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Teskari masalaga yana bir misol keltiraylik. Har qanday fizik maydonlarni (elektromagnit, termal) qayd qiluvchi qurilmaning eng oddiy chiziqli modeli quyidagicha tavsiflanishi mumkin. Qurilmaning kirishida $u(t)$ signal qabul qilinadi va chiqishda $f(t)$ signali yoziladi, ular bir-biriga quyidagicha bogliq:

$$\int_0^t K(t,s)u(s)ds = f(s) \tag{2}$$

bu yerda $K(t,s)$ - ma'lum yadroviy funksiya. Teskari masala qurilma qayd etgan $f(t)$ funksiya asosida $u(t)$ kirish signalini aniqlashdan, ya'ni (2) integral tenglamaning yechimini topishdan iborat.

Teskari masalalar nazariyasi asosan so‘nggi 35-40 yil ichida shakllangan bo‘lsada, dastlabki ishlar XX asrning 30-yillariga to‘g‘ri keladi. So‘nggi yillarda matematika modellarining tobora mukammallashuvi va ishonchliligi aynan teskari masalalar nazariyasidagi yutuqlar bilan bog‘liq. Masalan, bu nazariya yordamida kompyuter tomografiyasi sohasida katta muvaffaqiyatlarga erishildi [3]. Ushbu metodning keng tarqalishi uning tibbiyot, biologiya, plazma diagnostikasida samarali qo‘llanilishi bilan bog‘liq.

Xulosa qilib aytganda, matematik fizika teskari masalalari nazariyasi - hozirgi zamon matematikasining jadal rivojlanayotgan yo‘nalishidir va u ko‘plab sohalarda $o'z$ amaliy qo‘llanilishiga ega. Biz bu tezisda ular haqida qisqacha to‘xtaldik!

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Construction an effective quadrature formula in the space of periodic functons

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The main goal of this work is to approximate the Fourier integrals by extending the optimal coefficients of quadrature formula

$$\int_0^1 e^{2\pi i\omega x}\varphi(x)dx \cong \sum_{k=1}^{N} C_k\varphi(hk),$$

which were obtained in [1] for approximating the Fourier coefficients, as a function of ω. Here

$$C_k = \frac{2}{4\pi^2\omega^2+1}\cdot\frac{e^{2h}-2e^h\cos(2\pi\omega h)+1}{e^{2h}-1},\ \text{for } k=1,2,\ldots,N,$$

$\omega \in \mathbb{Z}$, functions $\varphi \in \widetilde{W}_2^{(1,0)}$ that are periodic, real-valued, absolute continuous and first order derivative (in the generalized sense) is square integrable.

We consider the quadrature formula of the following form

$$\int_a^b e^{2\pi i\omega x}\varphi(x)dx \cong \sum_{k=0}^{N} C_{k,\omega}[a,b]\varphi(hk+a), \tag{1}$$

where $\omega \in \mathbb{R}$.

The following theorem holds for the coefficients $C_{k,\omega}[a,b]$ of the effective quadrature formula (1).

Teorema 1. The coefficients $C_{k,\omega}[a,b]$ of the effective quadrature formula (1) with $\omega \in \mathbb{R}$ in the space $W_2^{(1,0)}(a,b)$ have the following forms

$$\begin{aligned} C_{0,\omega}[a,b] &= \frac{(b-a)K_{\omega,1}}{(2\pi\omega_1)^2+1}\cdot e^{2\pi i\omega a}, \\ C_{k,\omega}[a,b] &= \frac{2(b-a)K_{\omega,1}}{(2\pi\omega_1)^2+1}\cdot e^{2\pi i\omega(hk+a)} \quad \text{for} \quad k=1,2,\ldots,N-1, \\ C_{N,\omega}[a,b] &= \frac{(b-a)K_{\omega,1}}{(2\pi\omega_1)^2+1}\cdot e^{2\pi i\omega b}, \end{aligned}$$

where $\omega_1 = (b-a)\omega$, $h = \frac{b-a}{N}$ and

$$K_{\omega,1} = \left[\frac{e^{2h}-1}{e^{2h}+1-2e^h\cos(2\pi\omega h)}\right]^{-1}.$$

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Kaputo-tipidagi Erdeyli-Kober kasr tartibli hosila qatnashgan differensial tenglama uchun Koshi masalasini taqribiy yechish

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Biz Kaputo-tipidagi Erdeyli-Kober kasr tartibli hosila qatnashgan kasr tartibli differensial tenglamani prediktor-korrektor metodi [4-6] ga asoslangan sonli metodni ko‘rib chiqmiz. Kasr tartibli metodlar ko‘rib chiqilgan sonli yechish uchun algoritmlar ishlab chiqildi. Buning uchun biz quyidagi Kaputo-tip Erdeyli-Kober kasr tartibli tenglamasi va unga qo‘yilgan boshlang‘ich qiymatli masalani ko‘ramiz:

$$\left({}_*D_{a+,\beta}^{\alpha,\gamma}y\right)(t) = F(t,y(t)), \quad t > a \geq 0, \tag{1}$$

$$y^{(k)}(a) = y_a^k, \quad k = 0,1,...,n-1. \tag{2}$$

bu yerda $n-1 < \alpha \leq n$, $n \in N$, $\beta > 0$, $\gamma \in R$ va ${}_*D_{a+,\beta}^{\alpha,\gamma}$ Luchko va Trujillo tomidan kiritilgan Kaputo tipidagi Erdeyli-Kober kasr tartibli hosila va u quyidagicha ta’rilagan: