Impact Factor:			
ISRA (India) = 1.344	SIS (USA) = 0.912	ICV (Poland) = 6.630
ISI (Dubai, UAE) = 0.829	РИНЦ (Russia) = 0.207	PIF (India) = 1.940
GIF (Australia) = 0.564	ESJI (KZ) = 4.102	IBI (India) = 4.260
JIF = 1.500	SJIF (Morocco) = 2.031	

SOI: 1.1/TAS DOI: 10.15863/TAS

International Scientific Journal

Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2018 **Issue:** 05 **Volume:** 61

Published: 01.05.2018 **http://T-Science.org**

Nauryzbay Serikbaev
master student,
Taraz State University named after M.Kh. Dulati

Alexandr Shevtsov
candidate of technical sciences, member of PILA (USA),
department of «Mathematics», deputy director on Science
of faculty of Information technologies,
automation and telecommunications,
Taraz state University named after M.Kh. Dulati
Shev_AlexXXXX@mail.ru

SECTION 2. Applied mathematics. Mathematical modeling.

THE DEVELOPMENT OF A LIBRARY OF DELPHI FOR THE SOLUTION OF TRANSCENDENTAL EQUATIONS

Abstract: *When solving transcendental equations arise some problems with the use of built-in functions in Delphi. More precisely CAS could not solve these equations, even numerically. This work proposes algorithms and developed the library for the CAS for the numerical solution of transcendental equations in a given interval.*

Key words: *Delphi, Maple, equation, library.*

Language: *English*

Citation: Serikbaev N, Shevtsov A (2018) THE DEVELOPMENT OF A LIBRARY OF DELPHI FOR THE SOLUTION OF TRANSCENDENTAL EQUATIONS. ISJ Theoretical & Applied Science, 05 (61): 1-12.

Soi: http://s-o-i.org/1.1/TAS-05-61-1 ***Doi***: crossref https://dx.doi.org/10.15863/TAS.2018.05.61.1

