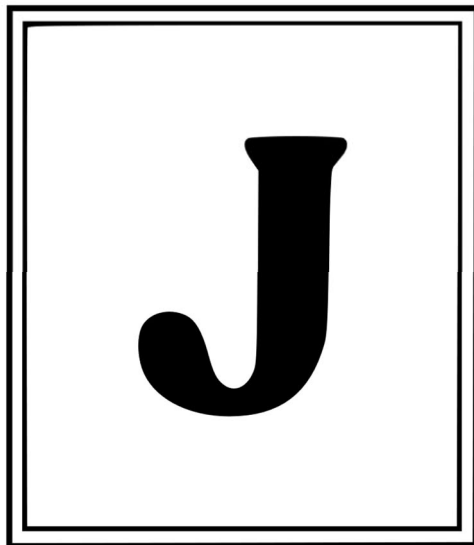




# JOURNAL OF CONTEMPORARY WORLD STUDIES



VOLUME | 4 ISSUE | 8 | JANUARY | 2026



JCWS

# SHTURM-LIUVILL OPERATORI PARAMETLARINI ANALITIK TIKLASH MASALALARI

*Rabimkul Abdunazarov*<sup>1</sup>, *Ibrohimov Javohir Bahrom o'g'li*<sup>2</sup>, *Belova Anna Sergeyevna*<sup>3</sup>

<sup>1</sup> O'zbekiston Milliy universiteti Jizzax filiali katta o'qituvchisi.

<sup>2</sup> O'zbekiston Milliy universiteti Jizzax filiali assistenti.

<sup>3</sup> Ufa fan va texnologiyalar universiteti assistenti.

e-mail: [rabimkulabdunazaro@gmail.com](mailto:rabimkulabdunazaro@gmail.com), [javohir1003@gmail.com](mailto:javohir1003@gmail.com)



**Accepted Date:**

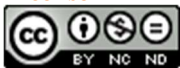
January 25, 2026,

**Published Date:**

January 30, 2026

**Journal Website:** <https://d-pressa.com/index.php/jcws/>

**License**



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

## ANNOTATION:

Ushbu maqolada Shturm- Liuvill operatori parametrlarini tiklash bilan bog'liq ikkita masala:  $(\lambda_n, a_n)$  **spectral berilganlari** asosida Shturm- Liuvill operatori parametrlarini analitiktik usulda tiklash masalasi va shu **spectral berilganlar** asosida natural spektrli yangi  $(n^2, \tilde{a}_n)$  **spectral berilganlarni** hosil qilish masalasi muhokama qilinadi. Ishning ahamiyatli jihati shundaki, klassik masalani izospektral masalga o'tkazib o'rganishda bir qancha qo'shimcha imkoniyatlar kelib chiqadi.

## KEYWORDS:

Shturm-Liuvill operatori, xos qiymat, xos funksiya, Gelfand-Levitan integral tenglamasi. teskari masala, spectral berilganlar.

**Kirish.** Berilgan  $\lambda_0 < \lambda_1 < \lambda_2 < \dots < \lambda_n < \dots$  sonlar ketma ketligi quyidagi

$$L(q(x), h, H)y \equiv -y'' + q(x)y = \lambda y, \quad (0 < x < \pi) \quad (1.1)$$

$$y'(0) - hy(0) = 0 \quad y'(\pi) + Hy(\pi) = 0 \quad (1.2)$$

chegaraviy masalaning xos qiymatlari,  $\alpha_0, \alpha_1, \alpha_2, \dots$  ketma ketliklar esa ushbu masalaning normallovchi sonlari bo'lsin. Ular uchun quyidagi asimtotika o'rinli bo'lsin:

$$s_n = \sqrt{\lambda_n} = n + \frac{c_0}{\pi n} + \frac{c_1}{n^3} + \dots, \quad \alpha_n = \frac{\pi}{2} + \frac{b_0}{n^2} + \frac{b_1}{n^4} + \dots, \quad c_0 = \frac{1}{\pi} \left( h + H + \frac{1}{2} \int_0^\pi q(s) ds \right)$$

Bu yerda  $c_1, b_0, b_1$  lar berilgan haqiqiy sonlar.

