Метод на последователните приближения за решаване на СЛАУ

In[145]:=

```
A = (1.1  0.02 -0.12
     0.13 0.98 -0.01
     0    0.01  1.2); b = {6.5, 12, -21.2};
Print["За сравнение точното решение е ", LinearSolve[A, b]]
```

За сравнение точното решение е {3.76104, 11.5647, -17.763}

Построяване на метода

In[149]:=

```
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 $x^{(k+1)} = \begin{pmatrix} -0.1 & -0.02 & 0.12 \\ -0.13 & 0.02 & 0.01 \\ 0 & -0.01 & -0.2 \end{pmatrix} . x^{(k)} + \begin{pmatrix} 6.5 \\ 12 \\ -21.2 \end{pmatrix}$

Пояснения във Wolfram

In[147]:=

```
E
```

Out[147]=

e

In[148]:=

```
IdentityMatrix[3] // MatrixForm
```

Out[148]//MatrixForm=

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

Проверка за сходимост ||B|| < 1

първа норма

In[154]:=

$$\text{Max}\left[\text{Table}\left[\sum_{j=1}^{n}\text{Abs}[B[[i, j]]], \{i, n\}\right]\right]$$

Out[154]=

0.24

втора норма

In[155]:=

$$\text{Max}\left[\text{Table}\left[\sum_{i=1}^{n}\text{Abs}[B[[i, j]]], \{j, n\}\right]\right]$$

Out[155]=

0.33

трета норма

In[156]:=

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

Out[156]=

0.28688

Избираме най-малката възможна норма, която в случая е **първа**.

Нормата на матрицата B е по-малка от 1, следователно процесът ще е сходящ при всеки избор на начално приближение.

Извършване на итерациите - окончателен код в една клетка

In[284]:=

```
A = (1.1   0.02  -0.12
     0.13  0.98  -0.01
     0     0.01   1.2 ); b = {6.5, 12, -21.2};

n = Length[A];
IM = IdentityMatrix[n];
B = IM - A;
c = b;
Print["Итерационният процес е x^(k+1) = ",
 B // MatrixForm, ". x^(k) + ", c // MatrixForm]
x = {9, 12, 1/2}; (*изборът на начално приближение е произволен*)
(*изчисляваме нормите според избора на норма,
който сме направили по време на проверка на условието на сходимост*)
normB = Max[Table[Sum[Abs[B[[i, j]]], {j, 1, n}], {i, n}]];
Print["Нормата на B е ", normB]
normx0 = Max[Abs[x]];
normc = Max[Abs[c]];
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
]
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} -0.1 & -0.02 & 0.12 \\ -0.13 & 0.02 & 0.01 \\ 0 & -0.01 & -0.2 \end{pmatrix} . \; x^{(k)} + \begin{pmatrix} 6.5 \\ 12 \\ -21.2 \end{pmatrix}$

Нормата на B е 0.24

k = 0 $x^{(k)}$ = $\{9, 12, \frac{1}{2}\}$ ε_k = 39.8947

k = 1 $x^{(k)}$ = {5.42, 11.075, -21.42} ε_k = 9.57474

k = 2 $x^{(k)}$ = {3.1661, 11.3027, -17.0268} ε_k = 2.29794

k = 3 $x^{(k)}$ = {3.91413, 11.6442, -17.9077} ε_k = 0.551505

k = 4 $x^{(k)}$ = {3.72678, 11.545, -17.7349} ε_k = 0.132361

k = 5 $x^{(k)}$ = {3.76823, 11.5691, -17.7685} ε_k = 0.0317667

За сравнение, точното решение е {3.76104, 11.5647, -17.763}

Определяне на брой итерации за достигане на

предварително зададена точност 10^{-6}

In[297]:=

$$\frac{\text{Log}\left[\frac{10^{-6}}{\text{normx0}+\frac{\text{normc}}{1-\text{normB}}}\right]}{\text{Log}[\text{normB}]}$$

Out[297]=

12.2637

Извод: Необходими са 13 на брой итерации.

