Міністерство Освіти та Науки України

Національний авіаційний університет

# Кафедра інформаційних технологій

## КУРСОВИЙ ПРОЕКТ

з дисципліни "Математичні моделі Інформаційних процесів та управління динамічних об'єктів"

### Розрахунково-пояснювальна записка

**Тема: Цифрова математична модель динаміки польоту літака Ту-І54Б в режимі автоматичного управління приладовою швидкістю через руль висоти**

**Виконавець**: студент 3 курсу 303 групи ФІТ

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Київ 2001 р.

Завдання на виконання курсового проекту

###### Варіант N 6

Дата видачи завдання на проектування: 01. 10. 2001 р.

Дата захисту проекту за навчальним планом: 01. 12. 2001 р.

Перелік питань, що підлягають розробці:

розробити математичну модель літака, та дослідити заданий закон автоматичного управління (стабілізація приладової швидкості через руль вистоти).

Початкові значення параметрів польоту літака:

 

Збурення, що діють на літак: Відмова центрального двигуна.

Метод чисельного інтегрування системи диференціальних рівнянь:

Рунги-Кутти 2 порядка з корекцією по середній похідній.

Дослідження динамічної подібності розробленої моделі та реального "вільного" об'єкту, використовуючи метод Рунге-Кутти другого порядку з корекцією у середній похідній.









Дослідження якості стабілізації нового зада­ного значення приладової швидкості при відсутності збурення



Дослідження якості стабілізації приладової швидкості при відмові центрального двигуна методом Рунге-Кутти другого порядку з корекцією у середній похідній.







uses crt;

 type mass=array[1..7] of real;

 matt=array[1..11] of real;

 const

 MzDZ = -0.0091; RAD= 180/PI; Ph = -0.287; CyDV = 0.005;

 FIdv = 0; Pdg = 132.89; S = 201.45; Cy0 = -0.255;

 \_g=9.81; mzo=0.2; dT=0.05; CyFIst = 0.0132;

 Po = 3500; KoefDZ = -0.14706; Pv = -9; cy\_alfa=0.1008;

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{ Даннi для інтерполяції }

mzffist:mass=( -0.0465, -0.0475, -0.0480, -0.0498, -0.0520, -0.0565, -0.0580);

mzwzTab:mass=(-12.850, -12.910, -13.000, -13.900, -14.000, -14.900, -15.800);

mzalfa:mass=(-0.0318, -0.0320, -0.0325, -0.0340, -0.0360, -0.0440, -0.0510);

ChisloMahaTab:mass=(0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9);

CxTab:mass=(0.020, 0.022, 0.030, 0.040, 0.054, 0.082, 0.135);

Cy\_Cx:mass=(0.000, 0.200, 0.400, 0.600, 0.800, 1.000, 1.200);

{Таблицi на 11 значень, для більшої точності }

time:matt=(0, 0.5, 1, 1.5, 2, 2.5, 2.8 , 3, 3.5, 4, 5);

pft:matt=(1686,1641.04,1475.25,1253.26, 899.2, 351.25, 0, -97, -240, -288, -299);

VzvukaTab:matt= (340.29, 339.91, 339.53, 339.14, 338.76, 337.98, 337.60, 337.21, 336.82, 336.43, 320.54);

HTab:matt= (0.0, 100.0, 200.0, 300.0, 400.0, 600.0, 700.0, 800.0, 900.0, 1000.0, 5000.0);

alfa\_mzalt :matt =(0,3.600,5,6.2500,7.500,10,12.800,14.2,15,18,19.7);

Mzaltfal :matt =(-2,-2.2,-2.6,-3.1,-3.7,-5,-6.9,-8.8,-10.8,-13.6,-17);

CyTab\_\_:matt=( 0.,-0.28, -0.07, 0.11, 0.30, 0.47, 0.63, 0.80, 0.93, 1.08, 1.18);

Cyal\_\_:matt=( -1., 0., 2., 4., 6., 8., 10., 12., 14., 16., 18);

mzdvtab1:mass=(-0.01450,-0.014525,-0.01455,-0.014585, -0.01460,-0.01462, -0.01465);

mzdval1:mass=(0.000000, 2.5000, 5.000000, 8.5000, 10.00000, 12.000, 15.00000);

var

Buf,Cy ,DZ ,Cx ,CyAL ,AL ,MzFIst ,dVpr ,MzAL ,MzAL1 ,MzWz ,M ,MzDV ,Vprz

,dMzdv, \_m ,G ,q ,Ro ,MzStat ,DV ,Xt ,FIst ,Pbal , MzVra ,Ba ,Mz ,Ye ,Iz ,P

,DGBal ,Xe ,Vpro ,Fun ,flag ,CyBal ,POtk ,TOtk ,ALBal ,DVBal ,Roh ,DG ,a

,Vpr ,Vprzad,Vpr0,Ny ,Tetab ,dTeta ,

delta1 ,delta ,Sigma , dVprzad ,CyAL1,T,

CxBal,XBal,YBal,Qdv,dvSau,wv,tv\_\_:real;

 pbaldv,dny:real;

 kv,kv\_,tv,tv\_,kidv,qq,sss,P1:real;

 mza,g0,dmz, deltavpr,flagg,flagbal,pdv,mz\_cy,delta\_ny,dv\_ny:real;

 CyB,cxb,gtop,Kh1,K\_v,K\_v1,T\_v,T\_v1,Kteta,Kh,Kwz,Ktet,Kint:real;

 F :text;

 x ,y ,d:array[1..20] of real;

 vib,met,ssau,i ,j :integer;

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procedure menu;

begin

clrscr;

 textcolor(3);

 write('Курсова робота з дисциплiни: ');

 writeln ('Математичнi моделi iнформацiйних процесiв та управлiння динамiчними обьєктами');

 writeln('Виконав студент групи 303 ФiТ Єрофеєв Юрiй');

 writeln;

 writeln(' Варианти польоту: ');

 writeln(' 1: Вiльний лiтак');

 writeln(' 2: Вiдмова центрального двигуна');

 writeln(' 3: Вiдмова центрального двигуна i стабiлiзацiя заданої прил. швидкостi через руль висоти');

 writeln;

 write(' Введiть варiант польоту: ');

 readln(vib);

writeln;writeln;

textcolor(7);

{writeln('Пiдключити САУ ? 1-Так/2-Нi');

readln(ssau);

writeln; }

writeln('Метод чисельного iнтегрування');

writeln(' 1: Ейлера');

writeln(' 2: Рунге-Кутти з корекцiєю по середнiй похiднiй');

writeln;

write(' Ваш вибiр ');

readln(met);

end;

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{Интерполяція функциї 1 змінної методом Лагранжу}

function InterpolFunction1(x1:real; var xm,fm:mass ):real;

const n=6;

var i,j:integer;

 p1,p2,p,r,r1,r2,q,s:real;

begin

p:=0.0; p1:=p; p2:=p;

for i:=1 to n do

 begin

 r:=1.0; r1:=0.0; r2:=r1;

 for j:=1 to n do if i<>j then

 begin

 q:=xm[i]-xm[j]; s:=x1-xm[j]; r2:=(r2\*s+2\*r1)/q;r1:=(r1\*s+r)/q;r:=r\*s/q;

 end;

 p2:=p2+r2\*fm[i];p1:=p1+r1\*fm[i];p:=p+r\*fm[i];

 end;

 InterpolFunction1:=p;

end;{InterpolFunction1}

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{Интерполяція функциї змінної методом Лагранжу таблиць на 11 значень}

function InterpolFunction11(x1:real; var xm,fm:matt ):real;

const n=10;

var i,j:integer;

 p1,p2,p,r,r1,r2,q,s:real;

begin

p:=0.0; p1:=p; p2:=p;

for i:=1 to n do

 begin

 r:=1.0; r1:=0.0; r2:=r1;

 for j:=1 to n do

 if i<>j then

 begin

 q:=xm[i]-xm[j]; s:=x1-xm[j]; r2:=(r2\*s+2\*r1)/q;r1:=(r1\*s+r)/q;r:=r\*s/q;

 end;

 p2:=p2+r2\*fm[i];p1:=p1+r1\*fm[i];p:=p+r\*fm[i];

 end;

 InterpolFunction11:=p;

end;{InterpolFunction1}

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{Процедура попередження користувача}

procedure attention;

begin

sound(100);

delay(2);

nosound;

end;

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{Процедура котролю за кутом атаки, закидом вертикального перевантаження, кількістю палива}

procedure control;

begin

dny:=ny-1;

if y[8]<0 then attention;

if (dny>0.2) or (dny<-0.2) then attention;

if y[5]>16 then attention;

end;

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{Вивід результатів на екран і в файл}

procedure PRINT;

begin

 write('|',t:6:1); write(y[3]:9:2,' '); write(vpr:6:3,'');

 write(y[6]:9:2,''); write(y[5]:7:3,' '); write(y[1]:7:3,' ');

 write(P1:8:3, ''); write(dV:8:3,' '); writeln(ny:6:4,' |');

 write(f,'|',t:6:1); write(f,y[3]:9:2,' '); write(f,vpr:7:3,' ');

 write(f,y[6]:9:2,' '); write(f,y[5]:7:3,' '); write(f,y[1]:7:3,' ');

 write(f,P1:8:3, ''); write(f,dV:8:3,' ');

 write(f,ny:6:4,' ');

 write(f,(2\*Pdv+P1):6:4,' ');

 writeln(f,y[4]:6:4,' |');

end;

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procedure prisvoenie;

begin

 if flagg=1 then

 begin

 for i := 1 to 20 do X[i] := 0;

 flagg := 0;

 end;

 Y[3] := 110; Y[6] := 1000; Gtop:=20000; G0:=53000; y[8]:=Gtop;

 G :=Gtop+G0; Iz := 660000; DZ := 0; Ba := 5.285; FIst :=0;

 Xt := 0.24; Ro := 0.1249; DG := 0; DV := 0; T := 0;

 flagg:=1; flag:=1; flagbal:=1;

 {SAU}

 Kh1:= 0.4; K\_v:= 1.8; K\_v1:= 2.16; T\_v:= 1.; T\_v1:=1.; Kteta:= 2.0;

 Kh:= 0.1; Kwz:= 3.0; Ktet:= 0.5; Kint:= 0.002; kidv:=0.04;

end;

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{ Чисельне інтегрування диференціальних рівнянь методом Эйлера }

procedure Eiler;

var i :integer;

begin

for i:=1 to 20 do y[i]:=y[i]+x[i]\*dt;

end;{Integrirovanie}

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{Вивід на екран початкових значень польоту та показників стійкості}

procedure print\_bal;

begin

clrscr;

writeln('Балансованi (початковi) значення польоту');

writeln;

writeln('Швидкiсть ',y[3]:5:3);

writeln('Висота ',y[6]:5:3);

writeln('Швидкiсть звуку ',a:6:3);

writeln('Густина повiтря ',roh:6:3);

writeln('Число маха ',M:6:3);

writeln('Cy ',cyb:6:3);

writeln('Cx ',cxb:6:3);

writeln('Кут атаки ',albal:6:3);

writeln('Руль висоти ',dvbal:6:3);

writeln('Дельта газу ',dgbal:6:3);

writeln('Ybal ',ybal:6:3);

writeln('Xbal ',xbal:6:3);

writeln('Початкова тяга силової установки ',pbal:6:3);

writeln('Початкова тяга двигуна ',p1:6:3);

writeln('Початкова приборна швидкiсть ',vpr0:6:3);

writeln;

textcolor(3);

writeln('Ступiнь повздовжноъ статичноъ стiйкостi ',mz\_cy:6:3);

writeln('Запас стiйкостi по перевантаженню ',delta\_ny:6:3);

writeln('Витрата руля висоти на одиницю перевантаження ',dv\_ny:6:3);

writeln('Перiод коливань (по швидкостi) ',tv\_\_:6:3);

textcolor(7);

readkey;

clrscr;

end;

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{ Балансуваня літака }

procedure Balansirovka;

begin

CyB:=(2\*G)/(S\*Roh\*y[3]\*y[3]);

albal:=InterpolFunction11(cyb,cytab\_\_,cyal\_\_);

CxB:=InterpolFunction1(CyB,Cy\_Cx,CxTab);

Ybal := CyB\*S\*q;

Xbal := CxB\*S\*q;

Mzdv:=InterpolFunction1(albal,mzdval1,mzdvTab1);

 DVBal := -(Mzo +MzAL\*ALBal + CyB\*(Xt-0.24) + MzDZ\*DZ + MzFIst\*FIst)/MzDV;

 Pbal := Xbal/cos((ALBal+FIdv)/RAD);

 DGBal:= (Pbal/3-Po-Pv\*Y[3]-Ph\*Y[6])/Pdg+66;

 P1 := Pbal/3;

Y[5] := ALBal; Y[1] := Y[5] ;Tetab := ALBal;

 Mzwz:=InterpolFunction1(M,ChisloMahaTab,mzwzTab);

mz\_cy:=mzal/cy\_alfa;

delta\_ny:=mz\_cy+(mzwz\*ba\*S\*roh)/(2\*\_m);

mzdv:=mzdv\*rad;

dv\_ny:=-rad\*(delta\_ny\*Cyb)/mzdv;

wv:=(\_g/y[3])\*sqrt((2\*mz\_cy)/delta\_ny);

tv\_\_:=(2\*3.14)/wv;

vpr:=y[3]\*sqrt(roh/ro);

vpr0:=vpr;

vprzad:=vpr0+10;

if vib=3 then vprzad:=vpr0;

print\_bal;

end;

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{Закон стабілізаціїї приладової швидкості через руль висоти}

procedure SAU;

begin

 deltavpr:=vprzad-vpr;

x[15]:=(1-y[15])/t\_v;

x[16]:=(1-y[16])/t\_v1;

x[17]:=kidv;

fun:=y[17]\*deltavpr;

 if(Fun>10) then Fun:=10;

 if(Fun<-10) then Fun:=-10;

 delta1:=(k\_v\*x[15]\*deltavpr+x[16]\*k\_v1\*100\*deltavpr+fun);

 if delta1 < -10 then delta1:=-10;

 if delta1 > 10 then delta1:=10;

 dTeta:=Y[1]-Tetab;

 delta:=delta1+Kteta\*dTeta;

 if delta <-3.5 then delta:=-3.5;

 if delta >3.5 then delta:=3.5;

 Sigma:=delta+Kwz\*Y[2];

 if Sigma<-10 then Sigma:=-10;

 if Sigma>10 then Sigma:=10;

 X[9]:=0;

 if delta<-2 then X[9]:=-0.6;

 if delta>2 then X[9]:=0.6;

 DVsau:=Sigma+Y[9];

end;

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{Система диференціальних рівнянь}

procedure dinamika;

 begin

 Roh := Ro - 0.0117\*Y[6]/1000 + 0.000343\*sqr(Y[6]/1000);

 G:=G0+y[8];

 \_m := G/\_g;

 q := Roh\*sqr(Y[3])/2;

 a:=InterpolFunction11(y[6],HTab,VzvukaTab);

 Vpr := y[3]\*sqrt(Roh/Ro);

 dVpr := Vpr - Vprzad;

 M := Y[3]/a;

 Qdv:=0.2586\*M+0.4428;

 mzfist:=InterpolFunction1(M,ChisloMahaTab,mzffist);

 mzal:=InterpolFunction1(M,ChisloMahaTab,mzalfa);

 if flagbal=1 then

 begin

 Balansirovka;

 flagbal:=0;

 end;

 Mzal1:=InterpolFunction11(Y[5],alfa\_mzalt , mzaltfal);

 Mzdv:=InterpolFunction1(y[5],mzdval1,mzdvTab1);

 Mzwz:=InterpolFunction1(M,ChisloMahaTab,mzwzTab);

 Cy:=InterpolFunction11(y[5],cyal\_\_,cytab\_\_);

 Cx:=InterpolFunction1(Cy,Cy\_Cx,CxTab);

 Ye := Cy\*S\*q;

 Xe := Cx\*S\*q;

 { Відмова двигуна }

if (vib=2) or (vib=3) then begin

if ((T>=0) and (T<=4)) then

 P1:=interpolfunction11(T,time,pft);

 end;

 if ((vib=3) or (ssau=1)) and (t>1.0) then SAU;

 dv:=dvbal+dvsau;

 MzStat:=mzo+mzal\*Y[5]+mzdv\*dv+mzdz\*dz+mzfist\*fist;

 MzVra := (MzWz\*Y[2] + MzAL1\*X[5])\*Ba/(RAD\*Y[3]);

 Mz := (MzStat + MzVra);

 DG := 0;

 Pdv := Po + Pv\*Y[3] + Ph\*Y[6] + Pdg\*(DGBal+DG-66);

 dMzdv := (Pbal/3 - Potk) \* 0.5;

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 x[1]:=y[2];

 x[2]:=(Mz\*S\*Ba\*q+dMzdv)\*RAD/Iz;

 x[3]:=(-G\*sin(Y[4]/RAD)+(2\*Pdv+P1)\*cos((Y[5]+FIdv)/RAD)-Xe)/\_m;

 x[4]:=(-G\*cos(Y[4]/RAD)+(2\*Pdv+P1)\*sin((Y[5]+FIdv)/RAD)+Ye)\*RAD/(\_m\*Y[3]);

 x[5]:=x[1]-x[4];

 x[6]:=y[3]\*sin(y[4]/RAD);

 x[7]:=y[3]\*cos(y[4]/RAD);

 x[8]:=-3\*qdv;

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{Добалансування літака}

if flag =1 then begin

d[1]:=-x[1];

d[2]:=-x[2];

d[3]:=-x[3];

d[4]:=-x[4];

d[5]:=-x[5];

d[6]:=-x[6];

flag:=0;

end;

x[1]:=x[1]+d[1];

x[2]:=x[2]+d[2];

x[3]:=x[3]+d[3];

x[4]:=x[4]+d[4];

x[5]:=x[5]+d[5];

x[6]:=x[6]+d[6];

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 {Вертикальне перевантаження }

 Ny := ((2\*Pdv + P1)\*sin((Y[5]+FIdv)/RAD)+Ye)/G;

end;

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{ Чисельне інтегрування диференціальних рівнянь методом Рунге-Кутти 2 порядку }

procedure R\_K;

const dt2=dt/2;

var x0:array [1..20] of real;

 i:integer;

begin

for i:=1 to 20 do x0[i]:=x[i];

for i:=1 to 20 do y[i]:=y[i]+x0[i]\*dt;

dinamika;

for i:=1 to 20 do y[i]:=y[i]+(x[i]-x0[i])\*dt2;

end;

{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_}

{Основний блок програми}

begin

 ClrScr;

 Assign (F,'data.dat');

 Rewrite(F);

 menu;

 clrscr;

 prisvoenie;

 dinamika;

 textcolor(3);

 writeln(' \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_');

 writeln('| T V Vpr H a teta P1 dV ny |');

 writeln(' ---------------------------------------------------------------------------');

 textcolor(7);

 writeln(f,'| T V Vpr H a teta P1 dV ny Psu traekt |');

 while (T<=180+dt) do

begin

 if abs(T-Round(T))<dt/2 then print;

 T:=T+dt;

 dinamika;

 if met=1 then Eiler;

 if met=2 then R\_K;

 control;

 end;

readln;

close(F);

end.

## Балансованi (початковi) значення польоту

Швидкiсть 110.000

Висота 1000.000

Швидкiсть звуку 336.430

Густина повiтря 0.114

Число маха 0.327

Cy 0.528

Cx 0.036

Кут атаки 9.131

# Руль висоти -6.392

Дельта газу 61.988

Ybal 73000.000

Xbal 5005.372

Початкова тяга силової установки 5069.611

Початкова тяга двигуна 1689.870

Початкова приборна швидкiсть 104.880

**Ступiнь повздовжної статичної стiйкостi -0.319**

**Запас стiйкостi по перевантаженню -0.426**

**Витрата руля висоти на одиницю перевантаження -15.385**

**Перiод коливань (по швидкостi) 57.543**

Дослідження динамічної подібності розробленої моделі та реального "вільного" об'єкту, використовуючи метод Рунге-Кутти другого порядку з корекцією у середній похідній.

