Симеон Юруков 1901261094

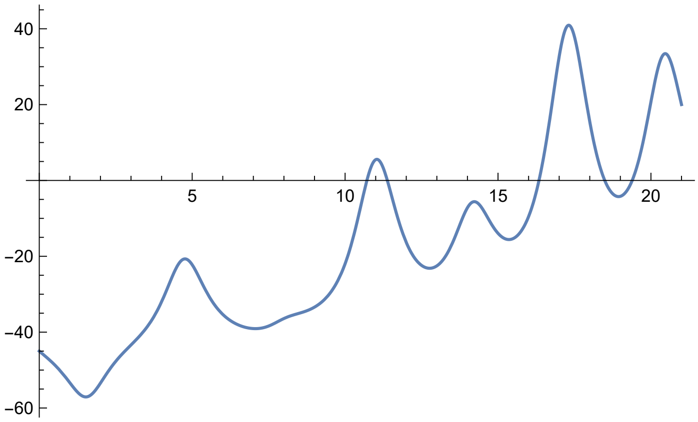
Изпит КЧМ

зад1

In[11]:=
$$f[x\_] := \frac{\sqrt{x^3} - 14 * Sin[x]}{1 + Cos[x]^2} - 45$$

In[17]:= `Plot[f[x], {x, 0, 21}]`

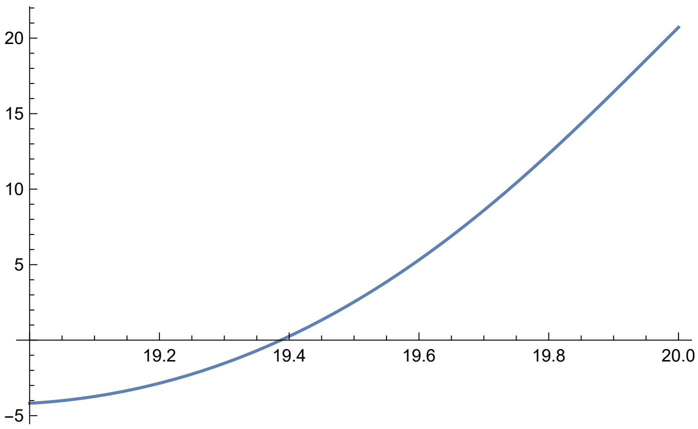
Out[17]=



Izvod: 5 Korena

In[19]:= `Plot[f[x], {x, 19, 20}]`

Out[19]=



In[22]:=
```
f[19.]
```
Out[22]=

−4.18114

In[23]:=
```
f[20.]
```
Out[23]=

20.7175

In[29]:= $f[x\_] := \frac{\sqrt{x^3} - 14 * Sin[x]}{1 + Cos[x]^2} - 45$

In[30]:=
```
a = 19.; b = 20.;
```

In[31]:=
$$\begin{aligned}&For\Big[n = 0,\ n \le 3,\ n{+}{+},\\ &\quad Print\Big["n = ", n, "\ a_n = ", a, "\ b_n = ", b,\\ &\quad\quad "\ m_n = ", m = \frac{a+b}{2}, "\ f(m_n) = ", f[m], "\ \varepsilon_n = ", \frac{b-a}{2}\Big];\\ &\quad If[f[m] > 0, b = m, a = m]\\ &\Big]\end{aligned}$$

n = 0 a_n = 19. b_n = 20. m_n = 19.5 $f(m_n)$ = 2.53021 ε_n = 0.5

n = 1 a_n = 19. b_n = 19.5 m_n = 19.25 $f(m_n)$ = −2.2511 ε_n = 0.25

n = 2 a_n = 19.25 b_n = 19.5 m_n = 19.375 $f(m_n)$ = −0.238705 ε_n = 0.125

n = 3 a_n = 19.375 b_n = 19.5 m_n = 19.4375 $f(m_n)$ = 1.0486 ε_n = 0.0625

In[32]:= $f[x\_] := \frac{\sqrt{x^3} - 14 * Sin[x]}{1 + Cos[x]^2} - 45$

In[33]:=
```
a = 19.; b = 20.;
```

In[34]:=
```
epszad = 0.0000001;
eps = Infinity; (*стойност по-голяма от зададената грешка*)
```
$$\begin{aligned}&For\Big[n = 0,\ eps > epszad,\ n{+}{+},\\ &\quad Print\Big["n = ", n, "\ a_n = ", a, "\ b_n = ", b,\\ &\quad\quad "\ m_n = ", m = \frac{a+b}{2}, "\ f(m_n) = ", f[m], "\ \varepsilon_n = ", eps = \frac{b-a}{2}\Big];\\ &\quad If[f[m] > 0, b = m, a = m]\\ &\Big]\end{aligned}$$