Ushbu shartlarni qanoatlantiruvchi  $\{\lambda_i, \alpha_i\}_{i=0}^\infty$  spectral berilganlarga ko'ra Shturm-Liuvill operatori parametrlarini tiklash masalasini Gelfand-Levitan sxemasi bo'yicha amalga oshiriladi [1], [2]. Bunda quyidagi munosabatlardan foydalaniladi

$$K(x, y) + F(x, y) + \int_0^x K(x, s)F(s, y) ds = 0 \quad (1.6)$$

$$q(x) = 2 \frac{d}{dx} K(x, x), \quad h = K(0, 0) = -F(0, 0) \quad (1.6')$$

$$F(x, y) = \frac{\cos s_0 x \cos s_0 y}{\alpha_0} - \frac{1}{\pi} + \sum_{k=1}^{\infty} \left[ \frac{\cos s_k x \cos s_k y}{\alpha_k} - \frac{2 \cos kx \cos ky}{\pi} \right] \quad (1.7)$$

Izospektral chegaraviy masalarni o'rganish mavzusi ham (1.1)-(1.3) chegaraviy masalalar orasida muhim yo'nalishlardan biri hisoblanadi [3-8]. Ma'lum shartlarga berilgan  $(n^2, \tilde{\alpha}_n)$  spectral juftlik asosida (1.1)-(1.3) uchun teskari masalani analitik usulda yechish, bu yechum asosida esa ko'pgina matematik fizika masalalarini tahlil qilish imkonini beradi.

**2. Masalaning qo'yilishi.** Ushbu maqolada ba'zi shartlarga bo'ysinuvchi  $(\lambda_n, \alpha_n)$  spectral berilganlarga ko'ra (1.1)-(1.3) teskari masalani analitik usulda yechish muammolari qaraladi. Shuningdek, maqolada ushbu  $(\lambda_n, \alpha_n)$  spektral berilganlar asosida operator parametrlarini bir xilda tiklaydigan yangi narural spektrli  $(n^2, \tilde{\alpha}_n)$  spectral berilganlarni qurish masalasi o'rganiladi

Bu mavzuning dolzarbligi va ushbu yo'nalishda olib borilgan ishlar tahlilili bilan A.Xasanov ishlarida tanishish mumkin [4]-[18].

### 3. Shturm - Liuvill operator paramitrlarin tiklash masalasi

#### 1) Izospektral chegaraviy masalani tiklash algoritmi.

**Teorema.** Aytaylik  $\{\lambda_n, \alpha_n\}_{n=0}^\infty$  haqiqiy sonlar ketma-ketliklari (1.1)-(1.2) chegaraviy masalaning spectral berilganlari bo'lsin. U holda quyidagicha

$$\lambda_n = n^2, n \geq 0; \quad \tilde{\alpha}_n = \alpha_n, \quad n = 0, 1, \dots, N; \quad \tilde{\alpha}_n = \frac{\pi}{2}, \quad n > N$$

aniqlangan ketma - ketliklar ham  $L(q(x, a_0, \dots, a_N), h(a_0, \dots, a_N), H(a_0, \dots, a_N))$  ko'rinishidagi biror Shturm-Liuvill operatorining spectral berilganlari bo'ladi. Bu yerda  $\{a_n\}_{n=0}^N$  berilgan musbat sonlar. Agar bu masala uchun qurilgan Gelfand-Levitan integral

tenglamasi yechimini shartli ravishda  $K_a(x, t)$  deb olsak, u holda  $K_a(\pi, t)$  uchun quyidagi tenglik o'rinli bo'ladi[4]

$$K_a(\pi, y) = -\frac{1}{\pi} \left(1 - \frac{a_0}{\pi}\right) - \frac{2}{\pi} \sum_{n=1}^N \left(1 - \frac{2}{\pi} a_n\right) \cos(ny) \quad (3.1)$$

## 2) Berilgan aniqlikda Shturm - Liuvill operator paramitrlarin tiklash masalasi

**Teorema.** Aytaylik  $\{\lambda_n, \alpha_n\}_{n=0}^{\infty}$  haqiqiy sonlar ketma-ketliklari (1.1)-(1.2) chegaraviy masalaning spectral berilganlari bo'lsin. Bu ketma-ketlik elementlaridan dastlabki  $N$  tasing qiymatlari ma'lum, qolgan elementlar uchun quyidagi

$$\lambda_n = n^2, \quad \alpha_n = \frac{\pi}{2}, \quad n > N.$$

munosabat o'rinli bo'lsa u holda ushbu shartlar bilan aniqlangan ketma-ketliklar yordamida (1.1)-(1.3) operator paramitrlarini analitik aniqlash mumkin.