 **T V Vpr H a teta P1 dV ny Psu traekt**

0.0 110.00 104.880 1000.00 9.131 9.131 1689.870 -6.392 1.0690 5069.6107 0.0000

1.0 110.00 104.880 1000.00 9.131 9.131 1689.870 -6.392 1.0690 5069.6107 0.0000

2.0 110.00 104.880 1000.00 9.131 9.131 1689.870 -6.392 1.0690 5069.6108 0.0002

3.0 109.99 104.870 1000.04 9.357 9.427 1689.870 -7.392 1.1036 5069.7758 0.0699

4.0 109.93 104.812 1000.40 9.529 9.859 1689.870 -7.392 1.1294 5070.6305 0.3294

5.0 109.82 104.698 1001.33 9.525 10.162 1689.870 -7.392 1.1262 5072.1567 0.6374

6.0 109.66 104.537 1002.82 9.500 10.412 1689.870 -7.392 1.1190 5074.1879 0.9121

7.0 109.45 104.336 1004.80 9.503 10.663 1689.870 -7.392 1.1152 5076.6695 1.1603

8.0 109.21 104.095 1007.24 9.515 10.909 1689.870 -7.392 1.1121 5079.5838 1.3938

9.0 108.94 103.818 1010.10 9.526 11.137 1689.870 -7.392 1.1080 5082.8963 1.6107

10.0 108.63 103.509 1013.35 9.536 11.342 1689.870 -7.392 1.1030 5086.5580 1.8059

11.0 108.30 103.173 1016.93 9.547 11.524 1689.870 -7.392 1.0977 5090.5166 1.9765

12.0 107.94 102.814 1020.80 9.560 11.680 1689.870 -7.392 1.0920 5094.7174 2.1205

13.0 107.57 102.436 1024.90 9.573 11.809 1689.870 -7.392 1.0861 5099.1038 2.2366

14.0 107.18 102.047 1029.18 9.586 11.910 1689.870 -7.392 1.0800 5103.6162 2.3233

15.0 106.79 101.649 1033.57 9.600 11.980 1689.870 -7.392 1.0739 5108.1938 2.3797

16.0 106.39 101.250 1038.03 9.615 12.020 1689.870 -7.392 1.0677 5112.7750 2.4051

17.0 106.00 100.854 1042.48 9.629 12.029 1689.870 -7.392 1.0616 5117.2983 2.3996

18.0 105.61 100.466 1046.89 9.644 12.007 1689.870 -7.392 1.0557 5121.7029 2.3634

19.0 105.24 100.092 1051.18 9.658 11.955 1689.870 -7.392 1.0500 5125.9297 2.2971

20.0 104.89 99.735 1055.30 9.671 11.873 1689.870 -7.392 1.0446 5129.9218 2.2018

21.0 104.56 99.402 1059.22 9.684 11.763 1689.870 -7.392 1.0396 5133.6257 2.0790

22.0 104.25 99.096 1062.88 9.696 11.627 1689.870 -7.392 1.0350 5136.9916 1.9306

23.0 103.98 98.821 1066.23 9.707 11.466 1689.870 -7.392 1.0309 5139.9744 1.7587

24.0 103.74 98.580 1069.25 9.716 11.282 1689.870 -7.392 1.0273 5142.5343 1.5657

25.0 103.54 98.376 1071.89 9.724 11.079 1689.870 -7.392 1.0242 5144.6372 1.3545

26.0 103.38 98.212 1074.13 9.730 10.858 1689.870 -7.392 1.0217 5146.2557 1.1279

27.0 103.26 98.089 1075.95 9.735 10.624 1689.870 -7.392 1.0199 5147.3691 0.8893

28.0 103.18 98.009 1077.33 9.737 10.379 1689.870 -7.392 1.0186 5147.9637 0.6419

29.0 103.15 97.973 1078.26 9.738 10.127 1689.870 -7.392 1.0180 5148.0335 0.3892

30.0 103.16 97.980 1078.73 9.737 9.872 1689.870 -7.392 1.0180 5147.5798 0.1347

31.0 103.21 98.031 1078.75 9.734 9.616 1689.870 -7.392 1.0186 5146.6114 -0.118

32.0 103.31 98.124 1078.31 9.729 9.363 1689.870 -7.392 1.0199 5145.1443 -0.366

33.0 103.44 98.257 1077.43 9.722 9.117 1689.870 -7.392 1.0217 5143.2018 -0.605

34.0 103.62 98.429 1076.13 9.714 8.881 1689.870 -7.392 1.0241 5140.8136 -0.833

35.0 103.83 98.636 1074.43 9.705 8.658 1689.870 -7.392 1.0271 5138.0154 -1.046

36.0 104.07 98.876 1072.35 9.694 8.452 1689.870 -7.392 1.0305 5134.8486 -1.242

37.0 104.34 99.146 1069.92 9.683 8.264 1689.870 -7.392 1.0344 5131.3593 -1.418

38.0 104.64 99.440 1067.19 9.670 8.098 1689.870 -7.392 1.0387 5127.5978 -1.572

39.0 104.95 99.756 1064.20 9.657 7.955 1689.870 -7.392 1.0434 5123.6172 -1.702

40.0 105.29 100.088 1060.97 9.644 7.837 1689.870 -7.392 1.0484 5119.4735 -1.807

41.0 105.63 100.432 1057.57 9.630 7.745 1689.870 -7.392 1.0535 5115.2237 -1.885

42.0 105.98 100.784 1054.04 9.617 7.681 1689.870 -7.392 1.0589 5110.9257 -1.936

43.0 106.33 101.137 1050.43 9.604 7.645 1689.870 -7.392 1.0643 5106.6373 -1.959

44.0 106.69 101.489 1046.78 9.591 7.636 1689.870 -7.392 1.0698 5102.4149 -1.954

45.0 107.03 101.833 1043.17 9.579 7.656 1689.870 -7.392 1.0752 5098.3135 -1.922

46.0 107.36 102.166 1039.62 9.568 7.703 1689.870 -7.392 1.0804 5094.3853 -1.864

47.0 107.68 102.483 1036.20 9.557 7.777 1689.870 -7.392 1.0855 5090.6795 -1.780

48.0 107.97 102.780 1032.94 9.547 7.875 1689.870 -7.392 1.0903 5087.2414 -1.671

49.0 108.24 103.053 1029.91 9.539 7.997 1689.870 -7.392 1.0947 5084.1121 -1.541

50.0 108.48 103.298 1027.14 9.531 8.141 1689.870 -7.392 1.0987 5081.3279 -1.390

51.0 108.70 103.513 1024.66 9.525 8.304 1689.870 -7.392 1.1023 5078.9202 -1.220

52.0 108.88 103.695 1022.52 9.520 8.484 1689.870 -7.392 1.1054 5076.9147 -1.035

53.0 109.02 103.842 1020.73 9.516 8.679 1689.870 -7.392 1.1079 5075.3319 -0.836

54.0 109.13 103.952 1019.34 9.513 8.885 1689.870 -7.392 1.1098 5074.1862 -0.627

55.0 109.20 104.024 1018.35 9.511 9.100 1689.870 -7.392 1.1111 5073.4866 -0.411

56.0 109.23 104.057 1017.78 9.511 9.321 1689.870 -7.392 1.1118 5073.2360 -0.189

57.0 109.23 104.052 1017.63 9.512 9.545 1689.870 -7.392 1.1118 5073.4316 0.0335

58.0 109.18 104.009 1017.90 9.514 9.769 1689.870 -7.392 1.1112 5074.0652 0.2554

59.0 109.10 103.929 1018.60 9.517 9.990 1689.870 -7.392 1.1101 5075.1231 0.4732

60.0 108.98 103.812 1019.70 9.521 10.205 1689.870 -7.392 1.1083 5076.5862 0.6840

61.0 108.83 103.662 1021.19 9.527 10.412 1689.870 -7.392 1.1060 5078.4307 0.8852

62.0 108.65 103.479 1023.05 9.533 10.607 1689.870 -7.392 1.1031 5080.6281 1.0742

63.0 108.44 103.268 1025.26 9.540 10.789 1689.870 -7.392 1.0998 5083.1459 1.2486

64.0 108.21 103.031 1027.77 9.549 10.955 1689.870 -7.392 1.0961 5085.9474 1.4062

65.0 107.95 102.772 1030.56 9.558 11.103 1689.870 -7.392 1.0921 5088.9930 1.5451

66.0 107.67 102.493 1033.58 9.567 11.231 1689.870 -7.392 1.0877 5092.2399 1.6635

67.0 107.38 102.199 1036.79 9.578 11.338 1689.870 -7.392 1.0831 5095.6432 1.7601

68.0 107.08 101.895 1040.16 9.588 11.422 1689.870 -7.392 1.0784 5099.1559 1.8338

69.0 106.77 101.583 1043.63 9.600 11.483 1689.870 -7.392 1.0736 5102.7301 1.8838

70.0 106.46 101.269 1047.16 9.611 11.520 1689.870 -7.392 1.0687 5106.3170 1.9094

71.0 106.15 100.957 1050.71 9.622 11.533 1689.870 -7.392 1.0639 5109.8679 1.9107

72.0 105.84 100.650 1054.23 9.633 11.521 1689.870 -7.392 1.0592 5113.3348 1.8877

73.0 105.55 100.352 1057.67 9.645 11.485 1689.870 -7.392 1.0547 5116.6707 1.8409

74.0 105.26 100.068 1060.99 9.655 11.426 1689.870 -7.392 1.0504 5119.8305 1.7711

75.0 105.00 99.802 1064.16 9.665 11.345 1689.870 -7.392 1.0463 5122.7717 1.6795

76.0 104.76 99.555 1067.14 9.674 11.242 1689.870 -7.392 1.0426 5125.4547 1.5672

77.0 104.54 99.333 1069.88 9.683 11.119 1689.870 -7.392 1.0392 5127.8433 1.4362

78.0 104.34 99.137 1072.37 9.690 10.978 1689.870 -7.392 1.0362 5129.9057 1.2881

79.0 104.18 98.969 1074.56 9.696 10.822 1689.870 -7.392 1.0337 5131.6146 1.1253

80.0 104.04 98.833 1076.45 9.701 10.651 1689.870 -7.392 1.0316 5132.9475 0.9498

81.0 103.94 98.728 1078.01 9.705 10.469 1689.870 -7.392 1.0300 5133.8872 0.7643

82.0 103.87 98.658 1079.22 9.707 10.279 1689.870 -7.392 1.0289 5134.4223 0.5714

83.0 103.84 98.621 1080.08 9.708 10.082 1689.870 -7.392 1.0283 5134.5468 0.3736

84.0 103.84 98.619 1080.57 9.708 9.881 1689.870 -7.392 1.0282 5134.2607 0.1738

85.0 103.87 98.650 1080.71 9.705 9.680 1689.870 -7.392 1.0285 5133.5696 -0.025

86.0 103.94 98.716 1080.48 9.702 9.481 1689.870 -7.392 1.0294 5132.4850 -0.221

87.0 104.04 98.813 1079.91 9.697 9.286 1689.870 -7.392 1.0308 5131.0237 -0.411

88.0 104.17 98.941 1079.00 9.692 9.099 1689.870 -7.392 1.0326 5129.2077 -0.592

89.0 104.33 99.097 1077.76 9.685 8.922 1689.870 -7.392 1.0348 5127.0639 -0.762

90.0 104.51 99.280 1076.23 9.677 8.757 1689.870 -7.392 1.0375 5124.6234 -0.919

91.0 104.72 99.486 1074.41 9.668 8.606 1689.870 -7.392 1.0405 5121.9214 -1.062

92.0 104.95 99.713 1072.35 9.658 8.471 1689.870 -7.392 1.0439 5118.9961 -1.187

93.0 105.19 99.957 1070.08 9.649 8.354 1689.870 -7.392 1.0475 5115.8887 -1.294

94.0 105.45 100.215 1067.61 9.638 8.257 1689.870 -7.392 1.0514 5112.6421 -1.381

95.0 105.72 100.483 1065.00 9.628 8.180 1689.870 -7.392 1.0555 5109.3008 -1.447

96.0 106.00 100.758 1062.29 9.617 8.125 1689.870 -7.392 1.0596 5105.9100 -1.492

97.0 106.27 101.036 1059.50 9.607 8.091 1689.870 -7.392 1.0639 5102.5148 -1.516

98.0 106.55 101.312 1056.68 9.597 8.079 1689.870 -7.392 1.0682 5099.1599 -1.517

99.0 106.82 101.584 1053.86 9.587 8.090 1689.870 -7.392 1.0725 5095.8888 -1.497

100.0 107.09 101.848 1051.10 9.578 8.122 1689.870 -7.392 1.0766 5092.7430 -1.456

101.0 107.34 102.099 1048.43 9.570 8.175 1689.870 -7.392 1.0806 5089.7620 -1.395

102.0 107.57 102.336 1045.89 9.562 8.247 1689.870 -7.392 1.0844 5086.9825 -1.314

103.0 107.79 102.555 1043.51 9.555 8.339 1689.870 -7.392 1.0879 5084.4376 -1.215

104.0 107.99 102.752 1041.33 9.548 8.448 1689.870 -7.392 1.0912 5082.1573 -1.100

105.0 108.16 102.927 1039.37 9.543 8.573 1689.870 -7.392 1.0940 5080.1675 -0.970

106.0 108.31 103.075 1037.68 9.539 8.712 1689.870 -7.392 1.0965 5078.4897 -0.826

107.0 108.43 103.197 1036.26 9.535 8.862 1689.870 -7.392 1.0985 5077.1414 -0.672

108.0 108.52 103.290 1035.13 9.533 9.023 1689.870 -7.392 1.1001 5076.1354 -0.510

109.0 108.58 103.353 1034.33 9.531 9.190 1689.870 -7.392 1.1013 5075.4799 -0.340

110.0 108.61 103.386 1033.85 9.531 9.364 1689.870 -7.392 1.1019 5075.1786 -0.167

111.0 108.61 103.388 1033.70 9.531 9.540 1689.870 -7.392 1.1020 5075.2306 0.0086

112.0 108.59 103.361 1033.88 9.532 9.716 1689.870 -7.392 1.1017 5075.6302 0.1837

113.0 108.53 103.304 1034.39 9.535 9.891 1689.870 -7.392 1.1009 5076.3677 0.3561

114.0 108.44 103.218 1035.22 9.538 10.062 1689.870 -7.392 1.0996 5077.4291 0.5235

115.0 108.33 103.105 1036.37 9.542 10.226 1689.870 -7.392 1.0979 5078.7962 0.6837

116.0 108.19 102.967 1037.80 9.547 10.382 1689.870 -7.392 1.0958 5080.4473 0.8347

117.0 108.03 102.806 1039.51 9.553 10.528 1689.870 -7.392 1.0933 5082.3571 0.9747

118.0 107.85 102.624 1041.47 9.559 10.661 1689.870 -7.392 1.0905 5084.4973 1.1017

119.0 107.65 102.423 1043.65 9.566 10.781 1689.870 -7.392 1.0874 5086.8368 1.2143

120.0 107.44 102.207 1046.02 9.574 10.885 1689.870 -7.392 1.0840 5089.3422 1.3110

Дослідження якості стабілізації нового зада­ного значення приладової швидкості при відсутності збурення