Introduction

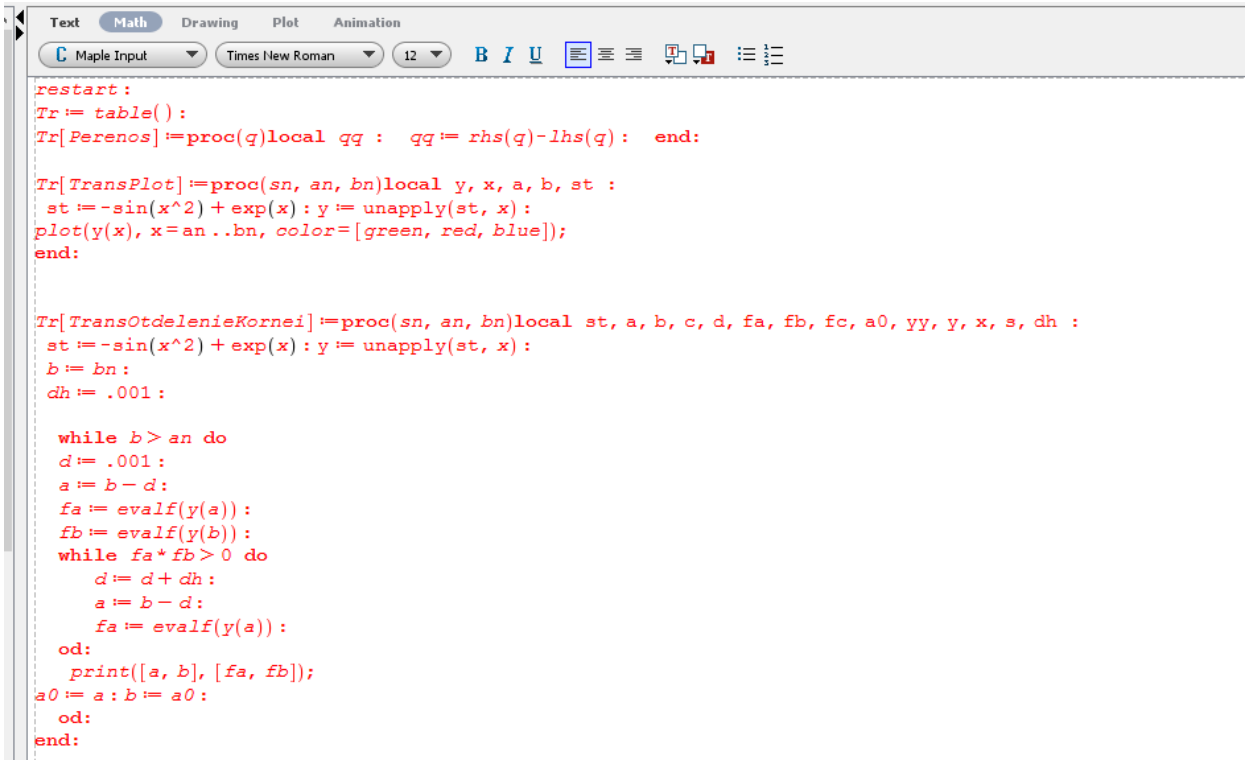
Consider the transcendent equation

$$e^x = \sin\left(x^2 + x\right)$$

Solving it in the system of computer algebra – Maple to find a solution on a predetermined interval is possible by a numerical method, according to [1].

Materials and Methods

An improved version of this library is as follows:




```
restart:
Tr := table():
Tr[Perenos] :=proc(q)local qq :  qq := rhs(q)-lhs(q):  end:

Tr[TransPlot] :=proc(sn, an, bn)local y, x, a, b, st :
 st := -sin(x^2) + exp(x) : y := unapply(st, x):
plot(y(x), x=an..bn, color=[green, red, blue]);
end:


Tr[TransOtdelenieKornei] :=proc(sn, an, bn)local st, a, b, c, d, fa, fb, fc, a0, yy, y, x, s, dh :
 st := -sin(x^2) + exp(x) : y := unapply(st, x):
 b := bn:
 dh := .001:

  while b > an do
  d := .001:
  a := b - d:
  fa := evalf(y(a)):
  fb := evalf(y(b)):
  while fa*fb > 0 do
     d := d + dh:
     a := b - d:
     fa := evalf(y(a)):
  od:
   print([a, b], [fa, fb]);
a0 := a : b := a0:
  od:
end:
```

```
Tr[TransMetodPolDelenia]:=proc(sn, an, bn, epsn, opt)local st, a, b, c, d, fa, fb, fc, a0, yy, y, x, s, dh :
st:=-sin(x^2)+exp(x):
  y:=unapply(st, x):
   b:=bn:
 dh:=.001:
  while b>an do
  d:=.001:
  a:=b-d:
  fa:=evalf(y(a)):
  fb:=evalf(y(b)):
  while fa*fb>0 do
     d:=d+dh:
     a:=b-d:
     fa:=evalf(y(a)):
  od:

 a0:=a:
 while b-a>epsn do
  c:=(a+b)/2:
  fa:=evalf(y(a)):   fb:=evalf(y(b)):   fc:=evalf(y(c)):
  if fa*fc>0 then a:=c:fi:
  if fc*fb>0 then b:=c:fi:
  od:
  c:=(a+b)/2:
  fc:=evalf(y(c)):
  print(c, fc);
  b:=a0:
  od:
 end:
```

```
 Tr[TransNeravBolsheNula]:=proc(sn, an, bn, epsn)local st, cc, fcc, a, b, c, d, fa, fb, fc, a0, yy, y, x, s, dh :

cc:=0;
st:=-sin(x^2)+exp(x):
  y:=unapply(st, x):
 b:=bn:
 dh:=.001;

  while b>an do
  d:=.001:
  a:=b-d:
  fa:=evalf(y(a)):
  fb:=evalf(y(b)):
  while fa*fb>0 do
     d:=d+dh:
     a:=b-d:
     fa:=evalf(y(a)):
  od:
 a0:=a:
 while b-a>epsn do
c:=(a+b)/2:
fa:=evalf(y(a)):   fb:=evalf(y(b)):   fc:=evalf(y(c)):
if fa*fc>0 then a:=c:fi:
if fc*fb>0 then b:=c:fi:
od:
c:=(a+b)/2:
fc:=evalf(y(c)):
fcc:=evalf(y((c+cc)/2));
```

```
if (fcc>0) then  print(c, cc, fcc);fi;

cc:=c;
b:=a0:
od:
end:
```

```
Tr[TransNeravMensheNula]:=proc(sn, an, bn, epsn)local st, cc, fcc, a, b, c, d, fa, fb, fc, a0, yy, y, x, s, dh :

cc:= 0;
st:=-sin(x^2)+exp(x):
  y:=unapply(st, x):

 b:=bn:
 dh:=.001;

  while b>an do
  d:=.001:
  a:=b-d:
  fa:=evalf(y(a)):
  fb:=evalf(y(b)):
  while fa*fb>0 do
     d:=d+dh:
     a:=b-d:
     fa:=evalf(y(a)):
  od:
 a0:=a:
 while b-a>epsn do
c:=(a+b)/2:
fa:=evalf(y(a)):  fb:=evalf(y(b)):  fc:=evalf(y(c)):
if fa*fc>0 then a:=c:fi:
if fc*fb>0 then b:=c:fi:
od:
c:=(a+b)/2:
fc:=evalf(y(c)):
fcc:=evalf(y((c+cc)/2));
if (fcc<0) then  print(c, cc, fcc);fi;

cc:=c;
b:=a0:
od:



end:


save(Tr, `Trans.m`):
```

The procedure for using the library is as follows. Set the initial transcendental equation and the interval on which we will look for solutions, as well as the accuracy of finding the roots of the equation.

Text Math Drawing Plot Animation

2D Input | Times New Roman | 12

```
restart:
read `Trans.m`;
 with(Tr);

a := -10;    b := 1;
q := sin(x^2)=exp(x);
epsilon := 0.00001;

r := solve(q, x);   allvalues(r);   r := fsolve(q, x);

q := Perenos(q);

TransPlot(q, a, b);
TransOtdelenieKornei(q, a, b);
TransMetodPolDelenia(q, a, b, epsilon);
TransNeravBolsheNula(q, a, b, epsilon);
TransNeravMensheNula(q, a, b, epsilon);
```

[*Perenos, TransMetodPolDelenia, TransNeravBolsheNula, TransNeravMensheNula, TransOtdelenieKornei, TransPlot*]

-10

1

$\sin(x^2) = e^x$

0.00001

$RootOf(\_Z^2 - RootOf(\_Z - \ln(\sin(\_Z))^2))$

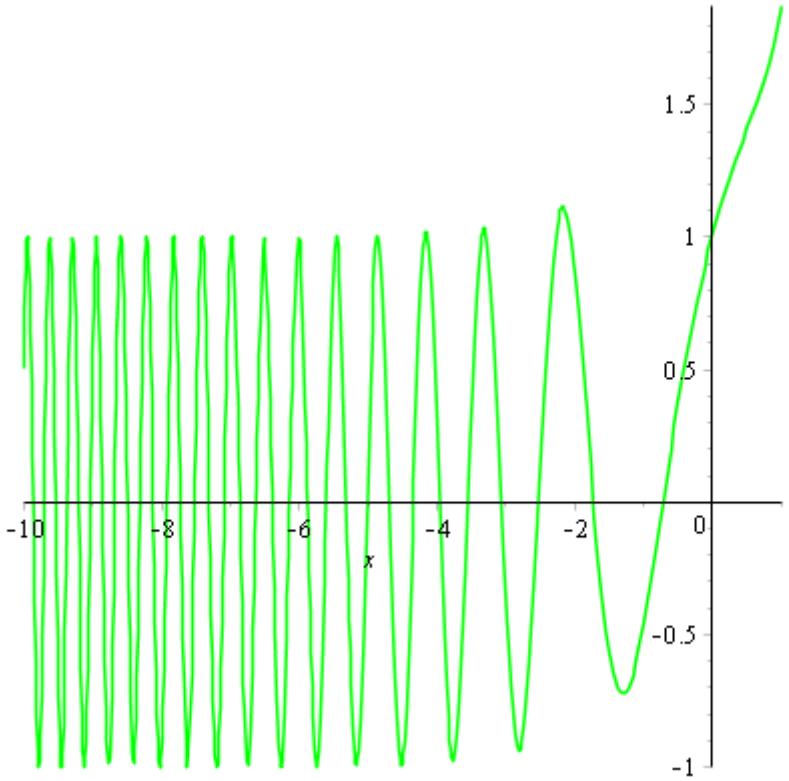
Error, (in RootOf/sort1) cannot numerically evaluate the argument

