ODT UCHUN CHEGARA MASALALARNI TAQRIBIY YECHISH

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ANNOTATSIYA

Ushbu maqola Kollokatsiya, Galyorkin, eng kichik kvadratlar, chekli ayirmalar usullari bilan taqribiy yechish Mathcad va Maple dasturlarida tashkil etilgan. [1]

Kalit so‘zlar: Kollokatsiya, Galyorkin, eng kichik kvadratlar, Mathcad va Maple

APPROXIMATE SOLUTION OF BOUNDARY EDGE PROBLEMS FOR ODT

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ABSTRACT

This article is organized in Mathcad and Maple programs on approximate solution by collocation, Galyorkin, least squares, finite difference methods. [1]

Keywords: Collocation, Galyorkin, least squares, Mathcad and Maple

ПРИБЛИЖЕННОЕ РЕШЕНИЕ ГРАНИЧНЫХ ПРОБЛЕМ ДЛЯ ОДТ

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АННОТАЦИЯ

Статья организована в программах Mathcad и Maple по приближенному решению методами коллокации, Галёркина, наименьших квадратов, конечных разностей. [1]

Ключевые слова: Коллокация, Галёркин, наименьшие квадраты, Mathcad и Maple.

ODT uchun chegara masala quyidagicha qo‘yiladi:

$Lu \equiv u'' + p(x)u' + q(x)u = f(x),\ a \le x \le b,$ (differentsial tenglama-DT),

$l_0 u \equiv \alpha_0 u(a) + \alpha_1 u'(a) = \gamma_0$, $l_1 u \equiv \beta_0 u(b) + \beta_1 u'(b) = \gamma_1$.(chegara shartlar-CHSH).

Quyida ushbu chegara masala yechiladi:

$p(x) = x^2\ \ q(x) = -x\ \ \ f(x) = 6/x^4 - 3/x\ \ ua(x) := 1/x^2\ \ a = 1\ \ b = 2$

DT va CHSH qanoatlantiruvchi $u = u(x) \in C^2[a,b]$ funktsiyani topish kerak.

Proektsion usullarda taqribiy echim $u_n(x) \approx u(x)$ quyidagicha izlanadi:

$$u_n(x) = \varphi_0(x) + \sum_{j=1}^{n} c_j \varphi_j(x),\ c_j\text{ -?}.$$

Bu erda $\{\varphi_i(x)\}$ lar bazis funktsiyalar, ular maxsus usul bilan tanlanadi.

Kollokatsiya usulida koeffitsentlar quyidagicha topiladi:

$$Lu_n(x_i) = f(x_i), i = 1..n \Leftrightarrow \sum_{j=1}^{n} c_j L_j \varphi_j(x_i) = f(x_i) - L\varphi_0(x_i), i = 1..n\,.$$

Eng kichik kvadratlar usulida koeffitsentlar quyidagicha topiladi:

$$Lu_n(x) - f(x) \perp L\varphi_i(x) \Leftrightarrow \sum_{j=1}^{n} c_j (L\varphi_j, L\varphi_i) = (f - L\varphi_0, L\varphi_i), i = 1..n\ \ (f,g) = \int_b^a f(x)g(x)dx$$

Galerkin-Ritts usulida koeffitsentlar quyidagicha topiladi:

$$Lu_n(x) - f(x) \perp \varphi_i(x) \Leftrightarrow \sum_{j=1}^{n} c_j (L\varphi_j, \varphi_i) = (f - L\varphi_0, \varphi_i),\ (f,g) = \int_b^a f(x)g(x)dx,\ i = 1,\ldots n$$

Bazis funtsiyalarni tanlash:

1-tur chegara shartlar: u (a)=A, u(b)=B , $\varphi_0(x) = A + (B-A)(x-a)/(b-a)$,

a) $\varphi_i(x) = (x-a)^i(b-x), i \ge 1$;b) $\varphi_i(x) = \sin(\pi i(x-a)/(b-a)), \quad i \ge 1.$

2-tur chegara shartlar: u′(a)=A, u′(b)=B ,

$\varphi_0(x) = Ax + (B-A)(x-a)^2/(2(b-a)) + C$,

a) $\varphi_i(x) = (x-a)^{i+1}(b-x)^2, \ i \ge 1$; b) $\varphi_i(x) = Cos(i\pi(x-a)/(b-a)), \quad i \ge 1$