n = 0 a_n = 19. b_n = 20. m_n = 19.5 f(m_n) = 2.53021 ε_n = 0.5

n = 1 a_n = 19. b_n = 19.5 m_n = 19.25 f(m_n) = -2.2511 ε_n = 0.25

n = 2 a_n = 19.25 b_n = 19.5 m_n = 19.375 f(m_n) = -0.238705 ε_n = 0.125

n = 3 a_n = 19.375 b_n = 19.5 m_n = 19.4375 f(m_n) = 1.0486 ε_n = 0.0625

n = 4 a_n = 19.375 b_n = 19.4375 m_n = 19.4063 f(m_n) = 0.380945 ε_n = 0.03125

n = 5 a_n = 19.375 b_n = 19.4063 m_n = 19.3906 f(m_n) = 0.0651594 ε_n = 0.015625

n = 6 a_n = 19.375 b_n = 19.3906 m_n = 19.3828 f(m_n) = -0.0882577 ε_n = 0.0078125

n = 7 a_n = 19.3828 b_n = 19.3906 m_n = 19.3867 f(m_n) = -0.011921 ε_n = 0.00390625

n = 8 a_n = 19.3867 b_n = 19.3906 m_n = 19.3887 f(m_n) = 0.0265262 ε_n = 0.00195313

n = 9 a_n = 19.3867 b_n = 19.3887 m_n = 19.3877 f(m_n) = 0.00727932 ε_n = 0.000976563

n = 10 a_n = 19.3867 b_n = 19.3877 m_n = 19.3872 f(m_n) = -0.00232666 ε_n = 0.000488281

n = 11 a_n = 19.3872 b_n = 19.3877 m_n = 19.3875 f(m_n) = 0.00247488 ε_n = 0.000244141

n = 12 a_n = 19.3872 b_n = 19.3875 m_n = 19.3873 f(m_n) = 0.0000737473 ε_n = 0.00012207

n = 13 a_n = 19.3872 b_n = 19.3873 m_n = 19.3873 f(m_n) = -0.00112655 ε_n = 0.0000610352

n = 14 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = -0.000526422 ε_n = 0.0000305176

n = 15 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = -0.000226343 ε_n = 0.0000152588

n = 16 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = -0.0000762993 ε_n = 7.62939×10^{-6}

n = 17 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = -1.27638×10^{-6} ε_n = 3.8147×10^{-6}

n = 18 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = 0.0000362354 ε_n = 1.90735×10^{-6}

n = 19 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = 0.0000174795 ε_n = 9.53674×10^{-7}

n = 20 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = 8.10153×10^{-6} ε_n = 4.76837×10^{-7}

n = 21 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = 3.41257×10^{-6} ε_n = 2.38419×10^{-7}

n = 22 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = 1.0681×10^{-6} ε_n = 1.19209×10^{-7}

n = 23 a_n = 19.3873 b_n = 19.3873 m_n = 19.3873 f(m_n) = -1.04144×10^{-7} ε_n = 5.96046×10^{-8}

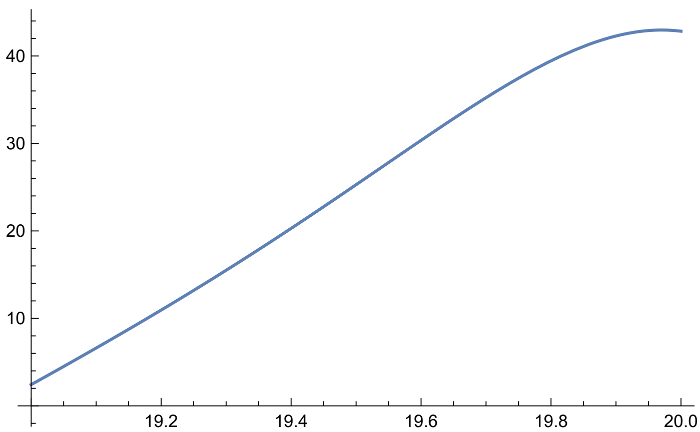
In[40]:= $\mathrm{Log2}\left[\frac{20.-19.}{0.0000001}\right]-1$

Out[40]=

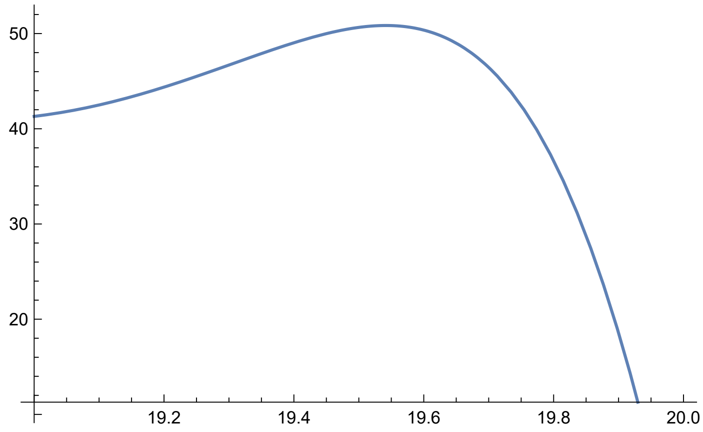
22.2535

In[42]:= **Plot[f'[x], {x, 19., 20.}]**

Out[42]=

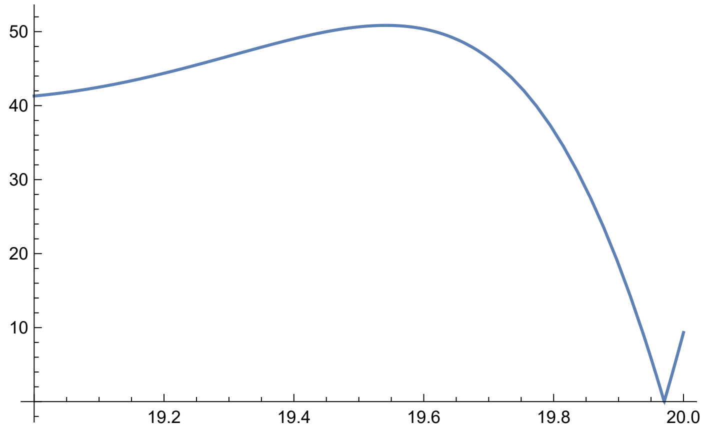


In[43]:=
```
Plot[f''[x], {x, 19., 20.}]
```
Out[43]=



In[44]:=
```
x0 = 19.
```
Out[44]=
```
19.
```

In[45]:=
```
Plot[Abs[f''[x]], {x, 19., 20.}]
```
Out[45]=



In[49]:=
```
M2 = Abs[f''[20.]]
```
Out[49]=
```
9.33048
```

In[47]:=
```
m1 = Abs[f'[19.]]
```
Out[47]=
```
2.42418
```

In[50]:=

$$P = \frac{M2}{2\,m1}$$

Out[50]=
```
1.92446
```

In[97]:=
```
f[x_] := (Sqrt[x^3] - 14*Sin[x])/(1 + Cos[x]^2) - 45
x0 = 19.;
M2 = Abs[f''[20.]];
m1 = Abs[f'[19.]];
P = M2/(2 m1);
epszad = 0.0000001;
eps = Infinity;
Print["n = ", 0, " xn = ", x0, " f(xn) = ", f[x0], " f'(xn) = ", f'[x0]]
For[n = 0, eps > epszad, n++,
 x1 = x0 - f[x0]/f'[x0];
 eps = P*Abs[x1 - x0]^2;
 x0 = x1;
 Print["n = ", n, " xn = ", x0,
  " f(xn) = ", f[x0], " f'(xn) = ", f'[x0], " εn = ", eps]
]
```

$$f[x\_] := \frac{\sqrt{x^3} - 14 * \mathrm{Sin}[x]}{1 + \mathrm{Cos}[x]^2} - 45$$

n = 0 x_n = 19. $f(x_n)$ = −4.18114 $f'(x_n)$ = 2.42418

n = 0 x_n = 20.7248 $f(x_n)$ = 29.3156 $f'(x_n)$ = −28.8815 ε_n = 5.72489

n = 1 x_n = 21.7398 $f(x_n)$ = 5.50297 $f'(x_n)$ = −1.94961 ε_n = 1.98274

n = 2 x_n = 24.5624 $f(x_n)$ = 30.6763 $f'(x_n)$ = −42.8066 ε_n = 15.3323

n = 3 x_n = 25.279 $f(x_n)$ = 18.2003 $f'(x_n)$ = 6.02293 ε_n = 0.988312

n = 4 x_n = 22.2572 $f(x_n)$ = 11.2876 $f'(x_n)$ = 25.4495 ε_n = 17.5731

n = 5 x_n = 21.8137 $f(x_n)$ = 5.49152 $f'(x_n)$ = 1.64363 ε_n = 0.378578

n = 6 x_n = 18.4726 $f(x_n)$ = 0.346913 $f'(x_n)$ = −20.1732 ε_n = 21.4826

n = 7 x_n = 18.4898 $f(x_n)$ = 0.00701639 $f'(x_n)$ = −19.3585 ε_n = 0.000569117

n = 8 x_n = 18.4901 $f(x_n)$ = 3.09693×10^{-6} $f'(x_n)$ = −19.3414 ε_n = 2.5281×10^{-7}

n = 9 x_n = 18.4901 $f(x_n)$ = 5.8975×10^{-13} $f'(x_n)$ = −19.3414 ε_n = 4.93397×10^{-14}