-0.7149689692

$e^x - \sin(x^2)$

The test of finding the analytical and numerical solution obviously failed, and therefore, the use of the developed library becomes relevant.

We build a graph of a homogeneous equation, a graphical method for solving the equation, separate the roots, find and Refine the roots of the half division method, and solve the inequality for both cases greater and less than zero.

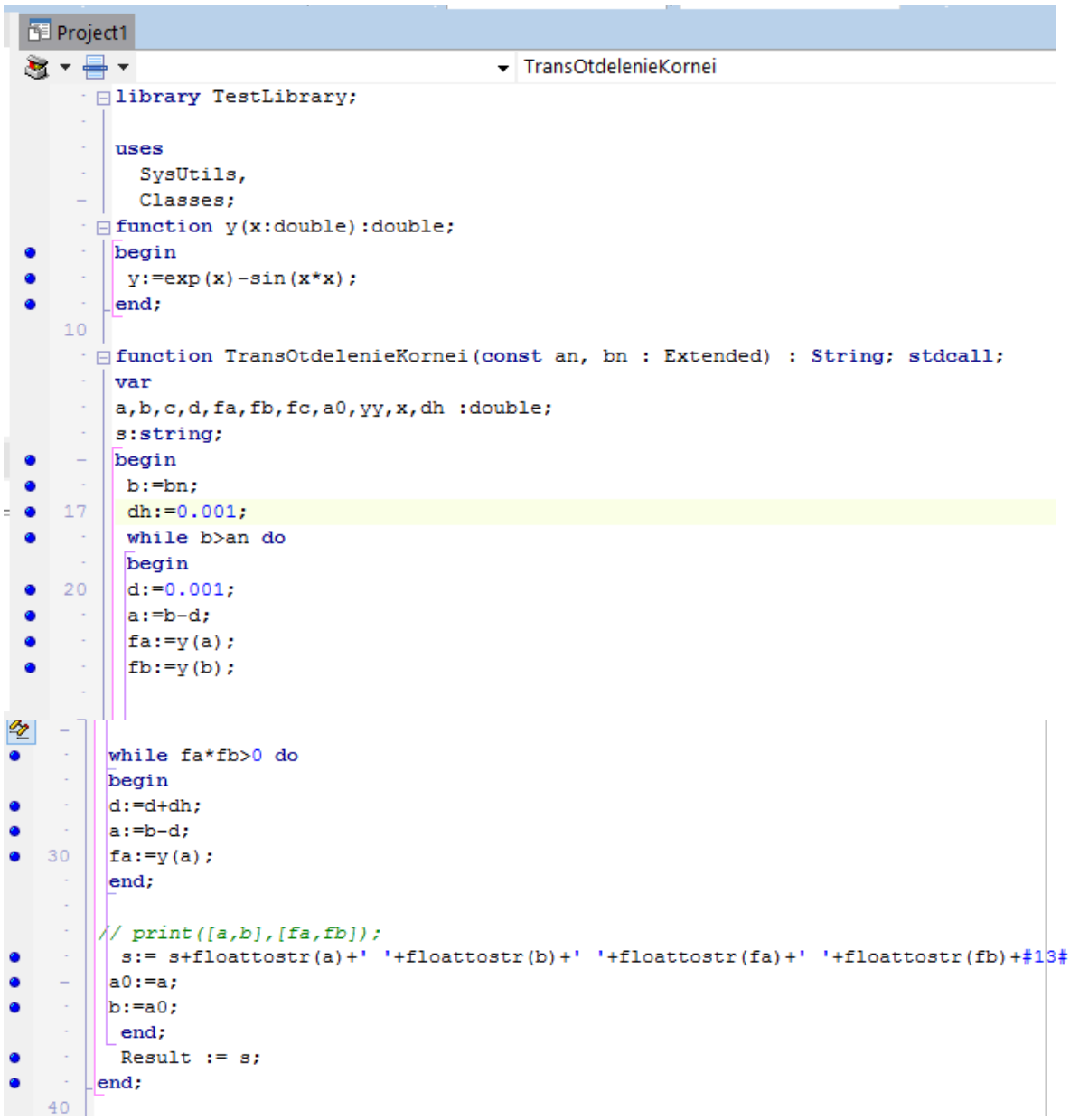


[−0.715, 1], [−0.0000538806, 1.876810843]
[−1.721, −0.715], [0.0001019374, −0.0000538806]
[−2.523, −1.721], [−0.00203207971, 0.0001019374]
[−3.063, −2.523], [0.00395135629, −0.00203207971]
[−3.549, −3.063], [−0.00027292953, 0.00395135629]
[−3.961, −3.549], [0.00060283817, −0.00027292953]
[−4.344, −3.961], [−0.00779409674, 0.00060283817]
[−4.689, −4.344], [0.004768316774, −0.00779409674]
[−5.014, −4.689], [−0.000810429245, 0.004768316774]
[−5.317, −5.014], [0.001062581191, −0.000810429245]
[−5.606, −5.317], [−0.007633480057, 0.001062581191]
[−5.879, −5.606], [0.007919369577, −0.007633480057]
[−6.141, −5.879], [−0.01061604015, 0.007919369577]
[−6.391, −6.141], [0.005853069975, −0.01061604015]
[−6.633, −6.391], [−0.01307514440, 0.005853069975]
[−6.865, −6.633], [0.005378865027, −0.01307514440]
[−7.090, −6.865], [−0.001784142208, 0.005378865027]
[−7.308, −7.090], [0.0004590449998, −0.001784142208]
[−7.520, −7.308], [−0.001190101951, 0.0004590449998]

−0.7149705601, −0.0000027623
−1.720965462, −0.0000088464
−2.522599220, 0.00001556674
−3.062353180, 0.00002357821
−3.548959212, 0.00001763252
−3.960921417, −0.00001808577
−4.343102926, 0.00000939613
−4.688491996, 0.000009304455
−5.013915695, 0.000035509997
−5.316902909, 0.000030607548
−5.605316482, 0.000031940236
