Ochilov Zarifjon Xusanovich (International school of finance technology and science instituti dotsenti, fizika-matematika fanlari nomzodi; ZarifjonOchilov@mail.ru),
Husanov Abduroziq Zarifjon o'g'li (International school of finance technology and science instituti o'qituvchisi, "O'zbekiston Respublikasi milliy statistika qo'mitasi kadrlar malakasini oshirish va statistik tadqiqotlar" instituti doktoranti; AbduroziqHusanov@mail.ru)

MAXSUS KO'RINISHDAGI VAZN FUNKSIYALI UMUMLASHGAN RADON ALMASHTIRISHLARI

Annotasiya. *Ushbu maqolada maxsus ko'rinishdagi vazn funksiyali uch o'lchovli fazoda Radon almashtirishining teskari masalasi ko'rib chiqiladi. Muayyan tabiiy sharoitlarda masalaning teskarilanishi isbotlangan va uning teskarilanish formulasi aniq keltirilgan.*

Kalit so'zlar: *integral geometriya masalasi, Radon almashtirishi, Furye almashtirishi, yagonalik teoremasi.*

Очилов Зарифжон Хусанович (доцент "International school of finance technology and science", кандидат физико-математических наук; ZarifjonOchilov@mail.ru),
Хусанов Абдураззок Зарифжонович (преподаватель института "International school of finance technology and science", докторант института "O'zbekiston Respublikasi milliy statistika qo'mitasi kadrlar malakasini oshirish va statistik tadqiqotlar"; AbduroziqHusanov@mail.ru)

ОБОБЩЕННОЕ ПРЕОБРАЗОВАНИЕ РАДОНА С ВЕСОВОЙ ФУНКЦИИ СПЕЦИАЛЬНОГО ВИДА

Аннотация. *В данной статье рассматривается обратная задача для преобразования Радона в трехмерном пространстве с весовой функцией особой формы. При некоторых естественных условиях доказывается обратимость задачи и приводится явная формула для ее обратного преобразования.*

Ключевые слова: *задача интегральной геометрии, преобразования Радона, преобразование Фурье, теорема единственности.*

Ochilov Zarifjon Khusanovich (Associate Professor at the International School of Finance, Technology and Science, Candidate of Physical and Mathematical Sciences; ZarifjonOchilov@mail.ru),
Husanov Abduroziq Zarifjon ugli (Lecturer at the International School of Finance, Technology and Science, Doctoral student at the institute "O'zbekiston Respublikasi milliy statistika qo'mitasi kadrlar malakasini oshirish va statistik tadqiqotlar"; AbduroziqHusanov@mail.ru)

GENERALIZED RADON TRANSFORMATION WITH A SPECIAL FORM WEIGHTING FUNCTION

Annotation. *in this paper we consider an inversion problem for the Radon transform in three-dimensional space with a weight function of a special form. Under some natural conditions we prove invertibility for the considering problem and find an explicit formula for the inverse of the problem.*

Keys word: *integral geometry problem, Radon transform, Fourier transform, theorem uniqueness.*

Kirish. Integral geometriya muammolari tabiiy ravishda seysmik qidiruv, geofizik va aerokosmik kuzatishlarni talqin qilish, kinetik tenglamalar bilan tavsiflangan turli jarayonlar va boshqalar kabi keng qo'llaniladigan sohalarda ko'plab matematik modellarni o'rganishda paydo bo'ladi. Integral geometriyaning ba'zi savollari, masalan, ma'lum bir chiziqli fazodagi funksiyani ushbu fazoga o'rnatilgan ko'philliklarning ma'lum bir oilasidagi ushbu funksiya qiymatlaridan tiklash [1], [2]da o'rganilgan. Volterra tipidagi integral geometriya masalalari deb, [1]da berilgan ta'rifgan ko'ra Volterra operatorli tenglamalarini o'rganishga keltirilishi mumkin bo'lgan masalalarga aytiladi.

