\frac{29}{33}, \frac{52}{33}, -\frac{8}{11}, \frac{59}{33}\right\}$$

добавяме намиране на детерминанта

```
In[•]:= A = {{1, 5 - 1, 3, 0}, {4, 2, 7, -2}, {0, 1, 1, 4}, {-(7 + 2), 2, 3, 5}}; c = {{5}, {5 - 7}, {7 + 1}, {2}}

n = Length[A];
deter = 1;
For[col = 1, col ≤ n, col++,
 deter = deter * A[[col, col]];

 A[[col]] = A[[col]] / A[[col, col]];

 For[row = 1, row ≤ n, row++,
  If[row ≠ col, A[[row]] = A[[row]] - A[[row, col]] * A[[col]]]
 ];
 Print[A // MatrixForm]
]
Print["Детерминантата на матрицата е ", deter]
```

Out[•]=

```
{{5}, {-2}, {8}, {2}}
```

$$\begin{pmatrix} 1 & 4 & 3 & 0 \\ 0 & -14 & -5 & -2 \\ 0 & 1 & 1 & 4 \\ 0 & 38 & 30 & 5 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & \frac{11}{7} & -\frac{4}{7} \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} \\ 0 & 0 & \frac{9}{14} & \frac{27}{7} \\ 0 & 0 & \frac{115}{7} & -\frac{3}{7} \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & -10 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & -99 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

```
Детерминантата на матрицата е 891
```

In[•]:=
```
Det[{{1, 5 - 1, 3, 0}, {4, 2, 7, -2}, {0, 1, 1, 4}, {-(7 + 2), 2, 3, 5}}]
```

Out[•]=
```
891
```

добавяме намиране на обратна матрица

In[•]:=
```
A = {{1, 5 - 1, 3, 0, 1, 0, 0, 0}, {4, 2, 7, -2, 0, 1, 0, 0}, {0, 1, 1, 4, 0, 0, 1, 0}, {-(7 + 2), 2, 3, 5, 0, 0, 0, 1}}; c = {{5}, {5 - 7}, {7 + 1}, {2}}
n = Length[A];
deter = 1;
For[col = 1, col ≤ n, col++,
 deter = deter * A[[col, col]];

 A[[col]] = A[[col]] / A[[col, col]];

 For[row = 1, row ≤ n, row++,
  If[row ≠ col, A[[row]] = A[[row]] - A[[row, col]] * A[[col]]]
 ];
 Print[A // MatrixForm]
]
Print["Детерминантата на матрицата е ", deter]
```

Out[•]=
```
{{5}, {-2}, {8}, {2}}
```

$$\begin{pmatrix} 1 & 4 & 3 & 0 & 1 & 0 & 0 & 0 \\ 0 & -14 & -5 & -2 & -4 & 1 & 0 & 0 \\ 0 & 1 & 1 & 4 & 0 & 0 & 1 & 0 \\ 0 & 38 & 30 & 5 & 9 & 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & \frac{11}{7} & -\frac{4}{7} & -\frac{1}{7} & \frac{2}{7} & 0 & 0 \\ 0 & 1 & \frac{5}{14} & \frac{1}{7} & \frac{2}{7} & -\frac{1}{14} & 0 & 0 \\ 0 & 0 & \frac{9}{14} & \frac{27}{7} & -\frac{2}{7} & \frac{1}{14} & 1 & 0 \\ 0 & 0 & \frac{115}{7} & -\frac{3}{7} & -\frac{13}{7} & \frac{19}{7} & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & -10 & \frac{5}{9} & \frac{1}{9} & -\frac{22}{9} & 0 \\ 0 & 1 & 0 & -2 & \frac{4}{9} & -\frac{1}{9} & -\frac{5}{9} & 0 \\ 0 & 0 & 1 & 6 & -\frac{4}{9} & \frac{1}{9} & \frac{14}{9} & 0 \\ 0 & 0 & 0 & -99 & \frac{49}{9} & \frac{8}{9} & -\frac{230}{9} & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & 0 & \frac{5}{891} & \frac{19}{891} & \frac{122}{891} & -\frac{10}{99} \\ 0 & 1 & 0 & 0 & \frac{298}{891} & -\frac{115}{891} & -\frac{35}{891} & -\frac{2}{99} \\ 0 & 0 & 1 & 0 & -\frac{34}{297} & \frac{49}{297} & \frac{2}{297} & \frac{2}{33} \\ 0 & 0 & 0 & 1 & -\frac{49}{891} & -\frac{8}{891} & \frac{230}{891} & -\frac{1}{99} \end{pmatrix}$$