−5.878329330, 0.000035982371
−6.140132477, 0.000039642813
−6.390538423, −0.000045802982
−6.632014069, 0.000004047497
−6.864607056, −0.000015681007
−7.089872970, 0.0000172307661
−7.307970062, 0.0000214951071
−7.519919129, 0.0000262310496
−7.725921417, 0.0000425618909
−7.926677965, −0.0000095045722
−8.122386903, 0.0000200939532
−8.313559918, 0.0000050386818

−0.7149705601, 0, 0.5719848397
−2.522599220, −1.720965462, 1.097759345
−3.548959212, −3.062353180, 1.034349642
−4.343102926, −3.960921417, 1.014950549
−5.013915695, −4.688491996, 1.007433504
−5.605316482, −5.316902909, 1.004019629
−6.140132477, −5.878329330, 1.002303564
−6.632014069, −6.390538423, 1.001377322
−7.089872970, −6.864607056, 1.000850854
−7.519919129, −7.307970062, 1.000538978
−7.926677965, −7.725921417, 1.000348197
−8.313559918, −8.122386903, 1.000227854
−8.683226516, −8.500380814, 1.000150867
−9.037783706, −8.862259811, 1.000099911
−9.378951003, −9.209934388, 1.000066494
−9.708131654, −9.544951873, 1.000043664
−10.02651300, −9.868604493, 1.000028353
−1.720965462, −0.7149705601, −0.7003567107
−3.062353180, −2.522599220, −0.9371598338
−3.960921417, −3.548959212, −0.9758917250
−4.688491996, −4.343102926, −0.9886752260
−5.316902909, −5.013915695, −0.9940454270
−5.878329330, −5.605316482, −0.9966256061
−6.390538423, −6.140132477, −0.9979791136
−6.864607056, −6.632014069, −0.9987373882
−7.307970062, −7.089872970, −0.9991828974
−7.725921417, −7.519919129, −0.9994552313
−8.122386903, −7.926677965, −0.9996272701
−8.500380814, −8.313559918, −0.9997389891
−8.862259811, −8.683226516, −0.9998131229
−9.209934388, −9.037783706, −0.9998635766
−9.544951873, −9.378951003, −0.9998986771
−9.868604493, −9.708131654, −0.9999232503

Let's redo the library for Delphi.