3-tur chegara shartlar: $\alpha_0 u(a) + \alpha_1 u'(a) = A, \ \ \beta_0 u(b) + \beta_1 u'(b) = B$,

Aytaylik, $\varphi_0(t) = kt + d$, u holda $(\alpha_0 a + \alpha_1)k + \alpha_0 d = A, \ (\beta_0 b + \beta_1)k + \beta_0 d = B$. Kramer qoidasiga asosan, $k = D_k / D, d = D_d / D$, bu erda

$$D = \begin{vmatrix} \alpha_0 a + \alpha_1 & \alpha_0 \\ \beta_0 b + \beta_1 & \alpha_1 \end{vmatrix}, \ D_k = \begin{vmatrix} A & \alpha_0 \\ B & \alpha_1 \end{vmatrix}, D_d = \begin{vmatrix} \alpha_0 a + \alpha_1 & A \\ \beta_0 b + \beta_1 & B \end{vmatrix}.$$

$$a)\varphi_i(x) = (x-a)^{i+1}(b-x)^2; \ b) \ \varphi_i(x) = (x-a)^{i+1}(\gamma_i - x), \ i \ge 1, \ \gamma_i = b + \beta_1 L/[\beta_0 L + \beta_1(i+1)], i \ge 1.$$

[16]

1.ODT uchun chegara masalani Galyorkin, kollokatsiya, EKK usullarda yechish.

$ORIGIN := 1 \ p(t) := t^2 \ q(t) := -t \ f(t) := (6/t^2 - 3/t) \ ua(t) := 1/t^2 \ a := 1 \ b := 2 \ L := b - a$

$n := 4 \ h := L/n \ i := 1..n \ x_i = a + ih/(n+1) \ \alpha 0 := 1 \ \alpha 1 := 0 \ A := 1 \ \beta 0 := 3 \ \beta 1 := 1 \ B := 0.5$

$$MD := \begin{bmatrix} \alpha 0 a + \alpha 1 & \alpha 0 \\ \beta 0 b + \beta 1 & \beta 0 \end{bmatrix} \ MDk := \begin{bmatrix} A & \alpha 0 \\ B & \beta 0 \end{bmatrix} \ MDd := \begin{bmatrix} \alpha 0 a + \alpha 1 & A \\ \beta 0 b + \beta 1 & B \end{bmatrix}$$

$D := |MD| \ Dk := |MDk| \ Dd := |Mdd| \ D = -4 \ Dk = 2.5 \ Dd = -0.625 \ k := Dk/D \ d := Md/D$

$функция \ \varphi 0(t) := kt + d \rightarrow -0.625t + 1.625 \ \varphi 0(t) := -0.625t + 1.625$

$функция \ \varphi(j,t): j := 1..n \ \ \gamma_j := b + \beta 1 L/(\beta 0 L + \beta 1(j+1)), \ \varphi(j,t) := (t-a)^{j+1}(\gamma_j - t)$

$\psi(j,t) := \varphi''(j,t) + p(t)\varphi'(j,t) + q(t)\varphi(j,t) \qquad \chi(t) := f(t) - \varphi 0''(t) + p(t)\varphi 0'(t) + q(t)\varphi 0(t)$

$i := 1..n \ \ aK_{i,j} := \psi(j, x_i) \ bK_i := \chi(x_i) \ |aK| = 9.515 * 10^{-4} \ cK := aK^{-1}bK$

$aG_{i,j} := Int(\psi(j,t)\varphi(i,t), t = a..b) \ bG_i := Int(\chi(t)\varphi(i,t), t = a..b) \ |aG| = 9.515 * 10^{-10} \ cG := aG^{-1}bG$

$aE_{i,j} := Int(\psi(j,t)\psi(i,t), t = a..b) \ bE_i := Int(\chi(t)\psi(i,t), t = a..b) \ |aE| = 0.012 \ cE := aE^{-1}bE$

$uK(t) := \varphi 0(t) + Sum(cK_i \varphi(i,t), i = 1..n)$

$uG(t) := \varphi 0(t) + Sum(cG_i \varphi(i,t), i = 1..n) \ uG_i := uG(x_i) \ U_{2,j} := uG_j$

$uE(t) := \varphi 0(t) + Sum(cE_i \varphi(i,t), i = 1..n) uE_i := uE(x_i) \ U_{3,j} := uE_j \ ua_j := ua(x_j) \ U_{4,j} := ua_j$

$$U = \begin{bmatrix} 0.974 & 0.957 & 0.947 & 0.942 \\ 0.933 & 0.822 & 0.696 & 0.574 \\ 0.972 & 0.95 & 0.932 & 0.916 \\ 0.907 & 0.826 & 0.756 & 0.694 \end{bmatrix}. \quad \left(U = \begin{bmatrix} 0.963 & 0.945 & 0.93 & 0.92 \\ 0.945 & 0.87 & 0.79 & 0.716 \\ 0.963 & 0.927 & 0.89 & 0.853 \\ 0.907 & 0.826 & 0.756 & 0.694 \end{bmatrix} \right)$$

Izoh. Qavs ichidagi echim quyidagi holga mos: $\alpha 0=\beta 0=1, \alpha 1=\beta 1=0, A=B=1$.

2. ODT uchun chegara masalani chekli ayirmalar usulida echish.

ODT sifatida ushbu tenglamani olamiz: $u''(t)+p(t)u'(t)+q(t)u(t)=f(t)$.

$p(t):=t^2,\ q(t):=-t,\ f(t):=6/t^4-3/t,\ a=1, b=2, \bar{u}a(t)=1/t^2$ //koeffitsientlar

n:=10 i:=0..n t_0:=1 t_n:=2 h:=(t_n-t_0)/n $t_i:=t_0+ih$ // kesma, parametrlar

$\alpha 0:=1\ \alpha 1:=0\ \ \gamma 0:=1\ \ \beta 0:=3\ \beta 1:=1\ \gamma 1:=0.5$ // CHSH koeffitsientlari

$b_0=\alpha 0h-\alpha 1, c0=\alpha 1, d_0=\gamma 0h,$ //0-tenglama koef.lari

$a_n=-\beta 1, b_n=\beta 0h+\beta 1\ d_n:=\gamma 1h$ //n-tenglama koeffitsientlari

i=1,..,n-1, $a_i=1-p_ih/2, b_i=q_ih^2-2, c_i=1+p_ih/2, d_i=f_ih^2$ //i-tenglama koef.tsientlari

$ut(x):=1/x^2\quad ut_i:=ut(x_i)$ // aniq echim va uning qiymatlari

$m_{0,0}$:=α0h-α1 $m_{0,1}:=\alpha 1\ \ d_0:=\gamma 0h$ // Mathcadda 0-tenglama koeffitsientlari

$i:=1..n-1\ \ m_{i,i-1}:=1-p(x_i)\dfrac{h}{2}\ m_{i,i}:=b_i\ \ m_{i,i+1}:=1+p(x_i)\dfrac{h}{2}\ \ d_i:=f(x_i)h_i^2$ //i-tenglama koef.

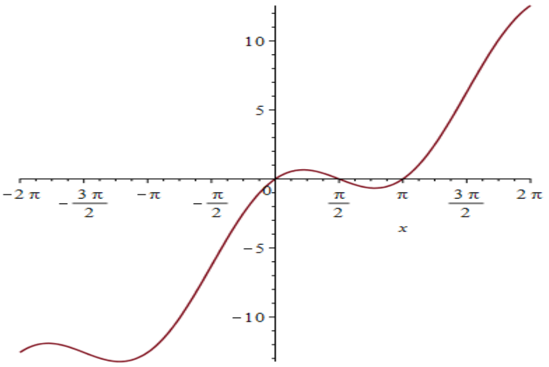
$m_{n,n-1}:=\beta 1 m_{n,n}:=\beta 0h+\beta 1\ \ d_n:=\gamma 1h$ // Mathcadda n-tenglama koeffitsientlari

$u:=m^{-1}d$ // CHAS ni echish va ekranga chiqarish //taqribiy va aniq yechimni chiqarish

$u^T=$	0		1	2	3	4	5	6	7	8	9	10
	1		0.8276	0.6963	0.5941	0.5131	0.4478	0.3944	0.3502	0.3132	0.282	0.2554

Masalani Mapleda yechish. $y^{(2)}+y=2x-\pi, y(0)=0, y(\frac{\pi}{2})=0$ chegara masala yechilsin.

```
restart;   de:=diff(y(x),x$2)+y(x)=2*x-Pi;
 sond:=y(0)=0,y(Pi/2)=0;
```
$cond := y(0)=0, y(\frac{\pi}{2})=0$
```
>dsolve({de,sond},y(x));
```
$y(x)=2x-\pi+\pi\cos(x)$
```
y1:=rhs(%):plot(y1,x=-10..20,thiskness=2);
```



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