За сравнение и проверка пускаме итерациите:

In[298]:=

$$A = \begin{pmatrix} 1.1 & 0.02 & -0.12 \\ 0.13 & 0.98 & -0.01 \\ 0 & 0.01 & 1.2 \end{pmatrix}; \; b = \{6.5, 12, -21.2\};$$

```
n = Length[A];
IM = IdentityMatrix[n];
B = IM - A;
c = b;
Print["Итерационният процес е x^(k+1) = ",
 B // MatrixForm, ". x^(k) + ", c // MatrixForm]
x = {9, 12, 1/2}; (*изборът на начално приближение е произволен*)
(*изчисляваме нормите според избора на норма,
който сме направили по време на проверка на условието на сходимост*)
normB = Max[Table[Sum[Abs[B[[i, j]]], {j, 1, n}], {i, n}]];
Print["Нормата на B е ", normB]
normx0 = Max[Abs[x]];
normc = Max[Abs[c]];
For[k = 0, k ≤ 13, k++,
 Print["k = ", k, " x^(k) = ", x, " ε_k = ", eps = normB^k (normx0 + normc/(1 - normB))];
 x = B.x + c
]
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} -0.1 & -0.02 & 0.12 \\ -0.13 & 0.02 & 0.01 \\ 0 & -0.01 & -0.2 \end{pmatrix} . x^{(k)} + \begin{pmatrix} 6.5 \\ 12 \\ -21.2 \end{pmatrix}$

Нормата на B е 0.24

$k = 0$ $x^{(k)} = \left\{9, 12, \frac{1}{2}\right\}$ $\varepsilon_k = 39.8947$

$k = 1$ $x^{(k)} = \{5.42, 11.075, -21.42\}$ $\varepsilon_k = 9.57474$

$k = 2$ $x^{(k)} = \{3.1661, 11.3027, -17.0268\}$ $\varepsilon_k = 2.29794$

$k = 3$ $x^{(k)} = \{3.91413, 11.6442, -17.9077\}$ $\varepsilon_k = 0.551505$

$k = 4$ $x^{(k)} = \{3.72678, 11.545, -17.7349\}$ $\varepsilon_k = 0.132361$

$k = 5$ $x^{(k)} = \{3.76823, 11.5691, -17.7685\}$ $\varepsilon_k = 0.0317667$

$k = 6$ $x^{(k)} = \{3.75958, 11.5638, -17.762\}$ $\varepsilon_k = 0.007624$

$k = 7$ $x^{(k)} = \{3.76133, 11.5649, -17.7632\}$ $\varepsilon_k = 0.00182976$

$k = 8$ $x^{(k)} = \{3.76098, 11.5647, -17.763\}$ $\varepsilon_k = 0.000439143$

$k = 9$ $x^{(k)} = \{3.76105, 11.5647, -17.763\}$ $\varepsilon_k = 0.000105394$

$k = 10$ $x^{(k)} = \{3.76103, 11.5647, -17.763\}$ $\varepsilon_k = 0.0000252946$

$k = 11$ $x^{(k)} = \{3.76104, 11.5647, -17.763\}$ $\varepsilon_k = 6.07071 \times 10^{-6}$

$k = 12$ $x^{(k)} = \{3.76104, 11.5647, -17.763\}$ $\varepsilon_k = 1.45697 \times 10^{-6}$

$k = 13$ $x^{(k)} = \{3.76104, 11.5647, -17.763\}$ $\varepsilon_k = 3.49673 \times 10^{-7}$

За сравнение, точното решение е $\{3.76104, 11.5647, -17.763\}$

Пример за разходящ процес

In[182]:=