 **T V Vpr H a teta P1 dV ny Psu traekt**

 0.0 110.00 104.880 1000.00 9.131 9.131 1689.870 -2.892 1.0690 5069.6107 0.0000

 1.0 110.00 104.881 1000.00 9.096 9.088 1689.870 -2.594 1.0638 5069.5924 -0.0081

 2.0 110.01 104.892 999.93 9.001 8.932 1689.870 -2.316 1.0496 5069.4171 -0.0689

 3.0 110.05 104.928 999.68 8.914 8.707 1689.870 -2.705 1.0371 5068.9050 -0.2073

 4.0 110.11 104.988 999.15 9.030 8.700 1689.870 -2.826 1.0559 5068.1385 -0.3299

 5.0 110.17 105.050 998.48 9.120 8.768 1689.870 -2.853 1.0708 5067.4227 -0.3518

 6.0 110.23 105.107 997.82 9.117 8.780 1689.870 -2.801 1.0715 5066.7850 -0.3369

 7.0 110.28 105.164 997.17 9.076 8.739 1689.870 -2.697 1.0664 5066.1449 -0.3366

 8.0 110.34 105.226 996.50 9.004 8.634 1689.870 -2.358 1.0568 5065.4171 -0.3707

 9.0 110.42 105.306 995.70 8.890 8.417 1689.870 -2.107 1.0411 5064.4400 -0.4736

 10.0 110.54 105.417 994.63 8.812 8.164 1689.870 -2.113 1.0313 5063.0641 -0.6475

 11.0 110.68 105.562 993.19 8.799 7.960 1689.870 -2.095 1.0323 5061.2955 -0.8398

 12.0 110.85 105.737 991.39 8.799 7.780 1689.870 -2.114 1.0357 5059.1972 -1.0191

 13.0 111.05 105.939 989.26 8.797 7.617 1689.870 -2.134 1.0393 5056.8131 -1.1805

 14.0 111.28 106.165 986.83 8.792 7.469 1689.870 -2.152 1.0430 5054.1830 -1.3236

 15.0 111.52 106.412 984.13 8.785 7.337 1689.870 -2.166 1.0467 5051.3463 -1.4483

 16.0 111.78 106.675 981.20 8.776 7.221 1689.870 -2.176 1.0504 5048.3421 -1.5545

 17.0 112.05 106.952 978.08 8.765 7.123 1689.870 -2.183 1.0542 5045.2089 -1.6422

 18.0 112.34 107.241 974.79 8.753 7.041 1689.870 -2.187 1.0579 5041.9845 -1.7116

 19.0 112.63 107.536 971.38 8.739 6.976 1689.870 -2.188 1.0615 5038.7050 -1.7632

 20.0 112.92 107.836 967.87 8.724 6.926 1689.870 -2.186 1.0651 5035.4049 -1.7976

 21.0 113.22 108.138 964.30 8.708 6.893 1689.870 -2.180 1.0685 5032.1166 -1.8154

 22.0 113.52 108.439 960.71 8.691 6.873 1689.870 -2.171 1.0717 5028.8699 -1.8177

 23.0 113.81 108.736 957.11 8.673 6.868 1689.870 -2.158 1.0747 5025.6922 -1.8055

 24.0 114.09 109.027 953.55 8.655 6.875 1689.870 -2.143 1.0775 5022.6075 -1.7800

 25.0 114.37 109.310 950.03 8.636 6.893 1689.870 -2.124 1.0799 5019.6372 -1.7427

 26.0 114.64 109.584 946.60 8.616 6.921 1689.870 -2.102 1.0821 5016.7991 -1.6950

 27.0 114.89 109.847 943.26 8.596 6.957 1689.870 -2.077 1.0840 5014.1080 -1.6383

 28.0 115.14 110.097 940.03 8.575 7.001 1689.870 -2.050 1.0856 5011.5753 -1.5742

 29.0 115.37 110.333 936.94 8.554 7.050 1689.870 -2.020 1.0868 5009.2094 -1.5043

 30.0 115.58 110.556 933.98 8.534 7.104 1689.870 -1.988 1.0878 5007.0156 -1.4300

 31.0 115.78 110.764 931.17 8.513 7.160 1689.870 -1.954 1.0884 5004.9961 -1.3528

 32.0 115.97 110.957 928.51 8.492 7.218 1689.870 -1.918 1.0887 5003.1508 -1.2741

 33.0 116.14 111.136 926.01 8.471 7.276 1689.870 -1.881 1.0888 5001.4769 -1.1953

 34.0 116.30 111.300 923.67 8.451 7.333 1689.870 -1.844 1.0886 4999.9696 -1.1175

 35.0 116.45 111.451 921.47 8.431 7.389 1689.870 -1.806 1.0883 4998.6222 -1.0417

 36.0 116.58 111.588 919.43 8.411 7.442 1689.870 -1.768 1.0877 4997.4264 -0.9690

 37.0 116.70 111.712 917.53 8.393 7.493 1689.870 -1.730 1.0869 4996.3729 -0.8999

 38.0 116.81 111.824 915.76 8.374 7.539 1689.870 -1.693 1.0861 4995.4512 -0.8352

 39.0 116.90 111.926 914.12 8.357 7.582 1689.870 -1.657 1.0851 4994.6504 -0.7753

 40.0 116.99 112.018 912.59 8.340 7.620 1689.870 -1.622 1.0841 4993.9591 -0.7206

 41.0 117.07 112.100 911.17 8.325 7.653 1689.870 -1.589 1.0831 4993.3659 -0.6711

 42.0 117.14 112.175 909.85 8.310 7.683 1689.870 -1.558 1.0820 4992.8597 -0.6269

 43.0 117.20 112.242 908.61 8.296 7.708 1689.870 -1.528 1.0810 4992.4297 -0.5880

 44.0 117.26 112.304 907.44 8.283 7.729 1689.870 -1.500 1.0800 4992.0655 -0.5542

 45.0 117.31 112.360 906.34 8.271 7.746 1689.870 -1.475 1.0791 4991.7577 -0.5251

 46.0 117.36 112.411 905.29 8.260 7.760 1689.870 -1.452 1.0782 4991.4976 -0.5005

 47.0 117.40 112.459 904.28 8.250 7.770 1689.870 -1.431 1.0775 4991.2773 -0.4799

 48.0 117.45 112.504 903.32 8.241 7.778 1689.870 -1.412 1.0768 4991.0899 -0.4630

 49.0 117.48 112.546 902.38 8.233 7.783 1689.870 -1.395 1.0762 4990.9295 -0.4492

 50.0 117.52 112.586 901.47 8.225 7.787 1689.870 -1.380 1.0757 4990.7911 -0.4381

 51.0 117.56 112.625 900.58 8.218 7.789 1689.870 -1.366 1.0753 4990.6706 -0.4293

 52.0 117.59 112.662 899.71 8.212 7.790 1689.870 -1.354 1.0750 4990.5647 -0.4223

 53.0 117.62 112.698 898.85 8.207 7.790 1689.870 -1.344 1.0748 4990.4709 -0.4167

 54.0 117.65 112.733 898.00 8.202 7.789 1689.870 -1.335 1.0746 4990.3875 -0.4122

 55.0 117.68 112.767 897.16 8.197 7.789 1689.870 -1.327 1.0745 4990.3131 -0.4085

 56.0 117.72 112.801 896.32 8.193 7.788 1689.870 -1.319 1.0744 4990.2471 -0.4052

 57.0 117.74 112.834 895.49 8.189 7.787 1689.870 -1.313 1.0744 4990.1890 -0.4023

 58.0 117.77 112.866 894.67 8.185 7.786 1689.870 -1.307 1.0744 4990.1388 -0.3994

 59.0 117.80 112.898 893.85 8.182 7.786 1689.870 -1.301 1.0745 4990.0965 -0.3964

 60.0 117.83 112.929 893.04 8.179 7.785 1689.870 -1.296 1.0745 4990.0626 -0.3933

 61.0 117.86 112.959 892.23 8.176 7.786 1689.870 -1.291 1.0746 4990.0373 -0.3901

 62.0 117.88 112.989 891.43 8.173 7.786 1689.870 -1.286 1.0746 4990.0210 -0.3866