Zad 2

In[106]:=

$$A = \begin{pmatrix} 1+\frac{2}{7} & 0.05 & -0.1 \\ 0.2 & 1-\frac{1}{11} & 0 \\ 0.5 & 0 & 1+\frac{3}{13} \end{pmatrix}; \; b = \{9, 5, 5\};$$

```
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

За сравнение, точното решение е {6.94213, 3.97273, 1.24226}

In[108]:=

```
n = Length[A];
IM = IdentityMatrix[n];
B = IM - A;
c = b;
Print["Итерационният процес е x^(k+1) = ", B // MatrixForm, ". x^(k) + ", c // MatrixForm]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} -\frac{2}{7} & -0.05 & 0.1 \\ -0.2 & \frac{1}{11} & 0 \\ -0.5 & 0 & -\frac{3}{13} \end{pmatrix} . x^{(k)} + \begin{pmatrix} 9 \\ 5 \\ 5 \end{pmatrix}$

Normi

```
Max[Table[Sum[Abs[B[[i, j]]], {j, 1, n}], {i, n}]] (*purva*)
```

$$\mathrm{Max}\left[\mathrm{Table}\left[\sum_{j=1}^{n} \mathrm{Abs}[B[\![i, j]\!]], \{i, n\}\right]\right] \text{ (*purva*)}$$

Out[113]=

0.730769

$$\mathrm{Max}\left[\mathrm{Table}\left[\sum_{i=1}^{n} \mathrm{Abs}[B[\![i, j]\!]], \{j, n\}\right]\right] \text{ (*vtora*)}$$

Out[114]=

0.985714

$$\sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} B[\![i, j]\!]^2} \text{ (*treta*)}$$

Out[115]=

0.667571

In[123]:=

$$A = \begin{pmatrix} 1 + \frac{2}{7} & 0.05 & -0.1 \\ 0.2 & 1 - \frac{1}{11} & 0 \\ 0.5 & 0 & 1 + \frac{3}{13} \end{pmatrix}; \; b = \{9, 5, 5\};$$

```
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

За сравнение, точното решение е {6.94213, 3.97273, 1.24226}

In[125]:=

```
n = Length[A];
IM = IdentityMatrix[n];
B = IM - A;
c = b;
Print["Итерационният процес е x^(k+1) = ", B // MatrixForm, ". x^(k) + ", c // MatrixForm]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} -\frac{2}{7} & -0.05 & 0.1 \\ -0.2 & \frac{1}{11} & 0 \\ -0.5 & 0 & -\frac{3}{13} \end{pmatrix} . x^{(k)} + \begin{pmatrix} 9 \\ 5 \\ 5 \end{pmatrix}$

In[139]:=

```
x = {6, 1, 15};
```

In[135]:=

$$\text{normB} = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} B[[i, j]]^2}$$

Out[135]=

0.667571

In[140]:=

```
normx0 = Norm[x, 1];
normc = Norm[c, 1];
For[k = 0, k ≤ 5, k++,
 Print["k = ", k, " x^(k) = ", x, " ε_k = ", eps = normB^k (normx0 + normc/(1 - normB))];
 x = B.x + c
]
```

k = 0 $x^{(k)}$ = {6, 1, 15} ε_k = 79.1551

k = 1 $x^{(k)}$ = {8.73571, 3.89091, -1.46154} ε_k = 52.8417

k = 2 $x^{(k)}$ = {6.16338, 3.60658, 0.969421} ε_k = 35.2756

k = 3 $x^{(k)}$ = {7.15565, 4.09519, 1.6946} ε_k = 23.549

k = 4 $x^{(k)}$ = {6.92023, 3.94116, 1.03112} ε_k = 15.7206

k = 5 $x^{(k)}$ = {6.92885, 3.97424, 1.30194} ε_k = 10.4946

In[143]:=

$$\frac{\text{Log}\left[\frac{10^{-4}}{\text{normx0} + \frac{\text{normc}}{1-\text{normB}}}\right]}{\text{Log}[\text{normB}]}$$

Out[143]=

33.6091

Proverka

In[152]:=

$$A = \begin{pmatrix} 1+\frac{2}{7} & 0.05 & -0.1 \\ 0.2 & 1-\frac{1}{11} & 0 \\ 0.5 & 0 & 1+\frac{3}{13} \end{pmatrix}; \; b = \{9, 5, 5\};$$

```
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

За сравнение, точното решение е {6.94213, 3.97273, 1.24226}

In[154]:=