```
A = {{11, 0.02, -0.12}, {0.13, 98, -0.01}, {0, 0.01, 12}}; b = {6.5, 12, -21.2};

n = Length[A];
IM = IdentityMatrix[n];
B = IM - A;
c = b;
Print["Итерационният процес е x^(k+1) = ",
 B // MatrixForm, ". x^(k) + ", c // MatrixForm]
x = {9, 12, 1/2}; (*изборът на начално приближение е произволен*)
(*изчисляваме нормите според избора на норма,
който сме направили по време на проверка на условието на сходимост*)
normB = Max[Table[Sum[Abs[B[[i, j]]], {j, 1, n}], {i, n}]];
Print["Нормата на B е ", normB]
normx0 = Max[Abs[x]];
normc = Max[Abs[c]];
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
]
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} -10 & -0.02 & 0.12 \\ -0.13 & -97 & 0.01 \\ 0 & -0.01 & -11 \end{pmatrix} . x^{(k)} + \begin{pmatrix} 6.5 \\ 12 \\ -21.2 \end{pmatrix}$

Нормата на B е 97.14

k = 0 $x^{(k)} = \left\{9, 12, \frac{1}{2}\right\}$ $\varepsilon_k = 11.7795$

k = 1 $x^{(k)} = \{-83.68, -1153.17, -26.82\}$ $\varepsilon_k = 1144.26$

k = 2 $x^{(k)} = \{863.145, 111880., 285.352\}$ $\varepsilon_k = 111153.$

k = 3 $x^{(k)} = \{-10828.3, -1.08524\times10^{7}, -4278.86\}$ $\varepsilon_k = 1.07974\times10^{7}$

k = 4 $x^{(k)} = \{324824., 1.05269\times10^{9}, 155571.\}$ $\varepsilon_k = 1.04886\times10^{9}$

k = 5 $x^{(k)} = \{-2.42833\times10^{7}, -1.02111\times10^{11}, -1.22382\times10^{7}\}$ $\varepsilon_k = 1.01887\times10^{11}$

За сравнение, точното решение е {0.571414, 0.121511, -1.76677}

Модификация на метода при положително определена матрица A

Проверка на приложимостта на модификацията

In[280]:=

$$A = \begin{pmatrix} 11 & 0.02 & -0.12 \\ 0.13 & 98 & -0.01 \\ 0 & 0.01 & 12 \end{pmatrix};$$

```
PositiveDefiniteMatrixQ[A]
```

Out[281]=

```
True
```

Определяне стойността на ρ

In[195]:=

```
Norm[A]
```

Out[195]=

```
98.0001
```

In[282]:=

```
ro = 200
```

Out[282]=

```
200
```

итерациите

In[311]:=

```
A = (11    0.02  -0.12
     0.13  98    -0.01
     0     0.01   12  ); b = {6.5, 12, -21.2};

n = Length[A];
IM = IdentityMatrix[n];
ro = 200;
B = IM - 2/ro A;
c = 2/ro b;
Print["Итерационният процес е x^(k+1) = ",
 B // MatrixForm, ". x^(k) + ", c // MatrixForm]
x = {9, 12, 1/2}; (*изборът на начално приближение е произволен*)
(*изчисляваме нормите според избора на норма,
който сме направили по време на проверка на условието на сходимост*)
normB = Max[Table[Sum[Abs[B[[i, j]]], {j, 1, n}], {i, n}]];
Print["Нормата на B e ", normB]
normx0 = Max[Abs[x]];
normc = Max[Abs[c]];
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
]
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} \frac{89}{100} & -0.0002 & 0.0012 \\ -0.0013 & \frac{1}{50} & 0.0001 \\ 0 & -0.0001 & \frac{22}{25} \end{pmatrix} . x^{(k)} + \begin{pmatrix} 0.065 \\ \frac{3}{25} \\ -0.212 \end{pmatrix}$

Нормата на B e 0.8914

k = 0 $x^{(k)} = \left\{9, 12, \frac{1}{2}\right\}$ $\varepsilon_k = 13.9521$

k = 1 $x^{(k)}$ = {8.0732, 0.34835, 0.2268} ε_k = 12.4369

k = 2 $x^{(k)}$ = {7.25035, 0.116495, -0.0124508} ε_k = 11.0863

k = 3 $x^{(k)}$ = {6.51777, 0.112903, -0.222968} ε_k = 9.8823

k = 4 $x^{(k)}$ = {5.86553, 0.113763, -0.408223} ε_k = 8.80908

k = 5 $x^{(k)}$ = {5.28481, 0.114609, -0.571248} ε_k = 7.85242

За сравнение, точното решение е {0.571414, 0.121511, -1.76677}

In[325]:=

$$\frac{\text{Log}\left[\frac{10^{-6}}{\text{normx0}+\frac{\text{normc}}{1-\text{normB}}}\right]}{\text{Log}[\text{normB}]}$$

Out[325]=

143.101

In[326]:=