**Isbot..** Teorema shartiga e'tibor qilinsa (1.4) asimptotikada qatnashayotgan  $c_0, c_1, \dots$  koefisientlarning nolga tengligi kelib chiqadi. Bundan  $n > N$  dan boshlab

$$\cos(s_n x) \cos(s_n y) = \cos nx \cos ny$$

tenglik o'rinli ekanligi hisobga olinsa (1.7) yadrosi quyidagi chekli yig'indi ko'rinishiga keladi

$$F(x, y) = \frac{\cos s_0 x \cos s_0 y}{\alpha_0} - \frac{1}{\pi} + \sum_{k=1}^N \left[ \frac{\cos s_k x \cos s_k y}{\alpha_k} - \frac{2 \cos kx \cos ky}{\pi} \right] \quad (3.2)$$

Bu esa (1.6) integral tenglamani o'zgaruvchilari ajralgan yadroli integral tenglama sifatida yechish imkonini beradi. Integral tenglamaga (3.2) yadroni qo'yib, ba'zi shakl almashtirishlardan so'ng  $K(x, y)$  uchun quyidagilarga ega bo'lamiz:

Shunday qilib  $K(x, y)$  uchun quyidagi tenglikga ega bo'ldik

$$K(x, y) = \frac{\psi(x, 0)}{\pi} + \frac{2}{\pi} \sum_{k=1}^N \psi(x, k) \cos ky - \sum_{k=0}^N \frac{\varphi(x, s_k)}{\alpha_k} \cos s_k y \quad (3.3)$$

Bu yerda

$$\begin{aligned} \psi(x, n) &= \cos(nx) + \int_0^x K(x, t) \cos(nt) dt \quad \varphi(x, s_n) \\ &= \cos(s_n x) + \int_0^x K(x, t) \cos(s_n t) dt, \end{aligned}$$

Topilgan  $K(x, y)$  ni (3.4), (3.5) tengliklarga qo'yib  $\psi(x, n)$ ,  $\varphi(x, s_n)$  larga nisbatan quyidagi tenglamalar sistemasini hosil qilamiz

$$\begin{aligned} \psi(x, n) &= \cos(nx) + \frac{\psi(x, 0)}{\pi} \int_0^x \cos nt dt + \frac{2}{\pi} \sum_{k=0, k \neq n}^N \psi(x, k) \int_0^x \cos kt \cos nt dt + \\ &+ \frac{2}{\pi} \psi(x, n) \int_0^x \cos^2 ntdt - \sum_{k=0}^N \frac{\varphi(x, s_k)}{\alpha_k} \int_0^x \cos s_k t dt \cos nt \quad (3.4) \end{aligned}$$

$$\varphi(x, s_n) = \cos(s_n x) + \frac{\psi(x, 0)}{\pi} \int_0^x \cos s_n t dt + \frac{2}{\pi} \sum_{k=1}^N \psi(x, k) \int_0^x \cos kt \cos s_n t dt -$$

$$-\frac{\varphi(x, s_n)}{\alpha_n} \int_0^x \cos^2 s_n t dt - \sum_{k=0, k \neq n}^N \frac{\varphi(x, s_k)}{\alpha_k} \int_0^x \cos(s_k t) \cos(s_n t) dt \quad (3.5)$$

Bu tengliklarni  $x = \pi$  nuqtada qarab, kelgusida foydalaniladigan ba'zi muhim tengliklarni keltirib chiqaramiz.

a) Agar (3.6)-(3.7) tengliklardagi  $x$  o'zgaruvchi o'rniga  $\pi$  qiymatni qo'ysak quyidagi tengliklarga ega bo'lamiz.

$$\sum_{k=0}^N \frac{\varphi(\pi, s_k)}{\alpha_k} \int_0^{\pi} \cos(s_k t) dt = 1, \quad \sum_{k=0}^N \frac{\varphi(\pi, s_k)}{\alpha_k} \int_0^{\pi} \cos(s_k t) \cos(nt) dt = (-1)^n \quad (3.6)$$

Topilgan (3.13), (3.14) tengliklarning  $x = \pi$  nuqtadagi qiyma'larini o'rganamiz. Buning uchun quyidagi limitlarni hisoblaymiz

$$\psi(\pi, 0) = \lim_{x \rightarrow \pi} \left( 1 + \frac{2}{\pi} \sum_{k=1}^N \psi(x, k) \int_0^x \cos kt dt - \sum_{k=0}^N \frac{\varphi(x, s_k)}{\alpha_k} \int_0^x \cos(s_k t) dt \right) \left( \frac{\pi}{\pi - x} \right)$$

$$\psi(\pi, n) = \lim_{x \rightarrow \pi} \left[ \cos(nx) + \frac{\psi(x, 0)}{\pi} \int_0^x \cos nt dt + \frac{2}{\pi} \sum_{\substack{k=1, \\ k \neq n}}^N \psi(x, k) \int_0^x \cos kt \cos nt dt - \sum_{k=0}^N \frac{\varphi(x, s_k)}{\alpha_k} \int_0^x \cos(s_k t) \cos(nt) dt \right] / \left( 1 - \frac{2}{\pi} \int_0^x \cos^2 nt dt \right)$$

Bu limitlarni (3.9), (3.10) tenglikdan foydalanib hisoblasak har ikkalasi uchun bir hil natija, quyidagi tenglik kelib chiqadi.

$$\frac{\psi(\pi, 0)}{\pi} + \frac{2}{\pi} \sum_{k=1}^N \psi(\pi, k) (-1)^k = \sum_{k=0}^N \frac{\varphi(\pi, s_k)}{\alpha_k} \cos \pi s_k + \sum_{k=0}^N \frac{\varphi'(\pi, s_k)}{\alpha_k} \int_0^{\pi} \cos s_k t dt \quad (3.7)$$

Agar (1.3), (3.9) tengliklarni hisobga olib (3.16) da elementar shak almashtirishlardan so'ng quyidagi tenglikka ega bo'lamiz.

$$\frac{\psi(\pi, 0)}{\pi} + \frac{2}{\pi} \sum_{k=1}^N \psi(\pi, k) (-1)^k = \sum_{k=0}^N \frac{\varphi(\pi, s_k)}{\alpha_k} \cos(\pi s_k) - H \quad (3.8)$$

Yuqoridagi (3.3) tenglik bilan aniqlangan  $K(x, y)$  ni  $x = y = \pi$  nuqtadagi qiymatlari va (3.17) tengliklarni solishtirsak ulardan quyidagi

$$K(\pi, \pi) = -H, \quad H = \sum_{k=0}^N \frac{\varphi(\pi, s_k)}{\alpha_k} \cos(\pi s_k) - \frac{\psi(\pi, 0)}{\pi} - \frac{2}{\pi} \sum_{k=1}^N \psi(\pi, k) (-1)^k \quad (3.9)$$

muhim tengliklarni olamiz. **Teorema isbotlandi.**

**3) Berilgan  $\{\lambda_i, \alpha_i\}_{i=0}^N$  spectral juftlik orqali yangi  $(n^2, \tilde{\alpha}_n)$  spectral berilganlarni qurish masalasi**

Gelfand -Levitan integral tenglamasining (3.3) formula bilan aniqlangan  $K(x, y)$  yechimini  $x = \pi$  nuqtada qaraymiz va uni shartli ravis quyidagicha belgilaymiz

$$K_r(\pi, y) = \frac{\psi_0}{\pi} + \frac{2}{\pi} \sum_{k=1}^N \psi_k \cos ky - \sum_{k=0}^N f_k \cos s_k y \quad (3.10)$$

Ushbu tasdiq o‘rinli: Yuqorida (3.1) va (3.19) formulalar bilan aniqlangan  $K_a(x, t)$  va  $K_r(x, t)$  funksiyalar (1.1)-(1.3) chegaraviy masalaning parametrlarini bir xilda aniqlashi uchun (3.1) tenglikda qatnashayotgan  $\{a_n\}_{n=0}^N$  sonlarni  $\{\lambda_i, \alpha_i\}_{i=0}^N$  sonlar o‘rqli quyidagicha tanlash zarur

$$a_0 = \pi^2 \psi_0 - \pi^2 + \pi, \quad a_n = \left(\frac{\pi}{2}\right)^2 \psi_n - \left(\frac{\pi}{2}\right)^2 + \frac{\pi}{2}, \quad n = 1, 2, \dots, N \quad (3.11)$$

Bu yerda  $\psi_n = \psi_n(\pi, n)$  yuqoridagi (3.12) sistemadan aniqlanadi.