```
n = Length[A];
IM = IdentityMatrix[n];
B = IM - A;
c = b;
Print["Итерационният процес е x^(k+1) = ", B // MatrixForm, ". x^(k) + ", c // MatrixForm]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} -\frac{2}{7} & -0.05 & 0.1 \\ -0.2 & \frac{1}{11} & 0 \\ -0.5 & 0 & -\frac{3}{13} \end{pmatrix} . x^{(k)} + \begin{pmatrix} 9 \\ 5 \\ 5 \end{pmatrix}$

In[159]:=

```
x = {6, 1, 15};
```

In[∘]:= normB = $\sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} B[[i,j]]^2}$

In[160]:=

```
normx0 = Norm[x, 1];
normc = Norm[c, 1];
For[k = 0, k ≤ 40, k++,
 Print["k = ", k, " x^(k) = ", x, " ε_k = ", eps = normB^k (normx0 + normc/(1 - normB))];
 x = B.x + c
]
```

k = 0 $x^{(k)}$ = {6, 1, 15} ε_k = 79.1551

k = 1 $x^{(k)}$ = {8.73571, 3.89091, -1.46154} ε_k = 52.8417

k = 2 $x^{(k)}$ = {6.16338, 3.60658, 0.969421} ε_k = 35.2756

k = 3 $x^{(k)}$ = {7.15565, 4.09519, 1.6946} ε_k = 23.549

k = 4 $x^{(k)}$ = {6.92023, 3.94116, 1.03112} ε_k = 15.7206

k = 5 $x^{(k)}$ = {6.92885, 3.97424, 1.30194} ε_k = 10.4946

k = 6 $x^{(k)}$ = {6.95181, 3.97553, 1.23513} ε_k = 7.00592

k = 7 $x^{(k)}$ = {6.9385, 3.97105, 1.23906} ε_k = 4.67695

k = 8 $x^{(k)}$ = {6.94292, 3.9733, 1.24481} ε_k = 3.1222

k = 9 $x^{(k)}$ = {6.94212, 3.97262, 1.24127} ε_k = 2.08429

k = 10 $x^{(k)}$ = {6.94203, 3.97272, 1.24249} ε_k = 1.39141

k = 11 $x^{(k)}$ = {6.94218, 3.97275, 1.24226} ε_k = 0.928868

k = 12 $x^{(k)}$ = {6.94211, 3.97272, 1.24224} ε_k = 0.620086

k = 13 $x^{(k)}$ = {6.94213, 3.97273, 1.24227} ε_k = 0.413951

k = 14 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.276342

k = 15 $x^{(k)}$ = {6.94212, 3.97273, 1.24226} ε_k = 0.184478

k = 16 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.123152

k = 17 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0822129

k = 18 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.054883

k = 19 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0366383

k = 20 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0244587

k = 21 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0163279

k = 22 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0109001

k = 23 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00727657

k = 24 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00485763

k = 25 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00324281

k = 26 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00216481

k = 27 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00144516

k = 28 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00096475

k = 29 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00064404

k = 30 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.000429943

k = 31 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.000287017

k = 32 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.000191605

k = 33 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.00012791

k = 34 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0000853889

k = 35 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0000570032

k = 36 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0000380537

k = 37 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0000254036

k = 38 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0000169587

k = 39 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 0.0000113211

k = 40 $x^{(k)}$ = {6.94213, 3.97273, 1.24226} ε_k = 7.55766×10^{-6}

In[147]:=

$$\frac{\text{Log}\left[\frac{10^{-7}}{\text{normx0}+\frac{\text{normc}}{1-\text{normB}}}\right]}{\text{Log}[\text{normB}]}$$

Out[147]=

50.3745

Zad4

In[199]:=

```
a = 0.; b = 0.5;
x = a;
y = 4.;
f[x_, y_] := y - 10 * Sin[x];
```

In[203]:=

```
n = 16;
```

In[204]:=

$$h = \frac{b-a}{n};$$

In[205]:=

```
Print["Мрежата е с n = ", n, " и стъпка h = ", h]
(*Изчисляваме теоретичната грешка*)
Print["Теоретичната локална  грешка е ", h^2]
Print["Теоретичната глобална грешка е ", h]
(*намираме неизвестните стойности за y_i*)
For[i = 0, i ≤ n, i++,
 Print["i = ", i, " x_i = ", x, " y_i = ", y, " f_i = ", f[x, y]];
 y = y + h * f[x, y];
 x = x + h
]
```

Мрежата е с n = 16 и стъпка h = 0.03125

Теоретичната локална грешка е 0.000976563

Теоретичната глобална грешка е 0.03125

i = 0 x_i = 0. y_i = 4. f_i = 4.