```
A = ( 11    0.02  -0.12
      0.13  98    -0.01
      0     0.01   12  ); b = {6.5, 12, -21.2};

n = Length[A];
IM = IdentityMatrix[n];
ro = 200;
B = IM - 2/ro A;
c = 2/ro b;
Print["Итерационният процес е x^(k+1) = ",
 B // MatrixForm, ". x^(k) + ", c // MatrixForm]
x = {9, 12, 1/2}; (*изборът на начално приближение е произволен*)
(*изчисляваме нормите според избора на норма,
който сме направили по време на проверка на условието на сходимост*)
normB = Max[Table[Sum[Abs[B[[i, j]]], {j, 1, n}], {i, n}]];
Print["Нормата на B е ", normB]
normx0 = Max[Abs[x]];
normc = Max[Abs[c]];
For[k = 0, k ≤ 144, k++,
 Print["k = ", k, " x^(k) = ", x, " ε_k = ", eps = normB^k (normx0 + normc/(1 - normB))];
 x = B.x + c
]
Print["За сравнение, точното решение е ", LinearSolve[A, b]]
```

Итерационният процес е $x^{(k+1)} = \begin{pmatrix} \frac{89}{100} & -0.0002 & 0.0012 \\ -0.0013 & \frac{1}{50} & 0.0001 \\ 0 & -0.0001 & \frac{22}{25} \end{pmatrix} . x^{(k)} + \begin{pmatrix} 0.065 \\ \frac{3}{25} \\ -0.212 \end{pmatrix}$

Нормата на B е 0.8914

$k = 0$ $x^{(k)} = \left\{9, 12, \frac{1}{2}\right\}$ $\varepsilon_k = 13.9521$

$k = 1$ $x^{(k)} = \{8.0732, 0.34835, 0.2268\}$ $\varepsilon_k = 12.4369$

$k = 2$ $x^{(k)} = \{7.25035, 0.116495, -0.0124508\}$ $\varepsilon_k = 11.0863$

$k = 3$ $x^{(k)} = \{6.51777, 0.112903, -0.222968\}$ $\varepsilon_k = 9.8823$

$k = 4$ $x^{(k)} = \{5.86553, 0.113763, -0.408223\}$ $\varepsilon_k = 8.80908$

k = 5 $x^{(k)}$ = {5.28481, 0.114609, -0.571248} ε_k = 7.85242

k = 6 $x^{(k)}$ = {4.76777, 0.115365, -0.71471} ε_k = 6.99964

k = 7 $x^{(k)}$ = {4.30743, 0.116038, -0.840956} ε_k = 6.23948

k = 8 $x^{(k)}$ = {3.89758, 0.116637, -0.952053} ε_k = 5.56187

k = 9 $x^{(k)}$ = {3.53268, 0.117171, -1.04982} ε_k = 4.95785

k = 10 $x^{(k)}$ = {3.20781, 0.117646, -1.13585} ε_k = 4.41943

k = 11 $x^{(k)}$ = {2.91856, 0.118069, -1.21156} ε_k = 3.93948

k = 12 $x^{(k)}$ = {2.66104, 0.118446, -1.27819} ε_k = 3.51165

k = 13 $x^{(k)}$ = {2.43177, 0.118782, -1.33682} ε_k = 3.13029

k = 14 $x^{(k)}$ = {2.22765, 0.119081, -1.38841} ε_k = 2.79034

k = 15 $x^{(k)}$ = {2.04592, 0.119347, -1.43381} ε_k = 2.48731

k = 16 $x^{(k)}$ = {1.88412, 0.119584, -1.47377} ε_k = 2.21719

k = 17 $x^{(k)}$ = {1.74008, 0.119795, -1.50893} ε_k = 1.9764