Yuqorida  $K_a(\pi, t), K_b(\pi, t)$  funksiyalar uchun berilgan (3.1), (3.19) tengliklar o‘rinli deb faraz qilaylik. U holda  $K_a(\pi, t)$  va  $K_r(\pi, t)$  funksiyalar  $h, H$  va  $q(x)$  parametrlarni bir xilda aniqlashi uchun  $\{a_n\}_{n=0}^N$  sonlarini shunday tanlaylikki,  $[0, \pi]$  oraliqda bu ikki funksiyalar uchun o‘rtacha kvadratik farq minimumga erishsin. Quidagi belgilashni kiritamiz

$$I(a_0, a_1, \dots, a_N) = \int_0^\pi \left( \frac{1}{\pi} \left(1 - \frac{a_0}{\pi}\right) + \frac{2}{\pi} \sum_{n=1}^N \left(1 - \frac{2}{\pi} a_n\right) \cos(nt) - K_r(\pi, t) \right)^2 dt$$

Bu tenglikka minimum beradigan  $a_n$  sonlarni topish uchun  $a_0, a_1, \dots, a_N$  larga nisbatan quyidagi

$$\frac{\partial I}{\partial a_0} = 0, \quad \frac{\partial I}{\partial a_1} = 0, \quad \dots, \quad \frac{\partial I}{\partial a_n} = 0$$

tegnlamalar sistemasini hosil qilamiz. Bu sistemani yechsak  $\{a_n\}_{n=0}^N$  va  $\{\lambda_i, \alpha_i\}_{i=0}^N$  spectral berilganlar o‘rtasidagi (3.20) munosabatlar hosil bo‘ladi. E’tiborli jihati shundaki, (3.20) tenglik bilan aniqlangan  $a_n$  sonlarni aniqlashda barcha  $\lambda_0, \lambda_1, \lambda_2, \dots, \lambda_n, \dots$  va  $\alpha_0, \alpha_1, \alpha_2, \dots$  berilgan sonlar qatnashgan, ya’ni topilgan har bir  $a_n$  barcha  $\{\lambda_i, \alpha_i\}_{i=0}^N$  juftliklarni o‘ziga singdirgan. **Teorema isbotlandi.**

Shunday qilib yetarli katta  $N$  dan boshlab

$$\lambda_n = n^2, \quad \alpha_n = \frac{\pi}{2}, \quad n > N.$$

shartni qanoatlantiruvchi  $\lambda_0 < \lambda_1 < \lambda_2 < \dots < \lambda_n < \dots$ ,  $\alpha_0, \alpha_1, \alpha_2, \dots$  sonlar ketma ketligi yordamida (1.1)-(1.3) teskari masalaning barcha parametrlarini quyidagi tengliklar orqali aniqlanadi

$$\begin{aligned} h = K(0,0) = -F(0,0) &= \frac{1}{\pi} - \frac{1}{\alpha_0} + \sum_{k=1}^N \left( \frac{1}{\alpha_k} - \frac{2}{\pi} \right), \quad \int_0^x q(t) dt = 2K(x, x) = \\ &= \frac{\psi(x, 0)}{\pi} + \frac{2}{\pi} \sum_{k=1}^N \psi(x, k) \cos ky - \sum_{k=0}^N \frac{\varphi(x, s_k)}{\alpha_k} \cos s_k y \quad 0 < x < \pi, \\ H &= \sum_{k=0}^N \frac{\varphi(\pi, s_k)}{\alpha_k} \cos(\pi s_k) - \frac{\psi(\pi, 0)}{\pi} - \frac{2}{\pi} \sum_{k=1}^N \psi(\pi, k) (-1)^k \end{aligned}$$

Bunda yuqorida keltirilgan (1.6), (1.7), (3.2), (3.3), (3.13), (3.14), (3.15), (3.19) tengliklardan foydalaniladi. Bu topilganlarga qo‘shimcha ravishda

$$\int_0^\pi q(t) dt = -2(h + H), \quad q(0) + q(\pi) = 4 \sum_{k=1}^N (\lambda_n - n^2) + 2(H^2 + h^2)$$

nengliklarni ham keltirish mumkin.