i = 1 x_i = 0.03125 y_i = 4.125 f_i = 3.81255

i = 2 x_i = 0.0625 y_i = 4.24414 f_i = 3.61955

i = 3 x_i = 0.09375 y_i = 4.35725 f_i = 3.42113

i = 4 x_i = 0.125 y_i = 4.46416 f_i = 3.21742

i = 5 x_i = 0.15625 y_i = 4.56471 f_i = 3.00856

i = 6 x_i = 0.1875 y_i = 4.65872 f_i = 2.79469

i = 7 x_i = 0.21875 y_i = 4.74606 f_i = 2.57596

i = 8 x_i = 0.25 y_i = 4.82656 f_i = 2.35252

i = 9 x_i = 0.28125 y_i = 4.90007 f_i = 2.12451

i = 10 x_i = 0.3125 y_i = 4.96646 f_i = 1.89208

i = 11 x_i = 0.34375 y_i = 5.02559 f_i = 1.65539

i = 12 x_i = 0.375 y_i = 5.07732 f_i = 1.4146

i = 13 x_i = 0.40625 y_i = 5.12153 f_i = 1.16986

i = 14 x_i = 0.4375 y_i = 5.15809 f_i = 0.921325

i = 15 x_i = 0.46875 y_i = 5.18688 f_i = 0.669164

i = 16 x_i = 0.5 y_i = 5.20779 f_i = 0.413535

Tochno reshenie

Obshto

In[188]:=

```
Clear[x, y]
DSolve[y'[x] == y[x] - 10 * Sin[x], y[x], x]
```

Out[189]=

$\{\{y[x] \to e^x c_1 + 5 (\text{Cos}[x] + \text{Sin}[x])\}\}$

Chastno

In[190]:=

```
Clear[x, y]
DSolve[{y'[x] == y[x] - 10 * Sin[x], y[0] == 4}, y[x], x]
```

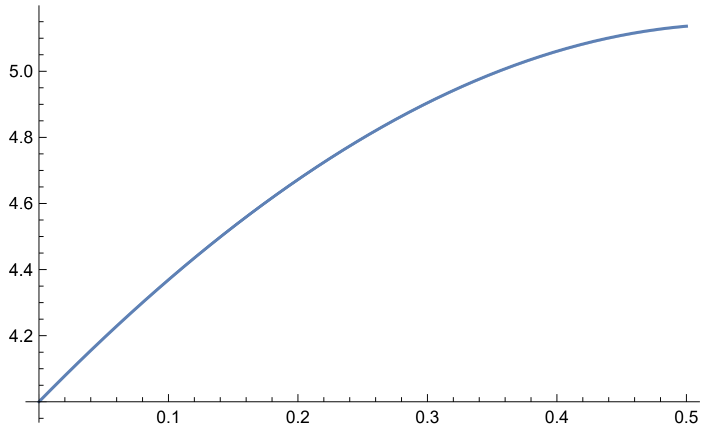
Out[191]=

$\{\{y[x] \to -e^x + 5\,\text{Cos}[x] + 5\,\text{Sin}[x]\}\}$

In[193]:=

```
yt[x_] := -e^x + 5 Cos[x] + 5 Sin[x]
```

In[194]:=
```
Plot[yt[x], {x, 0., 0.5}]
```
Out[194]=



Modificiran Metod na Oller

In[217]:=
```
a = 0.; b = 0.5;
x = a;
y = 4.;
f[x_, y_] := y - 10 * Sin[x];
```
In[209]:=
```
points = {{x, y}};
```
In[ ]:=
```
n = 16;
```
In[221]:=

$$h = \frac{b - a}{n};$$

In[226]:=
```
Print["Мрежата е с n = ", n, " и стъпка h = ", h]
(*Изчисляваме теоретичната грешка*)
Print["Теоретичната локална  грешка е ", h^3]
Print["Теоретичната глобална грешка е ", h^2]
```
```
Мрежата е с n = 16 и стъпка h = 0.03125
Теоретичната локална  грешка е 0.0000305176
Теоретичната глобална грешка е 0.000976563
```

In[222]:=

```
For[i = 0, i ≤ n, i++,
 x12 = x + h/2;
 y12 = y + h/2 * f[x, y];
 Print["i = ", i, " x_i = ", x, " y_i = ", y, " f_i = ",
  f[x, y], " x_{i+1/2} = ", x12, " y_{i+1/2} = ", y12, " f_{i+1/2} = ", f[x12, y12],
  " y_точно = ", yt[x], " истинска грешка = ", Abs[y - yt[x]]];
 y = y + h * f[x12, y12];
 x = x + h;
 AppendTo[points, {x, y}]
]
(*визуализация на резултатите*)
gryt = Plot[yt[x], {x, 0., 0.5}, PlotStyle → Red];
grp = ListPlot[points, PlotStyle → Black];
Show[gryt, grp]
```

i = 0 x_i = 0. y_i = 4. f_i = 4. $x_{i+1/2}$ = 0.015625
$y_{i+1/2}$ = 4.0625 $f_{i+1/2}$ = 3.90626 $y_{точно}$ = 4. истинска грешка = 0.