k = 18 $x^{(k)}$ = {1.61183, 0.119983, -1.53987} ε_k = 1.76176

k = 19 $x^{(k)}$ = {1.49766, 0.12015, -1.5671} ε_k = 1.57044

k = 20 $x^{(k)}$ = {1.39601, 0.120299, -1.59106} ε_k = 1.39989

k = 21 $x^{(k)}$ = {1.30552, 0.120432, -1.61214} ε_k = 1.24786

k = 22 $x^{(k)}$ = {1.22495, 0.12055, -1.6307} ε_k = 1.11234

k = 23 $x^{(k)}$ = {1.15323, 0.120655, -1.64702} ε_k = 0.991541

k = 24 $x^{(k)}$ = {1.08937, 0.120749, -1.66139} ε_k = 0.88386

k = 25 $x^{(k)}$ = {1.03252, 0.120833, -1.67404} ε_k = 0.787872

k = 26 $x^{(k)}$ = {0.981912, 0.120907, -1.68517} ε_k = 0.702309

k = 27 $x^{(k)}$ = {0.936855, 0.120973, -1.69496} ε_k = 0.626039

k = 28 $x^{(k)}$ = {0.896743, 0.121032, -1.70358} ε_k = 0.558051

k = 29 $x^{(k)}$ = {0.861033, 0.121085, -1.71116} ε_k = 0.497447

k = 30 $x^{(k)}$ = {0.829241, 0.121131, -1.71783} ε_k = 0.443424

k = 31 $x^{(k)}$ = {0.800939, 0.121173, -1.7237} ε_k = 0.395268

k = 32 $x^{(k)}$ = {0.775743, 0.12121, -1.72887} ε_k = 0.352342

k = 33 $x^{(k)}$ = {0.753313, 0.121243, -1.73342} ε_k = 0.314078

k = 34 $x^{(k)}$ = {0.733344, 0.121272, -1.73742} ε_k = 0.279969

k = 35 $x^{(k)}$ = {0.715567, 0.121298, -1.74094} ε_k = 0.249564

k = 36 $x^{(k)}$ = {0.699741, 0.121322, -1.74404} ε_k = 0.222461

k = 37 $x^{(k)}$ = {0.685652, 0.121342, -1.74677} ε_k = 0.198302

k = 38 $x^{(k)}$ = {0.67311, 0.121361, -1.74917} ε_k = 0.176767

k = 39 $x^{(k)}$ = {0.661945, 0.121377, -1.75128} ε_k = 0.15757

k = 40 $x^{(k)}$ = {0.652005, 0.121392, -1.75314} ε_k = 0.140458

k = 41 $x^{(k)}$ = {0.643157, 0.121405, -1.75477} ε_k = 0.125204

k = 42 $x^{(k)}$ = {0.635279, 0.121417, -1.75621} ε_k = 0.111607

k = 43 $x^{(k)}$ = {0.628267, 0.121427, -1.75748} ε_k = 0.0994863

k = 44 $x^{(k)}$ = {0.622024, 0.121436, -1.75859} ε_k = 0.0886821

k = 45 $x^{(k)}$ = {0.616467, 0.121444, -1.75958} ε_k = 0.0790512

k = 46 $x^{(k)}$ = {0.61152, 0.121452, -1.76044} ε_k = 0.0704662

k = 47 $x^{(k)}$ = {0.607116, 0.121458, -1.7612} ε_k = 0.0628136

k = 48 $x^{(k)}$ = {0.603195, 0.121464, -1.76187} ε_k = 0.055992

k = 49 $x^{(k)}$ = {0.599705, 0.121469, -1.76245} ε_k = 0.0499113

k = 50 $x^{(k)}$ = {0.596599, 0.121474, -1.76297} ε_k = 0.0444909

k = 51 $x^{(k)}$ = {0.593833, 0.121478, -1.76343} ε_k = 0.0396592

k = 52 $x^{(k)}$ = {0.591371, 0.121481, -1.76383} ε_k = 0.0353522