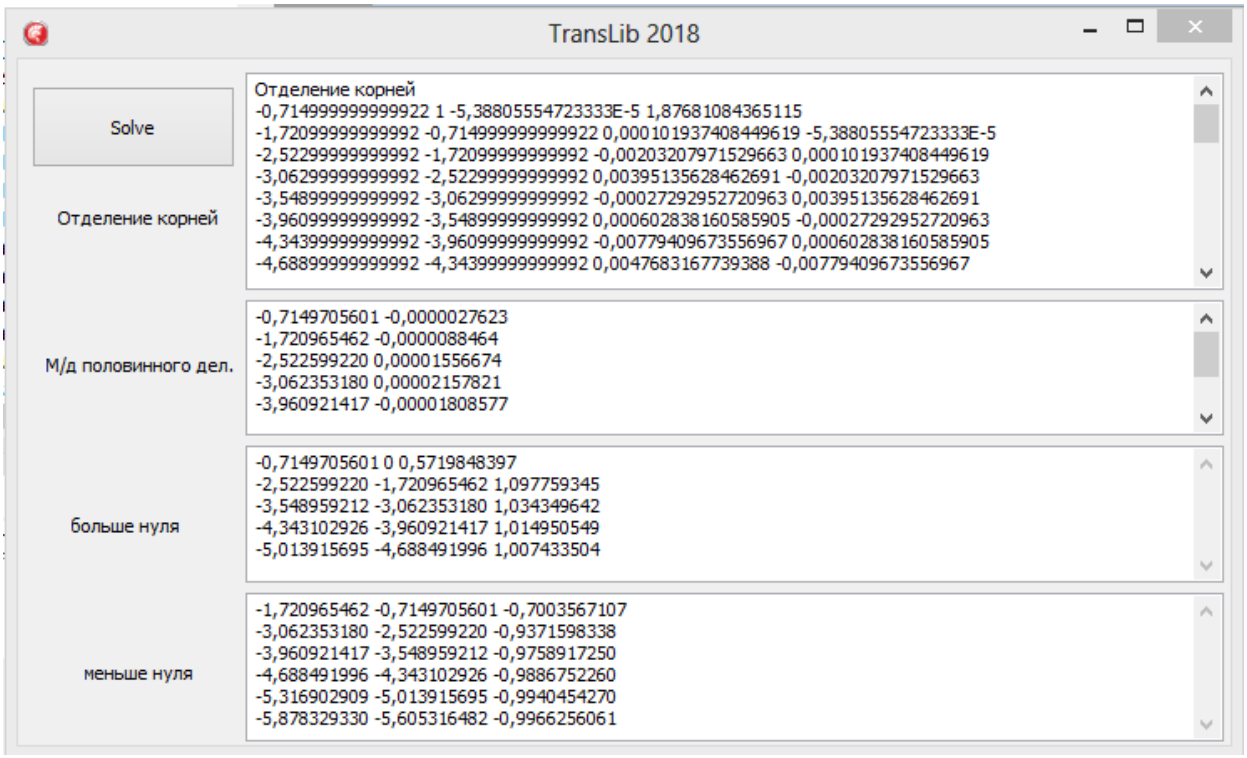

Project1
TransOtdelenieKornei
library TestLibrary;
uses
SysUtils,
Classes;
function y(x:double):double;
begin
y:=exp(x)-sin(x*x);
end;
function TransOtdelenieKornei(const an, bn : Extended) : String; stdcall;
var
a,b,c,d,fa,fb,fc,a0,yy,x,dh :double;
s:string;
begin
b:=bn;
dh:=0.001;
while b>an do
begin
d:=0.001;
a:=b-d;
fa:=y(a);
fb:=y(b);
while fa*fb>0 do
begin
d:=d+dh;
a:=b-d;
fa:=y(a);
end;
// print([a,b],[fa,fb]);
s:= s+floattostr(a)+' '+floattostr(b)+' '+floattostr(fa)+' '+floattostr(fb)+#13#10;
a0:=a;
b:=a0;
end;
Result := s;
end;

```
function TransMetodPolDelenia(const qn, an, bn, epsilon : Extended) : String; stdcall;
var  a,b,c,d,fa,fb,fc,a0,yy,x,dh: double ;   s:string;
begin
 b:=bn;
 dh:=0.001;
 while b>an do begin
   d:=0.001;
   a:=b-d;
   fa:=y(a);
   fb:=y(b);
   while fa*fb>0 do begin
   d:=d+dh;
   a:=b-d;
   fa:=y(a);
   end;
   a0:=a;
   while b-a>epsilon do begin
                 c:=(a+b)/2;
                 fa:=y(a);
                 fb:=y(b);
                 fc:=y(c);
                 if fa*fc>0 then a:=c;
                 if fc*fb>0 then b:=c;
                         end;
                 c:=(a+b)/2;
                 fc:=y(c);

//                 print(c,fc);
s:=s+floattostr(c)+' '+floattostr(fc)+#13#10;
                 b:=a0;
                 end;

  Result := s;
end;

function TransNeravBolsheNula(const qn, an, bn, epsilon : Extended) : string; stdcall;
var  fcc,cc,a,b,c,d,fa,fb,fc,a0,yy,x,dh: double ;   s:string;
begin
 cc:=0;
 b:=bn;
dh:=0.001;
while b>an do begin  d:=0.001;
a:=b-d;
fa:=y(a);
fb:=y(b);
 while fa*fb>0 do begin
 d:=d+dh;
 a:=b-d;
 fa:=y(a);
 end;
 a0:=a;
 while b-a>epsilon do   begin
 c:=(a+b)/2;
 fa:=y(a);
 fb:=y(b);
  fc:=y(c);
  if fa*fc>0 then a:=c;
  if fc*fb>0 then b:=c;
  end;
  c:=(a+b)/2;
  fc:=y(c);
  fcc:=y((c+cc)/2);
  if (fcc>0) then
```

```
//  print(c,cc,fcc);
  s:=s+floattostr(c)+' '+floattostr(cc)+' '+floattostr(fcc)+#13#10;

  cc:=c;   b:=a0;   end;
  Result := s;
end;

function TransNeravMensheNula(const qn, an, bn, epsilon : Extended) : string; stdcall;
var  fcc,cc,a,b,c,d,fa,fb,fc,a0,yy,x,dh: double ;
s:string;
begin
  cc:=0;
  b:=bn;
  dh:=0.001;
  while b>an do begin
  d:=0.001;
  a:=b-d;
  fa:=y(a);
  fb:=y(b);
  while fa*fb>0 do begin
  d:=d+dh;
  a:=b-d;
  fa:=y(a);
                  end;
  a0:=a;
  while b-a>epsilon do begin
  c:=(a+b)/2;
  fa:=y(a);
  fb:=y(b);
  fc:=y(c);
  if fa*fc>0 then a:=c;
  if fc*fb>0 then b:=c;
                        end;
  c:=(a+b)/2;
  fc:=y(c);
  fcc:=y((c+cc)/2);
  if (fcc<0) then
//  print(c,cc,fcc);
  s:=s+floattostr(c)+' '+floattostr(cc)+' '+floattostr(fcc)+#13#10;

cc:=c;   b:=a0;  end;
  Result := s;
end;



exports TransOtdelenieKornei,
        TransMetodPolDelenia,
        TransNeravBolsheNula,
        TransNeravMensheNula;

begin
end.
```

Connect the library for Delphi to our program and solve the transcendent equation.