i = 1 x_i = 0.03125 y_i = 4.12207 f_i = 3.80962 $x_{i+1/2}$ = 0.046875 $y_{i+1/2}$ = 4.1816 $f_{i+1/2}$ = 3.71302 $y_{точно}$ = 4.12204 истинска грешка = 0.0000305563

i = 2 x_i = 0.0625 y_i = 4.2381 f_i = 3.61351 $x_{i+1/2}$ = 0.078125 $y_{i+1/2}$ = 4.29456 $f_{i+1/2}$ = 3.51411 $y_{точно}$ = 4.23804 истинска грешка = 0.0000626239

i = 3 x_i = 0.09375 y_i = 4.34792 f_i = 3.41179 $x_{i+1/2}$ = 0.109375 $y_{i+1/2}$ = 4.40123 $f_{i+1/2}$ = 3.30966 $y_{точно}$ = 4.34782 истинска грешка = 0.0000962306

i = 4 x_i = 0.125 y_i = 4.45134 f_i = 3.2046 $x_{i+1/2}$ = 0.140625 $y_{i+1/2}$ = 4.50142 $f_{i+1/2}$ = 3.0998 $y_{точно}$ = 4.45121 истинска грешка = 0.000131405

i = 5 x_i = 0.15625 y_i = 4.54821 f_i = 2.99206 $x_{i+1/2}$ = 0.171875 $y_{i+1/2}$ = 4.59496 $f_{i+1/2}$ = 2.88466 $y_{точно}$ = 4.54805 истинска грешка = 0.000168177

i = 6 x_i = 0.1875 y_i = 4.63836 f_i = 2.77433 $x_{i+1/2}$ = 0.203125 $y_{i+1/2}$ = 4.68171 $f_{i+1/2}$ = 2.6644 $y_{точно}$ = 4.63815 истинска грешка = 0.000206576

i = 7 x_i = 0.21875 y_i = 4.72162 f_i = 2.55153 $x_{i+1/2}$ = 0.234375 $y_{i+1/2}$ = 4.76149 $f_{i+1/2}$ = 2.43914 $y_{точно}$ = 4.72138 истинска грешка = 0.000246633

i = 8 x_i = 0.25 y_i = 4.79784 f_i = 2.32381 $x_{i+1/2}$ = 0.265625 $y_{i+1/2}$ = 4.83415 $f_{i+1/2}$ = 2.20903 $y_{точно}$ = 4.79756 истинска грешка = 0.000288381

i = 9 x_i = 0.28125 y_i = 4.86688 f_i = 2.09131 $x_{i+1/2}$ = 0.296875 $y_{i+1/2}$ = 4.89955 $f_{i+1/2}$ = 1.97422 $y_{точно}$ = 4.86655 истинска грешка = 0.000331852

i = 10 x_i = 0.3125 y_i = 4.92857 f_i = 1.85419 $x_{i+1/2}$ = 0.328125 $y_{i+1/2}$ = 4.95754 $f_{i+1/2}$ = 1.73486 $y_{точно}$ = 4.92819 истинска грешка = 0.000377081

i = 11 x_i = 0.34375 y_i = 4.98279 f_i = 1.61259 $x_{i+1/2}$ = 0.359375 $y_{i+1/2}$ = 5.00798 $f_{i+1/2}$ = 1.49109 $y_{точно}$ = 4.98236 истинска грешка = 0.000424103

i = 12 x_i = 0.375 y_i = 5.02938 f_i = 1.36666 $x_{i+1/2}$ = 0.390625 $y_{i+1/2}$ = 5.05074 $f_{i+1/2}$ = 1.24307 $y_{точно}$ = 5.02891 истинска грешка = 0.000472953

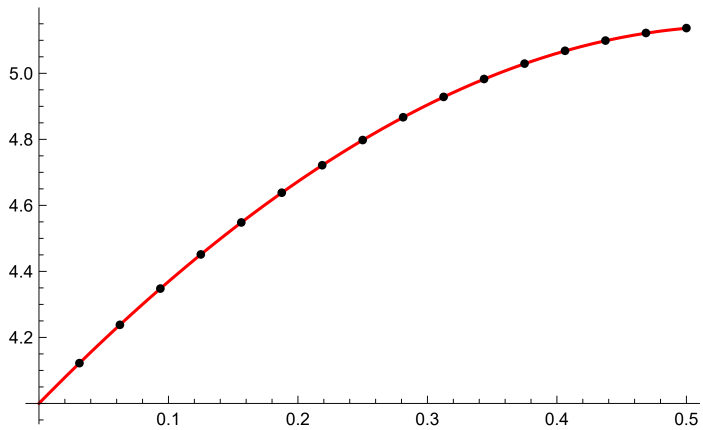
i = 13 x_i = 0.40625 y_i = 5.06823 f_i = 1.11655 $x_{i+1/2}$ = 0.421875 $y_{i+1/2}$ = 5.08567 $f_{i+1/2}$ = 0.990957 $y_{точно}$ = 5.0677 истинска грешка = 0.00052367