k = 53 $x^{(k)}$ = {0.589179, 0.121484, -1.76418} ε_k = 0.031513

k = 54 $x^{(k)}$ = {0.587228, 0.121487, -1.76449} ε_k = 0.0280907

k = 55 $x^{(k)}$ = {0.585491, 0.12149, -1.76476} ε_k = 0.02504

k = 56 $x^{(k)}$ = {0.583945, 0.121492, -1.76501} ε_k = 0.0223207

k = 57 $x^{(k)}$ = {0.582569, 0.121494, -1.76522} ε_k = 0.0198967

k = 58 $x^{(k)}$ = {0.581344, 0.121496, -1.7654} ε_k = 0.0177359

k = 59 $x^{(k)}$ = {0.580253, 0.121498, -1.76557} ε_k = 0.0158098

k = 60 $x^{(k)}$ = {0.579282, 0.121499, -1.76571} ε_k = 0.0140928

k = 61 $x^{(k)}$ = {0.578418, 0.1215, -1.76584} ε_k = 0.0125623

k = 62 $x^{(k)}$ = {0.577649, 0.121501, -1.76595} ε_k = 0.0111981

k = 63 $x^{(k)}$ = {0.576964, 0.121502, -1.76605} ε_k = 0.00998196

k = 64 $x^{(k)}$ = {0.576354, 0.121503, -1.76613} ε_k = 0.00889792

k = 65 $x^{(k)}$ = {0.575812, 0.121504, -1.76621} ε_k = 0.0079316

k = 66 $x^{(k)}$ = {0.575329, 0.121505, -1.76628} ε_k = 0.00707023

k = 67 $x^{(k)}$ = {0.574899, 0.121506, -1.76634} ε_k = 0.00630241

k = 68 $x^{(k)}$ = {0.574516, 0.121506, -1.76639} ε_k = 0.00561796

k = 69 $x^{(k)}$ = {0.574175, 0.121507, -1.76643} ε_k = 0.00500785

k = 70 $x^{(k)}$ = {0.573872, 0.121507, -1.76647} ε_k = 0.004464

k = 71 $x^{(k)}$ = {0.573602, 0.121507, -1.76651} ε_k = 0.00397921

k = 72 $x^{(k)}$ = {0.573362, 0.121508, -1.76654} ε_k = 0.00354707

k = 73 $x^{(k)}$ = {0.573148, 0.121508, -1.76657} ε_k = 0.00316186

k = 74 $x^{(k)}$ = {0.572957, 0.121508, -1.76659} ε_k = 0.00281848

k = 75 $x^{(k)}$ = {0.572788, 0.121509, -1.76661} ε_k = 0.00251239

k = 76 $x^{(k)}$ = {0.572637, 0.121509, -1.76663} ε_k = 0.00223955

k = 77 $x^{(k)}$ = {0.572503, 0.121509, -1.76665} ε_k = 0.00199633

k = 78 $x^{(k)}$ = {0.572383, 0.121509, -1.76666} ε_k = 0.00177953

k = 79 $x^{(k)}$ = {0.572277, 0.121509, -1.76667} ε_k = 0.00158627

k = 80 $x^{(k)}$ = {0.572182, 0.12151, -1.76669} ε_k = 0.001414

k = 81 $x^{(k)}$ = {0.572098, 0.12151, -1.7667} ε_k = 0.00126044

k = 82 $x^{(k)}$ = {0.572022, 0.12151, -1.7667} ε_k = 0.00112356

k = 83 $x^{(k)}$ = {0.571956, 0.12151, -1.76671} ε_k = 0.00100154

k = 84 $x^{(k)}$ = {0.571896, 0.12151, -1.76672} ε_k = 0.000892773

k = 85 $x^{(k)}$ = {0.571843, 0.12151, -1.76672} ε_k = 0.000795818

k = 86 $x^{(k)}$ = {0.571796, 0.12151, -1.76673} ε_k = 0.000709392

k = 87 $x^{(k)}$ = {0.571754, 0.12151, -1.76673} ε_k = 0.000632352

k = 88 $x^{(k)}$ = {0.571717, 0.12151, -1.76674} ε_k = 0.000563679

k = 89 $x^{(k)}$ = {0.571684, 0.12151, -1.76674} ε_k = 0.000502463

k = 90 $x^{(k)}$ = {0.571654, 0.12151, -1.76675} ε_k = 0.000447896

k = 91 $x^{(k)}$ = {0.571628, 0.12151, -1.76675} ε_k = 0.000399254

k = 92 $x^{(k)}$ = {0.571604, 0.12151, -1.76675} ε_k = 0.000355895

k = 93 $x^{(k)}$ = {0.571583, 0.12151, -1.76675} ε_k = 0.000317245

k = 94 $x^{(k)}$ = {0.571565, 0.12151, -1.76675} ε_k = 0.000282792

k = 95 $x^{(k)}$ = {0.571548, 0.12151, -1.76676} ε_k = 0.000252081

k = 96 $x^{(k)}$ = {0.571534, 0.121511, -1.76676} ε_k = 0.000224705

k = 97 $x^{(k)}$ = {0.57152, 0.121511, -1.76676} ε_k = 0.000200302

k = 98 $x^{(k)}$ = {0.571509, 0.121511, -1.76676} ε_k = 0.000178549

k = 99 $x^{(k)}$ = {0.571498, 0.121511, -1.76676} ε_k = 0.000159159

k = 100 $x^{(k)}$ = {0.571489, 0.121511, -1.76676} ε_k = 0.000141874

k = 101 $x^{(k)}$ = {0.571481, 0.121511, -1.76676} ε_k = 0.000126467

k = 102 $x^{(k)}$ = {0.571474, 0.121511, -1.76676} ε_k = 0.000112732

k = 103 $x^{(k)}$ = {0.571467, 0.121511, -1.76676} ε_k = 0.00010049

k = 104 $x^{(k)}$ = {0.571461, 0.121511, -1.76676} ε_k = 0.0000895764

k = 105 $x^{(k)}$ = {0.571456, 0.121511, -1.76676} ε_k = 0.0000798484

k = 106 $x^{(k)}$ = {0.571452, 0.121511, -1.76676} ε_k = 0.0000711769

k = 107 $x^{(k)}$ = {0.571447, 0.121511, -1.76677} ε_k = 0.0000634471

k = 108 $x^{(k)}$ = {0.571444, 0.121511, -1.76677} ε_k = 0.0000565567

k = 109 $x^{(k)}$ = {0.571441, 0.121511, -1.76677} ε_k = 0.0000504147

k = 110 $x^{(k)}$ = {0.571438, 0.121511, -1.76677} ε_k = 0.0000449396

k = 111 $x^{(k)}$ = {0.571435, 0.121511, -1.76677} ε_k = 0.0000400592

k = 112 $x^{(k)}$ = {0.571433, 0.121511, -1.76677} ε_k = 0.0000357088

k = 113 $x^{(k)}$ = {0.571431, 0.121511, -1.76677} ε_k = 0.0000318308

k = 114 $x^{(k)}$ = {0.571429, 0.121511, -1.76677} ε_k = 0.000028374

k = 115 $x^{(k)}$ = {0.571427, 0.121511, -1.76677} ε_k = 0.0000252925

k = 116 $x^{(k)}$ = {0.571426, 0.121511, -1.76677} ε_k = 0.0000225458

k = 117 $x^{(k)}$ = {0.571425, 0.121511, -1.76677} ε_k = 0.0000200973

k = 118 $x^{(k)}$ = {0.571424, 0.121511, -1.76677} ε_k = 0.0000179147