32-bit Windows
Unit1
TForm1
TForm1.Button1Click
unit Unit1;
interface
uses
Winapi.Windows, Winapi.Messages, System.SysUtils, System.Variants, System.Classes, Vcl.Graph
Vcl.Controls, Vcl.Forms, Vcl.Dialogs, Vcl.StdCtrls;
type
TForm1 = class(TForm)
Button1: TButton;
Memo1: TMemo;
Memo2: TMemo;
Memo3: TMemo;
Memo4: TMemo;
procedure Button1Click(Sender: TObject);
private
{ Private declarations }
public
{ Public declarations }
end;
var
Form1: TForm1;
function TransOtdelenieKornei(const an, bn : Extended) : String; stdcall;
external 'TransLib.dll' name 'TransOtdelenieKornei';
function TransMetodPolDelenia(const an, bn, epsilon : Extended) : String; stdcall;
external 'TransLib.dll' name 'TransMetodPolDelenia';
function TransNeravBolsheNula(const an, bn, epsilon : Extended) : String; stdcall;
external 'TransLib.dll' name 'TransNeravBolsheNula';
function TransNeravMensheNula(const an, bn, epsilon : Extended) : String; stdcall;
external 'TransLib.dll' name 'TransNeravMensheNul';
implementation
{$R *.dfm}
procedure TForm1.Button1Click(Sender: TObject);
var
a,b,epsilon : Extended;
s,yn:string;
begin
Memo1.Clear;
Memo1.Lines.Add('Отделение корней');
yn:='sin(x*x)=exp(x)';
a:=-10;
b:=1;
epsilon:=0.0001;
S := TransOtdelenieKornei(a, b);
Memo1.Lines.Add(S);
S := TransMetodPolDelenia(a, b, epsilon);
Memo2.Lines.Add(S);
S := TransNeravBolsheNula(a, b, epsilon);
Memo3.Lines.Add(S);
S := TransNeravMensheNula(a, b, epsilon);
Memo4.Lines.Add(S);
end;
end.



Conclusion

As a result of the study, the algorithms for calculating transcendent equations for the Maple system were improved.

The obtained algorithms allow solving more complex transcendent equations and inequalities in the Maple system.

Libraries for Maple and Delphi, for the numerical solution of transcendent equations and inequalities are developed.

References:

1. Serikbaev N, Shevtsov A (2017) THE DEVELOPMENT OF A LIBRARY OF MAPLE FOR THE SOLUTION OF TRANSCENDENTAL EQUATIONS. ISJ Theoretical & Applied Science, USA, 12 (56): 261-279. Doi: https://dx.doi.org/10.15863/TAS.2017.12.56.42 Published: 30.12.2017
2. Zaytsev O. V., Vladimirov A. M. (2010) " Grafika v Delphi"
3. Kandzyuba S. P., Gromov V. N. (2010) "Delphi 6/7. Bazy dannykh i prilozheniya. Lektsii i uprazhneniya"
4. Kozhedub O. (2004) "Razrabotka internet-prilozheniy v Delphi"
5. Arkhangel'skiy A. Ya. (2002) "Razrabotka prikladnykh programm dlya Windows v Delphi 5"
6. Borovskiy A. N. (2005) "Programmirovanie v Delphi 2005"
7. Galiseev G. V. (2010) "Programmirovanie v srede Delphi 8 for.NET"
8. Gofman V. E., Khomonenko A. D. (2000) "Delphi. Bystryy start"
9. Darakhvelidae P. G., Markov E. P. (2003) "Programmirovanie v Delphi 7."

10. Darakhvelidze P. G., Markov E. P. (2001) "Programmirovanie v Delphi 7"
11. Elmanova N. (2010) "Delphi, C++Builder i COM: voprosy i otvety"
12. Elmanova N. (2010) "Delphi i tekhnologiya COM. Master-klass"
13. (2018) "Delphi Russian Knowledge Base "
14. Arkhangel'skiy A. Ya. (2006) "Delphi 2006. Spravochnoe posobie: Yazyk Delphi, klassy, funktsii Win32 i .NET"
15. Arkhangel'skiy A. Ya. (2008) "100 komponentov obshchego naznacheniya biblioteki Delphi 5"
16. Arkhangel'skiy A. Ya. (2010) "Priemy programmirovaniya v Delphi na osnove VCL"