i = 14 x_i = 0.4375 y_i = 5.0992 f_i = 0.862433 $x_{i+1/2}$ = 0.453125 $y_{i+1/2}$ = 5.11267 $f_{i+1/2}$ = 0.734898 $y_{точно}$ = 5.09862 истинска грешка = 0.000576293

i = 15 x_i = 0.46875 y_i = 5.12216 f_i = 0.604447 $x_{i+1/2}$ = 0.484375 $y_{i+1/2}$ = 5.13161 $f_{i+1/2}$ = 0.475052 $y_{точно}$ = 5.12153 истинска грешка = 0.000630861

i = 16 x_i = 0.5 y_i = 5.13701 f_i = 0.342751 $x_{i+1/2}$ = 0.515625 $y_{i+1/2}$ = 5.14236 $f_{i+1/2}$ = 0.211575 $y_{точно}$ = 5.13632 истинска грешка = 0.000687417

Out[225]=



Zad3

In[229]:=

```
xt = Table[9 + q * (0.5), {q, -5, 5}]
```

Out[229]=

```
{6.5, 7., 7.5, 8., 8.5, 9., 9.5, 10., 10.5, 11., 11.5}
```

In[230]:=

```
bigN = Length[xt]
```

Out[230]=

```
11
```

In[231]:=

```
f[x_] := x - 3 * Cos[x]
```

In[232]:=

```
yt = f[xt]
```

Out[232]=

```
{3.57024, 4.73829, 6.46009, 8.4365, 10.306,
 11.7334, 12.4915, 12.5172, 11.9266, 10.9867, 10.0501}
```

In[233]:=

xt^2

Out[233]=

```
{42.25, 49., 56.25, 64., 72.25, 81., 90.25, 100., 110.25, 121., 132.25}
```

In[234]:=

```
yt * xt
```

Out[234]=

```
{23.2065, 33.1681, 48.4507, 67.492, 87.6013,
 105.601, 118.669, 125.172, 125.229, 120.854, 115.576}
```

In[235]:=

xt^3

Out[235]=

```
{274.625, 343., 421.875, 512., 614.125, 729., 857.375, 1000., 1157.63, 1331., 1520.88}
```

In[236]:=

xt^4

Out[236]=

```
{1785.06, 2401., 3164.06, 4096., 5220.06,
 6561., 8145.06, 10000., 12155.1, 14641., 17490.1}
```

In[237]:=

$yt * xt^2$

Out[237]=

```
{150.843, 232.176, 363.38, 539.936, 744.611,
 950.405, 1127.36, 1251.72, 1314.91, 1329.39, 1329.12}
```

In[238]:=

$$\sum_{i=1}^{bigN} xt[[i]]$$

Out[238]=

```
99.
```

In[239]:=

$$\sum_{i=1}^{bigN} yt[[i]]$$

Out[239]=

103.217

In[240]:=

$$\sum_{i=1}^{bigN} xt[[i]]^2$$

Out[240]=

918.5

In[241]:=

$$\sum_{i=1}^{bigN} yt[[i]] * xt[[i]]$$

Out[241]=

971.02

In[242]:=

$$\sum_{i=1}^{bigN} xt[[i]]^3$$

Out[242]=

8761.5

In[243]:=

$$\sum_{i=1}^{bigN} xt[[i]]^4$$

Out[243]=

85 658.4

In[244]:=

$$\sum_{i=1}^{bigN} yt[[i]] * xt[[i]]^2$$

Out[244]=

9333.86

In[250]:=

$$A = \begin{pmatrix} 11 & 99. & 918.5 \\ 99. & 918.5 & 8761.5 \\ 918.5 & 8761.5 & 85658.4 \end{pmatrix}; \; b = \{103.217, 971.02, 9333.86\};$$

```
LinearSolve[A, b]
```

Out[251]=

{-65.7874, 15.6095, -0.782209}

In[253]:=

$$P2[x\_] := -0.782209\, x^2 + 15.6095\, x - 65.7874$$

In[254]:=

```
grP2 = Plot[P2[x], {x, xt⟦1⟧ - 0.2, xt⟦bigN⟧ + 0.2}, PlotStyle → Green]
```

Out[254]=