k = 119 $x^{(k)}$ = {0.571423, 0.121511, -1.76677} ε_k = 0.0000159692

k = 120 $x^{(k)}$ = {0.571422, 0.121511, -1.76677} ε_k = 0.0000142349

k = 121 $x^{(k)}$ = {0.571421, 0.121511, -1.76677} ε_k = 0.000012689

k = 122 $x^{(k)}$ = {0.57142, 0.121511, -1.76677} ε_k = 0.000011311

k = 123 $x^{(k)}$ = {0.571419, 0.121511, -1.76677} ε_k = 0.0000100826

k = 124 $x^{(k)}$ = {0.571419, 0.121511, -1.76677} $\varepsilon_k = 8.98765\times10^{-6}$

k = 125 $x^{(k)}$ = {0.571418, 0.121511, -1.76677} $\varepsilon_k = 8.01159\times10^{-6}$

k = 126 $x^{(k)}$ = {0.571418, 0.121511, -1.76677} $\varepsilon_k = 7.14153\times10^{-6}$

k = 127 $x^{(k)}$ = {0.571418, 0.121511, -1.76677} $\varepsilon_k = 6.36596\times10^{-6}$

k = 128 $x^{(k)}$ = {0.571417, 0.121511, -1.76677} $\varepsilon_k = 5.67462\times10^{-6}$

k = 129 $x^{(k)}$ = {0.571417, 0.121511, -1.76677} $\varepsilon_k = 5.05836\times10^{-6}$

k = 130 $x^{(k)}$ = {0.571417, 0.121511, -1.76677} $\varepsilon_k = 4.50902\times10^{-6}$

k = 131 $x^{(k)}$ = {0.571416, 0.121511, -1.76677} $\varepsilon_k = 4.01934\times10^{-6}$

k = 132 $x^{(k)}$ = {0.571416, 0.121511, -1.76677} $\varepsilon_k = 3.58284\times10^{-6}$

k = 133 $x^{(k)}$ = {0.571416, 0.121511, -1.76677} $\varepsilon_k = 3.19374\times10^{-6}$

k = 134 $x^{(k)}$ = {0.571416, 0.121511, -1.76677} $\varepsilon_k = 2.8469\times10^{-6}$

k = 135 $x^{(k)}$ = {0.571416, 0.121511, -1.76677} $\varepsilon_k = 2.53773\times10^{-6}$

k = 136 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 2.26213\times10^{-6}$

k = 137 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 2.01646\times10^{-6}$

k = 138 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 1.79748\times10^{-6}$

k = 139 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 1.60227\times10^{-6}$

k = 140 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 1.42826\times10^{-6}$

k = 141 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 1.27315\times10^{-6}$

k = 142 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 1.13489\times10^{-6}$

k = 143 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 1.01164\times10^{-6}$

k = 144 $x^{(k)}$ = {0.571415, 0.121511, -1.76677} $\varepsilon_k = 9.01776\times10^{-7}$

За сравнение, точното решение е {0.571414, 0.121511, -1.76677}