### Foydalanilgan adabiyotlar ro'yxati:

1. Левитан Б. М., Саргсян И. С. Операторы Штурма–Лиувилля и Дирака. — М.: Наука, 1988. — 432 с. [Levitan B. M., Sargsyan I. S. Sturm–Liouville and Dirac Operators. — Dordrecht: Kluwer Acad. Publ., 1990.]
2. Алимов Ш. А. Работы А. Н. Тихонова по обратным задачам для уравнения Штурма–Лиувилля // УМН. — 1976. — Т. 31, вып. 6(192). — С. 84–88.
3. Mirzaev O., Abdunazarov R., Nosirova G. Partially-isospectral Sturm–Liouville operators and their applications // Scientific journal of Samarkand University. — 2025. — Vol. 3, no. 1(151). — P. 101–111.
4. Мирзаев О. Э., Хасанов А. Б. Изоспектральные операторы Штурма–Лиувилля на конечном сегменте // Докл. АН Респ. Узбекистан. — 2020. — № 3. — С. 3–9.
5. Abdunazarov R. Recovery of the parameters of a partially isospectral Sturm–Liouville operator on a finite segment // Scientific journal of Samarkand University. — 2025. — Vol. 5, no. 1(153). — P. 79–87.
6. Baxtiyor P. et al. BA'ZI BIR MUHIM XOSMAS INTEGRALLARNI HISOBLASHDA FRULLANI FORMULASIDAN FOYDALANISH //International Journal of Contemporary Scientific and Technical Research. — 2023. — С. 363-367.
7. Po'latov B., Ibrohimov J. BA'ZI RATSIONAL FUNKSIYALARNI INTEGRALLASHDA OSTRAGRADSKIY USULIDAN FOYDALANISH //Talqin va tadqiqotlar. — 2023. — Т. 1. — С. 21.
8. Bahrom o'g'li I. J. OCHIQ CHIZIQLI QAVARIQ TO 'PLAMDA POLINOMIAL QAVARIQLIKNING

- YETARLI SHARTI //International Journal of Contemporary Scientific and Technical Research. — 2022. — Т. 1. — №. 2. — С. 363-5.
9. Xurramov Y., Polatov B., Ibrohimov J. Kophadning keltirilmaslik alomati //Zamonaviy innovatsion tadqiqotlarning dolzarb muammolari va rivojlanish tendensiyalari: yechimlar va istiqbollar. — 2022. — Т. 1. — №. 1. — С. 399-401.
  10. Xurramov Y., Polatov B., Ibrohimov J. Kophadning keltirilmaslik alomati //Zamonaviy innovatsion tadqiqotlarning dolzarb muammolari va rivojlanish tendensiyalari: yechimlar va istiqbollar. — 2022. — Т. 1. — №. 1. — С. 399-401.
  11. Пулатов Б. и др. Darajali geometriyaning oddiy differensial tenglamalarda qo 'llanilishi //Информатика и инженерные технологии. — 2023. — Т. 1. — №. 2. — С. 266-269.
  12. Javohir I. et al. XEVISAYD USULI YORDAMIDA RATSIONAL FUNKSIYALARNI INTEGRALLASH //International Journal of Contemporary Scientific and Technical Research. — 2023. — Т. 416. — С. 418.
  13. Polatov B., Xurramov Y., Ibrohimov J. Murakkab funksiyalardan olingan aniq integralni taqribiy hisoblash //Zamonaviy innovatsion tadqiqotlarning dolzarb muammolari va rivojlanish tendensiyalari: yechimlar va istiqbollar. — 2022. — Т. 1. — №. 1.
  14. Javohir I. B.. o 'g 'li, & Muxammadiyev, GJ. o 'g 'li.(2023). AYRIM IRRATSIONAL KO 'RINISHDAGI INTEGRALLARNI EYLER ALMASHTIRISHLARI YORDAMIDA RATSIONALLASHTIRISH //Educational Research in Universal Sciences. — Т. 2. — №. 2. — С. 237-241.

15. Бозоров А. Р. и др. ИНТЕГРИРОВАНИЕ РАЦИОНАЛЬНЫХ ФУНКЦИЙ ПО СХЕМЕ ГОРНЕРА //ДОСТИЖЕНИЯ ВУЗОВСКОЙ НАУКИ. – 2023. – Т. 2023. – С. 13-16.
16. Sobirovich P. B. Darajali Geometriyani Algebraik Tenglamalarda Qo‘l lab Asimptotik Yechimlarini Topish. – 2022.
17. Nuraliyev T. et al. MATRISANING XOS SON VA XOS VEKTORLARNI TOPISH //Science technology&Digital finance. – 2024. – Т. 2. – №. 4. – С. 62-71.
18. САФАРОВА Ф. и др. РАЦИОНАЛИЗАЦИЯ НЕКОТОРЫХ ИНТЕГРАЛОВ ИРРАЦИОНАЛЬНОЙ ФОРМЫ С ПОМОЩЬЮ ЗАМЕН ЭЙЛЕРА. – Наука и Просвещение (ИП Гуляев ГЮ) КОНФЕРЕНЦИЯ: СТУДЕНТ ГОДА 2024 Пенза, 05 апреля 2024 года Организаторы: Наука и Просвещение (ИП Гуляев ГЮ), 2024.