 63.0 117.91 113.018 890.64 8.159 7.772 1689.870 -1.255 1.0729 4990.0050 -0.3867

 64.0 117.94 113.049 889.84 8.155 7.762 1689.870 -1.250 1.0727 4989.9732 -0.3927

 65.0 117.97 113.080 889.02 8.155 7.758 1689.870 -1.253 1.0734 4989.9370 -0.3967

 66.0 117.99 113.111 888.21 8.155 7.758 1689.870 -1.257 1.0741 4989.9045 -0.3976

 67.0 118.02 113.142 887.39 8.155 7.760 1689.870 -1.259 1.0747 4989.8807 -0.3955

 68.0 118.05 113.172 886.58 8.154 7.763 1689.870 -1.259 1.0751 4989.8697 -0.3911

 69.0 118.07 113.200 885.78 8.153 7.768 1689.870 -1.257 1.0754 4989.8740 -0.3850

 70.0 118.10 113.228 884.99 8.151 7.773 1689.870 -1.254 1.0756 4989.8953 -0.3777

 71.0 118.12 113.253 884.22 8.149 7.779 1689.870 -1.250 1.0757 4989.9341 -0.3698

 72.0 118.14 113.277 883.47 8.146 7.784 1689.870 -1.245 1.0757 4989.9903 -0.3616

 73.0 118.16 113.300 882.73 8.143 7.789 1689.870 -1.239 1.0757 4990.0629 -0.3537

 74.0 118.18 113.322 882.01 8.140 7.794 1689.870 -1.232 1.0756 4990.1506 -0.3462

 75.0 118.19 113.342 881.30 8.137 7.797 1689.870 -1.225 1.0754 4990.2518 -0.3394

 76.0 118.21 113.361 880.61 8.134 7.800 1689.870 -1.219 1.0752 4990.3646 -0.3335

 77.0 118.22 113.379 879.92 8.130 7.802 1689.870 -1.212 1.0751 4990.4871 -0.3285

 78.0 118.24 113.396 879.25 8.127 7.803 1689.870 -1.206 1.0749 4990.6176 -0.3243

 79.0 118.25 113.413 878.59 8.125 7.804 1689.870 -1.200 1.0747 4990.7545 -0.3210

 80.0 118.27 113.429 877.93 8.122 7.804 1689.870 -1.195 1.0746 4990.8964 -0.3184

 81.0 118.28 113.445 877.27 8.119 7.803 1689.870 -1.191 1.0745 4991.0423 -0.3163

 82.0 118.29 113.460 876.62 8.117 7.802 1689.870 -1.186 1.0744 4991.1913 -0.3148

 83.0 118.30 113.476 875.97 8.108 7.793 1689.870 -1.159 1.0732 4991.3398 -0.3150

 84.0 118.32 113.493 875.31 8.103 7.781 1689.870 -1.157 1.0725 4991.4696 -0.3219

 85.0 118.33 113.511 874.64 8.103 7.775 1689.870 -1.160 1.0731 4991.5871 -0.3285

 86.0 118.35 113.529 873.96 8.105 7.773 1689.870 -1.166 1.0737 4991.7008 -0.3323

 87.0 118.36 113.548 873.27 8.106 7.773 1689.870 -1.170 1.0743 4991.8162 -0.3333

 88.0 118.38 113.566 872.58 8.107 7.775 1689.870 -1.173 1.0747 4991.9376 -0.3318

 89.0 118.39 113.584 871.90 8.106 7.778 1689.870 -1.173 1.0751 4992.0679 -0.3285

 90.0 118.41 113.601 871.23 8.106 7.782 1689.870 -1.173 1.0753 4992.2091 -0.3239

 91.0 118.42 113.617 870.56 8.105 7.786 1689.870 -1.170 1.0754 4992.3621 -0.3184

 92.0 118.43 113.631 869.91 8.103 7.790 1689.870 -1.167 1.0754 4992.5269 -0.3127

 93.0 118.44 113.645 869.27 8.101 7.794 1689.870 -1.163 1.0754 4992.7026 -0.3072

 94.0 118.45 113.658 868.64 8.099 7.797 1689.870 -1.158 1.0753 4992.8881 -0.3020

 95.0 118.46 113.670 868.02 8.097 7.799 1689.870 -1.153 1.0751 4993.0818 -0.2976

 96.0 118.47 113.681 867.41 8.094 7.800 1689.870 -1.148 1.0749 4993.2820 -0.2939

 97.0 118.48 113.692 866.80 8.092 7.801 1689.870 -1.143 1.0748 4993.4871 -0.2910

 98.0 118.48 113.703 866.20 8.090 7.801 1689.870 -1.139 1.0746 4993.6956 -0.2890

 99.0 118.49 113.713 865.61 8.088 7.800 1689.870 -1.135 1.0745 4993.9063 -0.2875

 100.0 118.50 113.723 865.01 8.086 7.800 1689.870 -1.131 1.0744 4994.1182 -0.2867

 101.0 118.51 113.733 864.42 8.085 7.798 1689.870 -1.128 1.0743 4994.3306 -0.2862

 102.0 118.51 113.743 863.83 8.083 7.797 1689.870 -1.126 1.0743 4994.5432 -0.2860

 103.0 118.52 113.753 863.24 8.082 7.796 1689.870 -1.124 1.0743 4994.7559 -0.2859

 104.0 118.53 113.763 862.65 8.081 7.795 1689.870 -1.122 1.0743 4994.9688 -0.2859

 105.0 118.53 113.773 862.06 8.080 7.794 1689.870 -1.120 1.0743 4995.1822 -0.2857

 106.0 118.54 113.783 861.47 8.079 7.793 1689.870 -1.119 1.0744 4995.3962 -0.2854

 107.0 118.55 113.793 860.88 8.078 7.793 1689.870 -1.117 1.0744 4995.6114 -0.2849

 108.0 118.55 113.803 860.29 8.077 7.793 1689.870 -1.116 1.0745 4995.8280 -0.2843

 109.0 118.56 113.812 859.70 8.076 7.792 1689.870 -1.114 1.0745 4996.0464 -0.2835

 110.0 118.57 113.822 859.11 8.075 7.792 1689.870 -1.113 1.0745 4996.2667 -0.2825

 111.0 118.57 113.831 858.53 8.074 7.793 1689.870 -1.111 1.0746 4996.4892 -0.2814

 112.0 118.58 113.840 857.95 8.073 7.793 1689.870 -1.109 1.0746 4996.7138 -0.2803

 113.0 118.59 113.849 857.37 8.072 7.793 1689.870 -1.107 1.0746 4996.9406 -0.2791

 114.0 118.59 113.857 856.79 8.071 7.793 1689.870 -1.105 1.0746 4997.1694 -0.2780

 115.0 118.60 113.866 856.22 8.070 7.793 1689.870 -1.103 1.0746 4997.4002 -0.2769

 116.0 118.60 113.874 855.65 8.069 7.793 1689.870 -1.101 1.0746 4997.6329 -0.2759

 117.0 118.61 113.882 855.08 8.068 7.793 1689.870 -1.099 1.0745 4997.8672 -0.2749

 118.0 118.61 113.890 854.51 8.067 7.793 1689.870 -1.097 1.0745 4998.1029 -0.2740

 119.0 118.62 113.898 853.94 8.065 7.792 1689.870 -1.095 1.0745 4998.3401 -0.2732

 120.0 118.62 113.905 853.38 8.064 7.792 1689.870 -1.094 1.0745 4998.5784 -0.2724

 121.0 118.63 113.913 852.81 8.057 7.784 1689.870 -1.073 1.0735 4998.8147 -0.2732

 122.0 118.63 113.922 852.24 8.054 7.775 1689.870 -1.073 1.0730 4999.0342 -0.2792

 123.0 118.64 113.932 851.66 8.056 7.771 1689.870 -1.078 1.0735 4999.2439 -0.2844

Дослідження якості стабілізації приладової швидкості при відмові центрального двигуна методом Рунге-Кутти другого порядку з корекцією у середній похідній.