Детерминантата на матрицата е 891

In[•]:=
```
Inverse[{{1, 5-1, 3, 0}, {4, 2, 7, -2}, {0, 1, 1, 4}, {-(7+2), 2, 3, 5}}] // MatrixForm
```

Out[•]//MatrixForm=

$$\begin{pmatrix} \frac{5}{891} & \frac{19}{891} & \frac{122}{891} & -\frac{10}{99} \\ \frac{298}{891} & -\frac{115}{891} & -\frac{35}{891} & -\frac{2}{99} \\ -\frac{34}{297} & \frac{49}{297} & \frac{2}{297} & \frac{2}{33} \\ -\frac{49}{891} & -\frac{8}{891} & \frac{230}{891} & -\frac{1}{99} \end{pmatrix}$$

Задача 3. а)

In[•]:=
```
xt = Table[5 + i * 0.2, {i, 1, 10}]
```

Out[•]=
```
{5.2, 5.4, 5.6, 5.8, 6., 6.2, 6.4, 6.6, 6.8, 7.}
```

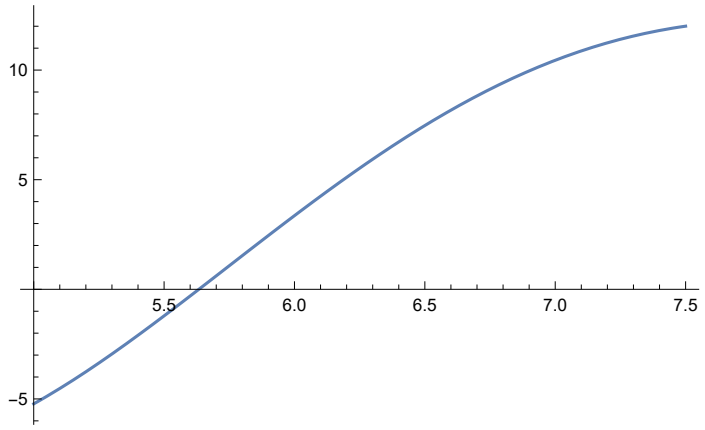
In[•]:=
```
f[x_] := (50 (5 + 2) Sin[x] + x^3 + 33) / ((7 + 2) + x^2)

yt = f[xt]
```

Out[•]=
```
{-3.76252, -2.09653, -0.305434, 1.53615,
 3.3601, 5.10638, 6.7241, 8.17229, 9.4202, 10.4473}
```

б)

In[•]:=
```
grf = Plot[f[x], {x, 5, 7.5}]
```

Out[•]=



в).

In[•]:=
```
L1[x_] := -2.09653 * (x - 5.2)/(5.6 - 5.2) - 1.886 * (x - 5.6)/(5.2 - 5.6)
```

In[•]:=
```
Expand[L1[x]]
```

Out[•]=
```
0.85089 - 0.526325 x
```

In[•]:=
```
L1[5.2]
L1[5.6]
```

Out[•]=
```
-1.886
```

Out[•]=
```
-2.09653
```

In[•]:=
```
M2 = Abs[f''[5.2]]
```

Out[•]=
```
5.1025
```

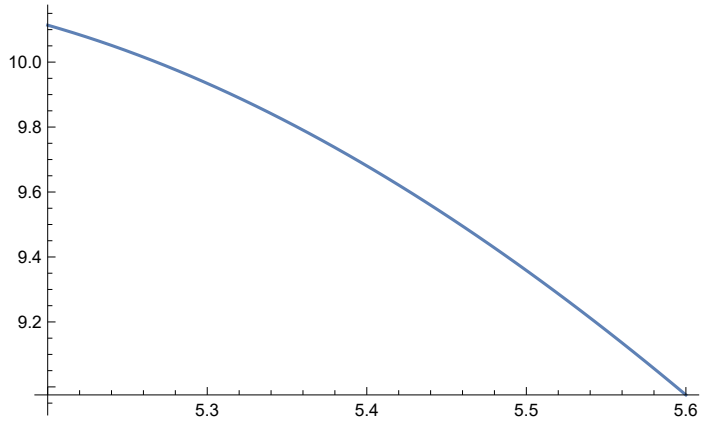
In[•]:=
```
R1[x_] := M2/2! Abs[(x - 5.2) (x - 5.6)]
```

In[•]:=
```
R1[5.6]
```

Out[•]=
```
0.
```

In[•]:=
```
Plot[Abs[f'''[x]], {x, 5.2, 5.6}]
```

Out[•]=



In[•]:=
```
M3 = Abs[f'''[5.6]]
```

Out[•]=
```
8.9753
```

In[•]:=
```
R2[x_] := M3/3! Abs[(x - 5.2) (x - 5.4) (x - 5.6)]
```

In[•]:=
```
R2[5.4]
```

Out[•]=
```
0.
```