**номінальниі значення параметрів законів управління АБСУ**

 **T V Vpr H a teta P1 dV ny Psu traekt**

0.0 110.00 104.880 1000.00 9.131 9.131 1686.000 -6.392 1.0690 5065.7404 0.0000

 1.0 110.01 104.892 1000.00 9.135 9.138 1475.250 -6.381 1.0694 4854.7596 0.0032

 2.0 109.95 104.836 1000.01 9.134 9.134 899.200 -6.384 1.0669 4279.7581 0.0001

 3.0 109.77 104.674 999.99 9.143 9.122 -97.000 -6.396 1.0627 3286.6218 -0.0213

 4.0 109.51 104.420 999.92 9.162 9.100 -288.000 -6.425 1.0601 3100.4608 -0.0614

 5.0 109.26 104.191 999.76 9.180 9.069 -288.000 -6.461 1.0582 3104.9054 -0.1104

 6.0 109.03 103.972 999.50 9.198 9.031 -288.000 -6.491 1.0566 3109.2071 -0.1675

 7.0 108.82 103.765 999.12 9.216 8.984 -288.000 -6.521 1.0551 3113.3528 -0.2319

 8.0 108.61 103.572 998.62 9.232 8.929 -288.000 -6.549 1.0537 3117.3298 -0.3034

 9.0 108.42 103.394 997.98 9.248 8.866 -288.000 -6.577 1.0524 3121.1267 -0.3812

 10.0 108.25 103.230 997.18 9.263 8.798 -288.000 -6.605 1.0514 3124.7347 -0.4644

 11.0 108.09 103.083 996.23 9.277 8.726 -288.000 -6.632 1.0506 3128.1471 -0.5517

 12.0 107.95 102.952 995.11 9.291 8.649 -288.000 -6.660 1.0501 3131.3601 -0.6421

 13.0 107.82 102.838 993.82 9.304 8.570 -288.000 -6.687 1.0497 3134.3721 -0.7342

 14.0 107.71 102.741 992.35 9.317 8.490 -288.000 -6.713 1.0497 3137.1840 -0.8269

 15.0 107.62 102.660 990.72 9.329 8.410 -288.000 -6.739 1.0498 3139.7990 -0.9191

 16.0 107.54 102.595 988.91 9.340 8.330 -288.000 -6.764 1.0502 3142.2224 -1.0096

 17.0 107.48 102.546 986.94 9.350 8.253 -288.000 -6.788 1.0507 3144.4617 -1.0974

 18.0 107.44 102.511 984.80 9.359 8.178 -288.000 -6.810 1.0514 3146.5260 -1.1816

 19.0 107.40 102.491 982.52 9.368 8.106 -288.000 -6.832 1.0523 3148.4261 -1.2614

 20.0 107.38 102.485 980.08 9.375 8.039 -288.000 -6.852 1.0533 3150.1739 -1.3360

 21.0 107.38 102.490 977.52 9.382 7.977 -288.000 -6.871 1.0544 3151.7827 -1.4048

 22.0 107.38 102.506 974.83 9.387 7.920 -288.000 -6.887 1.0556 3153.2663 -1.4674

 23.0 107.39 102.532 972.03 9.392 7.869 -288.000 -6.902 1.0569 3154.6393 -1.5235

 24.0 107.42 102.567 969.13 9.396 7.823 -288.000 -6.915 1.0582 3155.9164 -1.5727

 25.0 107.44 102.609 966.14 9.399 7.784 -288.000 -6.927 1.0595 3157.1125 -1.6150

 26.0 107.48 102.658 963.08 9.401 7.750 -288.000 -6.936 1.0608 3158.2419 -1.6503

 27.0 107.52 102.711 959.96 9.402 7.723 -288.000 -6.943 1.0621 3159.3189 -1.6790

 28.0 107.56 102.768 956.79 9.402 7.701 -288.000 -6.947 1.0633 3160.3569 -1.7010

 29.0 107.61 102.828 953.58 9.401 7.684 -288.000 -6.950 1.0645 3161.3685 -1.7169

 30.0 107.66 102.890 950.34 9.400 7.673 -288.000 -6.951 1.0656 3162.3652 -1.7270

 31.0 107.71 102.953 947.09 9.398 7.666 -288.000 -6.950 1.0666 3163.3577 -1.7317

 32.0 107.75 103.015 943.84 9.395 7.663 -288.000 -6.947 1.0675 3164.3553 -1.7317

 33.0 107.80 103.077 940.58 9.392 7.664 -288.000 -6.942 1.0683 3165.3661 -1.7274

 34.0 107.85 103.137 937.34 9.388 7.668 -288.000 -6.936 1.0690 3166.3968 -1.7194

 35.0 107.89 103.196 934.11 9.383 7.675 -288.000 -6.928 1.0695 3167.4532 -1.7084

 36.0 107.93 103.252 930.91 9.378 7.684 -288.000 -6.918 1.0700 3168.5394 -1.6949

 37.0 107.97 103.305 927.73 9.373 7.694 -288.000 -6.908 1.0704 3169.6587 -1.6795

 38.0 108.01 103.356 924.58 9.368 7.705 -288.000 -6.897 1.0706 3170.8131 -1.6627

 39.0 108.04 103.403 921.46 9.362 7.717 -288.000 -6.884 1.0707 3172.0037 -1.6451

 40.0 108.07 103.448 918.37 9.356 7.729 -288.000 -6.872 1.0708 3173.2306 -1.6271

 41.0 108.10 103.489 915.32 9.351 7.741 -288.000 -6.859 1.0708 3174.4933 -1.6091

 42.0 108.12 103.528 912.30 9.345 7.753 -288.000 -6.845 1.0707 3175.7903 -1.5915

 43.0 108.14 103.563 909.31 9.339 7.764 -288.000 -6.832 1.0706 3177.1200 -1.5745

 44.0 108.16 103.596 906.35 9.333 7.775 -288.000 -6.819 1.0704 3178.4801 -1.5584

 45.0 108.18 103.626 903.42 9.327 7.784 -288.000 -6.806 1.0702 3179.8681 -1.5434

 46.0 108.19 103.654 900.52 9.322 7.792 -288.000 -6.794 1.0700 3181.2812 -1.5296

 47.0 108.21 103.680 897.65 9.317 7.800 -288.000 -6.781 1.0698 3182.7168 -1.5170

 48.0 108.22 103.704 894.79 9.312 7.806 -288.000 -6.770 1.0696 3184.1720 -1.5057

 49.0 108.22 103.727 891.96 9.307 7.812 -288.000 -6.759 1.0693 3185.6441 -1.4956

 50.0 108.23 103.748 889.14 9.303 7.816 -288.000 -6.749 1.0691 3187.1308 -1.4867

 51.0 108.24 103.768 886.34 9.298 7.820 -288.000 -6.739 1.0689 3188.6296 -1.4790

 52.0 108.24 103.787 883.55 9.295 7.822 -288.000 -6.730 1.0687 3190.1384 -1.4723

 53.0 108.25 103.805 880.78 9.291 7.825 -288.000 -6.722 1.0686 3191.6556 -1.4664

 54.0 108.25 103.822 878.01 9.288 7.826 -288.000 -6.714 1.0684 3193.1794 -1.4614

 55.0 108.25 103.839 875.25 9.284 7.827 -288.000 -6.707 1.0683 3194.7086 -1.4570

 56.0 108.26 103.855 872.51 9.281 7.828 -288.000 -6.701 1.0682 3196.2422 -1.4532

 57.0 108.26 103.870 869.76 9.279 7.829 -288.000 -6.695 1.0682 3197.7793 -1.4497

 58.0 108.26 103.886 867.03 9.276 7.830 -288.000 -6.689 1.0681 3199.3195 -1.4466

 59.0 108.26 103.901 864.30 9.274 7.830 -288.000 -6.684 1.0681 3200.8622 -1.4437

 60.0 108.26 103.915 861.57 9.271 7.831 -288.000 -6.679 1.0681 3202.4073 -1.4409

 61.0 108.26 103.930 858.85 9.269 7.831 -288.000 -6.674 1.0681 3203.9546 -1.4382

 62.0 108.26 103.944 856.14 9.267 7.832 -288.000 -6.670 1.0681 3205.5041 -1.4356

 63.0 108.26 103.958 853.43 9.265 7.832 -288.000 -6.665 1.0681 3207.0558 -1.4329

 64.0 108.26 103.971 850.72 9.263 7.833 -288.000 -6.661 1.0681 3208.6097 -1.4302

 65.0 108.26 103.984 848.02 9.261 7.834 -288.000 -6.657 1.0681 3210.1661 -1.4274

 66.0 108.26 103.997 845.33 9.260 7.835 -288.000 -6.653 1.0681 3211.7248 -1.4246

 67.0 108.26 104.010 842.64 9.258 7.836 -288.000 -6.649 1.0681 3213.2861 -1.4217

 68.0 108.26 104.022 839.96 9.256 7.837 -288.000 -6.645 1.0681 3214.8499 -1.4188

 69.0 108.26 104.034 837.28 9.254 7.838 -288.000 -6.641 1.0681 3216.4163 -1.4159

 70.0 108.26 104.046 834.61 9.253 7.839 -288.000 -6.637 1.0681 3217.9851 -1.4130

 71.0 108.25 104.057 831.94 9.251 7.841 -288.000 -6.634 1.0681 3219.5564 -1.4101

 72.0 108.25 104.068 829.28 9.249 7.842 -288.000 -6.630 1.0681 3221.1300 -1.4072

 73.0 108.25 104.078 826.62 9.247 7.843 -288.000 -6.626 1.0681 3222.7058 -1.4044

 74.0 108.25 104.089 823.97 9.246 7.844 -288.000 -6.622 1.0681 3224.2837 -1.4016

 75.0 108.24 104.099 821.33 9.244 7.845 -288.000 -6.618 1.0681 3225.8634 -1.3990

 76.0 108.24 104.108 818.69 9.243 7.846 -288.000 -6.615 1.0681 3227.4448 -1.3963

 77.0 108.23 104.118 816.05 9.241 7.847 -288.000 -6.611 1.0680 3229.0277 -1.3938

 78.0 108.23 104.127 813.42 9.239 7.848 -288.000 -6.608 1.0680 3230.6120 -1.3913

 79.0 108.23 104.136 810.79 9.238 7.849 -288.000 -6.604 1.0680 3232.1975 -1.3889

 80.0 108.22 104.145 808.17 9.237 7.850 -288.000 -6.601 1.0680 3233.7839 -1.3866

 81.0 108.22 104.153 805.56 9.235 7.851 -288.000 -6.598 1.0680 3235.3713 -1.3843

 82.0 108.21 104.162 802.94 9.234 7.852 -288.000 -6.595 1.0680 3236.9594 -1.3821

 83.0 108.21 104.170 800.34 9.232 7.852 -288.000 -6.592 1.0679 3238.5481 -1.3800

 84.0 108.20 104.178 797.73 9.231 7.853 -288.000 -6.589 1.0679 3240.1374 -1.3779

 85.0 108.20 104.186 795.13 9.230 7.854 -288.000 -6.586 1.0679 3241.7271 -1.3758

 86.0 108.19 104.194 792.54 9.229 7.855 -288.000 -6.583 1.0679 3243.3172 -1.3738

 87.0 108.18 104.201 789.94 9.227 7.855 -288.000 -6.580 1.0679 3244.9076 -1.3718

 88.0 108.18 104.208 787.36 9.226 7.856 -288.000 -6.577 1.0679 3246.4983 -1.3698

 89.0 108.17 104.216 784.77 9.225 7.857 -288.000 -6.574 1.0679 3248.0892 -1.3678

 90.0 108.17 104.223 782.19 9.224 7.858 -288.000 -6.572 1.0679 3249.6802 -1.3659

 91.0 108.16 104.230 779.61 9.223 7.859 -288.000 -6.569 1.0679 3251.2714 -1.3640

 92.0 108.15 104.236 777.04 9.221 7.859 -288.000 -6.567 1.0679 3252.8627 -1.3621

 93.0 108.15 104.243 774.47 9.220 7.860 -288.000 -6.564 1.0679 3254.4539 -1.3602

 94.0 108.14 104.250 771.91 9.219 7.861 -288.000 -6.561 1.0679 3256.0452 -1.3583

 95.0 108.13 104.256 769.35 9.218 7.862 -288.000 -6.559 1.0679 3257.6365 -1.3564

 96.0 108.13 104.262 766.79 9.217 7.862 -288.000 -6.556 1.0679 3259.2276 -1.3546

 97.0 108.12 104.268 764.23 9.216 7.863 -288.000 -6.554 1.0678 3260.8186 -1.3528

 98.0 108.11 104.274 761.68 9.215 7.864 -288.000 -6.552 1.0678 3262.4094 -1.3510

 99.0 108.11 104.280 759.13 9.214 7.865 -288.000 -6.549 1.0678 3264.0000 -1.3492

100.0 108.10 104.286 756.59 9.213 7.866 -288.000 -6.547 1.0678 3265.5903 -1.3474

101.0 108.09 104.292 754.05 9.212 7.866 -288.000 -6.545 1.0678 3267.1802 -1.3457

102.0 108.08 104.297 751.51 9.211 7.867 -288.000 -6.542 1.0678 3268.7698 -1.3440

103.0 108.08 104.303 748.98 9.210 7.868 -288.000 -6.540 1.0678 3270.3590 -1.3423

104.0 108.07 104.308 746.45 9.209 7.869 -288.000 -6.538 1.0678 3271.9478 -1.3406

105.0 108.06 104.313 743.92 9.208 7.869 -288.000 -6.536 1.0678 3273.5361 -1.3389

106.0 108.05 104.319 741.40 9.207 7.870 -288.000 -6.533 1.0678 3275.1239 -1.3372

107.0 108.05 104.324 738.88 9.206 7.871 -288.000 -6.531 1.0678 3276.7111 -1.3356

108.0 108.04 104.329 736.36 9.206 7.872 -288.000 -6.529 1.0678 3278.2978 -1.3339

109.0 108.03 104.334 733.85 9.205 7.872 -288.000 -6.527 1.0678 3279.8838 -1.3323

110.0 108.02 104.338 731.34 9.204 7.873 -288.000 -6.525 1.0678 3281.4693 -1.3307

111.0 108.01 104.343 728.83 9.203 7.874 -288.000 -6.523 1.0677 3283.0540 -1.3291

112.0 108.01 104.348 726.33 9.202 7.875 -288.000 -6.521 1.0677 3284.6382 -1.3275

113.0 108.00 104.353 723.83 9.201 7.875 -288.000 -6.519 1.0677 3286.2216 -1.3259

114.0 107.99 104.357 721.33 9.200 7.876 -288.000 -6.517 1.0677 3287.8042 -1.3244

115.0 107.98 104.361 718.84 9.200 7.877 -288.000 -6.515 1.0677 3289.3862 -1.3228

116.0 107.97 104.366 716.34 9.199 7.878 -288.000 -6.513 1.0677 3290.9674 -1.3213

117.0 107.96 104.370 713.86 9.198 7.878 -288.000 -6.511 1.0677 3292.5477 -1.3197

118.0 107.96 104.374 711.37 9.197 7.879 -288.000 -6.509 1.0677 3294.1273 -1.3182

119.0 107.95 104.379 708.89 9.196 7.880 -288.000 -6.507 1.0677 3295.7061 -1.3167

120.0 107.94 104.383 706.41 9.196 7.881 -288.000 -6.506 1.0677 3297.2840 -1.3151

Дослідження якості стабілізації приладової швидкості при відмові центрального двигуна методом Рунге-Кутти другого порядку з корекцією у середній похідній.

# ***Значення параметрів законів управління АБСУ збільшені \*100 (Kv\_)***

 **T V Vpr H a teta P1 dV ny Psu traekt**

0.0 110.00 104.880 1000.00 9.131 9.131 1686.000 -6.392 1.0690 5065.7404 0.0000

 1.0 110.00 104.876 1000.06 9.375 9.475 1475.250 -5.440 1.1063 4855.0198 0.1003

 2.0 109.90 104.787 1000.35 8.955 9.094 899.200 -5.395 1.0388 4280.4543 0.1388

 3.0 109.75 104.641 1000.37 8.713 8.565 -97.000 -5.551 0.9978 3286.9938 -0.1476

 4.0 109.56 104.465 999.75 8.837 8.347 -288.000 -5.943 1.0126 3099.7369 -0.4907

 5.0 109.43 104.342 998.58 9.049 8.346 -288.000 -6.361 1.0417 3102.8451 -0.7030

 6.0 109.30 104.231 997.15 9.196 8.412 -288.000 -6.587 1.0616 3105.8927 -0.7837

 7.0 109.18 104.122 995.64 9.262 8.467 -288.000 -6.688 1.0693 3108.9721 -0.7948

 8.0 109.06 104.010 994.13 9.283 8.498 -288.000 -6.713 1.0704 3112.0796 -0.7849

 9.0 108.93 103.898 992.65 9.287 8.510 -288.000 -6.708 1.0687 3115.1872 -0.7776

 10.0 108.81 103.788 991.17 9.285 8.504 -288.000 -6.694 1.0662 3118.2646 -0.7811

 11.0 108.69 103.681 989.67 9.283 8.486 -288.000 -6.682 1.0637 3121.2847 -0.7972

 12.0 108.57 103.579 988.14 9.282 8.457 -288.000 -6.674 1.0615 3124.2250 -0.8251

 13.0 108.47 103.485 986.54 9.283 8.420 -288.000 -6.671 1.0597 3127.0677 -0.8630

 14.0 108.37 103.400 984.86 9.285 8.376 -288.000 -6.672 1.0583 3129.7995 -0.9087

 15.0 108.28 103.324 983.10 9.288 8.328 -288.000 -6.676 1.0573 3132.4107 -0.9605

 16.0 108.20 103.258 981.23 9.292 8.276 -288.000 -6.684 1.0566 3134.8956 -1.0164

 17.0 108.13 103.203 979.26 9.297 8.222 -288.000 -6.693 1.0562 3137.2511 -1.0748

 18.0 108.08 103.159 977.17 9.302 8.167 -288.000 -6.704 1.0561 3139.4774 -1.1344

 19.0 108.03 103.126 974.98 9.307 8.113 -288.000 -6.716 1.0562 3141.5767 -1.1937

 20.0 107.99 103.103 972.67 9.312 8.060 -288.000 -6.729 1.0565 3143.5534 -1.2518

 21.0 107.97 103.089 970.26 9.317 8.009 -288.000 -6.742 1.0570 3145.4137 -1.3077

 22.0 107.95 103.086 967.75 9.321 7.961 -288.000 -6.754 1.0576 3147.1654 -1.3605

 23.0 107.94 103.090 965.14 9.325 7.916 -288.000 -6.766 1.0583 3148.8172 -1.4096

 24.0 107.94 103.103 962.44 9.329 7.874 -288.000 -6.777 1.0592 3150.3789 -1.4545

 25.0 107.95 103.123 959.66 9.332 7.837 -288.000 -6.788 1.0601 3151.8607 -1.4947

 26.0 107.96 103.149 956.81 9.335 7.804 -288.000 -6.797 1.0610 3153.2734 -1.5301

 27.0 107.98 103.181 953.90 9.337 7.776 -288.000 -6.805 1.0620 3154.6276 -1.5604

 28.0 108.00 103.216 950.93 9.338 7.752 -288.000 -6.811 1.0629 3155.9342 -1.5857

 29.0 108.02 103.256 947.93 9.339 7.733 -288.000 -6.816 1.0639 3157.2033 -1.6060

 30.0 108.05 103.298 944.88 9.339 7.718 -288.000 -6.820 1.0648 3158.4450 -1.6214

 31.0 108.08 103.342 941.81 9.339 7.706 -288.000 -6.822 1.0657 3159.6685 -1.6323

 32.0 108.11 103.387 938.73 9.338 7.699 -288.000 -6.822 1.0665 3160.8821 -1.6388

 33.0 108.14 103.432 935.63 9.336 7.695 -288.000 -6.821 1.0672 3162.0937 -1.6415

 34.0 108.18 103.478 932.53 9.334 7.694 -288.000 -6.819 1.0679 3163.3098 -1.6406

 35.0 108.21 103.522 929.44 9.332 7.695 -288.000 -6.815 1.0685 3164.5363 -1.6366

 36.0 108.24 103.566 926.35 9.329 7.699 -288.000 -6.810 1.0689 3165.7780 -1.6300

 37.0 108.26 103.608 923.28 9.326 7.704 -288.000 -6.804 1.0693 3167.0387 -1.6213

 38.0 108.29 103.648 920.23 9.322 7.711 -288.000 -6.797 1.0696 3168.3214 -1.6108

 39.0 108.31 103.687 917.20 9.318 7.719 -288.000 -6.789 1.0699 3169.6280 -1.5990

 40.0 108.34 103.723 914.19 9.314 7.728 -288.000 -6.781 1.0700 3170.9599 -1.5863

 41.0 108.36 103.757 911.20 9.310 7.737 -288.000 -6.771 1.0701 3172.3175 -1.5731

 42.0 108.37 103.789 908.24 9.306 7.746 -288.000 -6.762 1.0701 3173.7006 -1.5597

 43.0 108.39 103.818 905.30 9.301 7.755 -288.000 -6.752 1.0701 3175.1087 -1.5464

 44.0 108.40 103.845 902.39 9.297 7.763 -288.000 -6.742 1.0700 3176.5405 -1.5335

 45.0 108.41 103.871 899.50 9.293 7.771 -288.000 -6.732 1.0699 3177.9946 -1.5211

 46.0 108.42 103.894 896.63 9.288 7.779 -288.000 -6.722 1.0698 3179.4692 -1.5095

 47.0 108.43 103.916 893.78 9.284 7.785 -288.000 -6.712 1.0696 3180.9624 -1.4986

 48.0 108.44 103.936 890.96 9.280 7.791 -288.000 -6.703 1.0695 3182.4721 -1.4887

 49.0 108.44 103.955 888.15 9.276 7.797 -288.000 -6.694 1.0693 3183.9964 -1.4797

 50.0 108.45 103.973 885.36 9.273 7.801 -288.000 -6.686 1.0691 3185.5333 -1.4716

 51.0 108.45 103.989 882.58 9.269 7.805 -288.000 -6.678 1.0690 3187.0809 -1.4644

 52.0 108.45 104.005 879.81 9.266 7.808 -288.000 -6.670 1.0688 3188.6374 -1.4581

 53.0 108.45 104.019 877.06 9.263 7.810 -288.000 -6.663 1.0687 3190.2012 -1.4525

 54.0 108.45 104.033 874.31 9.260 7.812 -288.000 -6.656 1.0685 3191.7710 -1.4477

 55.0 108.45 104.047 871.58 9.257 7.814 -288.000 -6.650 1.0684 3193.3456 -1.4434

 56.0 108.45 104.060 868.85 9.255 7.815 -288.000 -6.645 1.0683 3194.9240 -1.4397

 57.0 108.45 104.073 866.13 9.252 7.816 -288.000 -6.639 1.0683 3196.5054 -1.4364

 58.0 108.45 104.085 863.41 9.250 7.817 -288.000 -6.634 1.0682 3198.0891 -1.4334

 59.0 108.45 104.097 860.70 9.248 7.817 -288.000 -6.630 1.0682 3199.6748 -1.4306

 60.0 108.44 104.109 858.00 9.246 7.818 -288.000 -6.626 1.0682 3201.2620 -1.4280

 61.0 108.44 104.120 855.30 9.244 7.819 -288.000 -6.622 1.0681 3202.8507 -1.4256

 62.0 108.44 104.132 852.60 9.242 7.819 -288.000 -6.618 1.0681 3204.4406 -1.4232

 63.0 108.44 104.143 849.91 9.241 7.820 -288.000 -6.614 1.0681 3206.0318 -1.4208

 64.0 108.43 104.153 847.22 9.239 7.821 -288.000 -6.610 1.0681 3207.6243 -1.4185

 65.0 108.43 104.164 844.54 9.238 7.822 -288.000 -6.607 1.0681 3209.2182 -1.4161

 66.0 108.43 104.174 841.87 9.236 7.822 -288.000 -6.604 1.0681 3210.8134 -1.4136

 67.0 108.42 104.184 839.19 9.235 7.823 -288.000 -6.600 1.0681 3212.4100 -1.4112

 68.0 108.42 104.194 836.53 9.233 7.824 -288.000 -6.597 1.0681 3214.0082 -1.4087

 69.0 108.42 104.204 833.86 9.232 7.826 -288.000 -6.594 1.0681 3215.6079 -1.4062

 70.0 108.41 104.213 831.20 9.230 7.827 -288.000 -6.591 1.0681 3217.2090 -1.4036

 71.0 108.41 104.222 828.55 9.229 7.828 -288.000 -6.587 1.0681 3218.8117 -1.4011

 72.0 108.40 104.231 825.90 9.227 7.829 -288.000 -6.584 1.0681 3220.4158 -1.3985

 73.0 108.40 104.240 823.26 9.226 7.830 -288.000 -6.581 1.0681 3222.0212 -1.3960

 74.0 108.39 104.248 820.62 9.225 7.831 -288.000 -6.578 1.0681 3223.6280 -1.3936

 75.0 108.39 104.256 817.99 9.223 7.832 -288.000 -6.575 1.0681 3225.2358 -1.3911

 76.0 108.38 104.264 815.36 9.222 7.833 -288.000 -6.572 1.0681 3226.8447 -1.3888

 77.0 108.38 104.272 812.73 9.221 7.834 -288.000 -6.569 1.0681 3228.4545 -1.3864

 78.0 108.37 104.279 810.11 9.220 7.835 -288.000 -6.566 1.0681 3230.0650 -1.3842

 79.0 108.36 104.286 807.50 9.218 7.836 -288.000 -6.563 1.0681 3231.6761 -1.3820

 80.0 108.36 104.293 804.89 9.217 7.837 -288.000 -6.560 1.0680 3233.2878 -1.3798

 81.0 108.35 104.300 802.28 9.216 7.838 -288.000 -6.557 1.0680 3234.8998 -1.3777

 82.0 108.35 104.307 799.68 9.215 7.839 -288.000 -6.555 1.0680 3236.5120 -1.3757

 83.0 108.34 104.314 797.08 9.214 7.840 -288.000 -6.552 1.0680 3238.1245 -1.3737

 84.0 108.33 104.320 794.48 9.212 7.841 -288.000 -6.550 1.0680 3239.7370 -1.3717

 85.0 108.32 104.326 791.89 9.211 7.842 -288.000 -6.547 1.0680 3241.3496 -1.3698

 86.0 108.32 104.333 789.30 9.210 7.842 -288.000 -6.544 1.0680 3242.9620 -1.3679

 87.0 108.31 104.339 786.72 9.209 7.843 -288.000 -6.542 1.0680 3244.5744 -1.3660

 88.0 108.30 104.345 784.14 9.208 7.844 -288.000 -6.540 1.0680 3246.1866 -1.3642

 89.0 108.30 104.350 781.56 9.207 7.845 -288.000 -6.537 1.0680 3247.7986 -1.3623

 90.0 108.29 104.356 778.99 9.206 7.846 -288.000 -6.535 1.0679 3249.4104 -1.3605

 91.0 108.28 104.362 776.42 9.205 7.847 -288.000 -6.533 1.0679 3251.0219 -1.3587

 92.0 108.27 104.367 773.85 9.204 7.847 -288.000 -6.531 1.0679 3252.6330 -1.3569

 93.0 108.27 104.373 771.29 9.203 7.848 -288.000 -6.528 1.0679 3254.2439 -1.3552

 94.0 108.26 104.378 768.73 9.202 7.849 -288.000 -6.526 1.0679 3255.8543 -1.3534

 95.0 108.25 104.383 766.18 9.202 7.850 -288.000 -6.524 1.0679 3257.4644 -1.3517

 96.0 108.24 104.388 763.63 9.201 7.851 -288.000 -6.522 1.0679 3259.0740 -1.3499

 97.0 108.23 104.393 761.08 9.200 7.852 -288.000 -6.520 1.0679 3260.6831 -1.3482

 98.0 108.23 104.398 758.53 9.199 7.852 -288.000 -6.518 1.0679 3262.2917 -1.3465

 99.0 108.22 104.403 755.99 9.198 7.853 -288.000 -6.516 1.0679 3263.8998 -1.3448

 100.0 108.21 104.407 753.45 9.197 7.854 -288.000 -6.514 1.0679 3265.5072 -1.3432

 101.0 108.20 104.412 750.92 9.196 7.855 -288.000 -6.512 1.0679 3267.1141 -1.3415

 102.0 108.19 104.416 748.39 9.196 7.856 -288.000 -6.510 1.0679 3268.7203 -1.3399

 103.0 108.18 104.421 745.86 9.195 7.856 -288.000 -6.508 1.0679 3270.3258 -1.3382

 104.0 108.17 104.425 743.33 9.194 7.857 -288.000 -6.506 1.0678 3271.9306 -1.3366

 105.0 108.17 104.429 740.81 9.193 7.858 -288.000 -6.504 1.0678 3273.5347 -1.3350

 106.0 108.16 104.434 738.29 9.192 7.859 -288.000 -6.502 1.0678 3275.1380 -1.3334

 107.0 108.15 104.438 735.78 9.192 7.860 -288.000 -6.500 1.0678 3276.7405 -1.3319

 108.0 108.14 104.442 733.27 9.191 7.860 -288.000 -6.498 1.0678 3278.3422 -1.3303

 109.0 108.13 104.446 730.76 9.190 7.861 -288.000 -6.496 1.0678 3279.9431 -1.3287

 110.0 108.12 104.450 728.25 9.189 7.862 -288.000 -6.495 1.0678 3281.5431 -1.3272

 111.0 108.11 104.453 725.75 9.189 7.863 -288.000 -6.493 1.0678 3283.1422 -1.3257

 112.0 108.10 104.457 723.25 9.188 7.864 -288.000 -6.491 1.0678 3284.7404 -1.3241

 113.0 108.09 104.461 720.75 9.187 7.864 -288.000 -6.489 1.0678 3286.3377 -1.3226

 114.0 108.08 104.465 718.26 9.186 7.865 -288.000 -6.488 1.0678 3287.9340 -1.3211

 115.0 108.08 104.468 715.77 9.186 7.866 -288.000 -6.486 1.0678 3289.5294 -1.3196

 116.0 108.07 104.472 713.28 9.185 7.867 -288.000 -6.484 1.0678 3291.1238 -1.3181

 117.0 108.06 104.475 710.80 9.184 7.868 -288.000 -6.482 1.0678 3292.7172 -1.3166

 118.0 108.05 104.479 708.32 9.184 7.869 -288.000 -6.481 1.0677 3294.3097 -1.3151

 119.0 108.04 104.482 705.84 9.183 7.869 -288.000 -6.479 1.0677 3295.9011 -1.3137

 120.0 108.03 104.485 703.36 9.182 7.870 -288.000 -6.478 1.0677 3297.4914 -1.3122