Mavzuga oid adabiyotlarning tahlili. Berilgan egrilikdagi egri chiziqlar oilasi uchun integral geometriya masalasi yechimining mavjudligi, yagonaligi va barqarorligi [13] va [14] ishlarda isbotlangan. Muammoning yechilishi mumkinligini isbotlash uchun muallif uni transport tenglamasi uchun haddan tashqari aniqlangan teskari masalaga keltirdi. Birinchi turdagi uzilishli sirt integrali uchun yagonaligi haqidagi teorema [6], [7] ishlarda isbotlangan. [12] ishda ma'lum egrilikning tekis egri chiziqlari bo'yicha integral geometriya masalalarini yechish mumkinligining umumiy shartiga bag'ishlangan bo'lib, tadqiqot transport tipidagi tenglamalar uchun ekvivalent teskari masalalarni yechish mumkinligiga asoslangan. [8] va [9] ishlarda ushbu g'oyani qo'llaydi va uch o'lchovli fazoda umumlashgan Radon almashtirishining ikkita yangi usulini taklif qiladi. [10], [11] maqolalarda ko'p o'lchovli fazolarda umumlashgan nurlar va Radon almashtirishlari uchun ineksiyaga qarshi misollar keltirilgan. Noyob davomiy natijalar integral geometriyada ham

qo‘llaniladi. Oddiy rentgenogramma operatori ixcham qo‘llab-quvvatlanadigan taqsimotlar sinfi uchun o‘ziga xoslik xususiyatini tan olishi [17] ishda isbotlangan. Bu oddiy operatorni Ries potensiali sifatida ko‘rib chiqish orqali amalga oshirildi.

To‘g‘ridan to‘g‘ri tekislikni almashtirish (d-tekislikni almashtirish) yaqinda davriy holatda tekis torusda [18,19] maqolalarda, shuningdek, boshqa shartlarda [16,20] ishlarda o‘rganildi. Umumlashgan va chegaralangan Radon almashtirishlari (d = n-1) yaqinda, masalan, [15] maqolada o‘rganilgan.

Yaqinda chop etilgan [21] maqolada uch o‘lchovli fazoda konuslar oilasi bo‘yicha umumlashgan Radon almashtirishim uchun teskari masala o‘rganilgan. Qiymatlar sohasi cheksiz silliq funksiyalar fazosini o‘zida tasvirlagan hol uchun Radon almashtirishining teskarilanish formulasi olingan.

Tadqiqot metodologiyasi. Quyidagi almashtirishlarni kiritamiz:

$(x,y,z),(\xi,\eta,\zeta)\in\mathbb{R}^3, \lambda,\mu\in\mathbb{R}, \quad \Omega=\{(x,y,z): x,y\in\mathbb{R}, z\in[0,h]\ h<\infty\}.$

Ω da uchining koordinatalari $(x,y,z)\in\Omega$ bo‘lgan, o‘zaro bir qiymatli parametrlanuvchi $S(x,y,z)$ konuslar oilasini qaraymiz:

$$S(x,y,z)=\left\{(\xi,\eta,\zeta):(x-\xi)^2+(y-\eta)^2=(z-\zeta)^2, \quad \xi,\eta\in\mathbb{R}, \quad 0\le\zeta\le z\right\}$$

$\mathcal{L}(\mathbb{R}^2,C^m[0,h])$ orqali $z\in[0,h]$ da m- marta uzluksiz differensiallanuvchi va $(x,y)\in\mathbb{R}^2$ da cheksiz differensiallanuvchi quyidagi tengsizlikni qanoatlantiruvchi $\varphi(x,y,z)$ funksiyalar to‘plamini belgilaymiz:

$$\sup|x^{\alpha_1}y^{\alpha_2}\frac{\partial^{\beta+\gamma}\varphi(x,y,z)}{\partial x^{\beta}\partial y^{\gamma}}|<\infty$$

bu yerda α_1,α_2,β va γ lar manfiy bo‘lmagan butun sonlar.

A Masala. Agar Ω qatlamdan olingan barcha (x,y,z) lar uchun $u(x,y,z)$ funksiyaning $S(x,y,z)$ konuslar oilasi bo‘yicha

$$\iint\limits_{S(x,y,z)} g(x-\xi,y-\eta)u(\xi,\eta,\zeta)ds=f(x,y,z), \tag{1}$$

integrallari ma’lum bo‘lsa, uch o‘zgaruvchili $u(x,y,z)$ funksiyani tiklash talab etiladi, bu yerda g $\mathbb{R}^2$ dagi vazn funksiya va $f\in\mathcal{L}(\mathbb{R}^2,C[0,h])$.

Eslatib o‘tamizki, (1) tenglamani chap tomonini S konuslar oilasi uchun umumlashgan **R** Radon almashtirishi sifatida qarash mumkin (q. 4 va 5], ya’ni $\mathbf{R}u=f$.

$\hat{\hat{f}}(\cdot,\cdot,z)$ orqali $f(x,y,z)\in\mathcal{L}(\mathbb{R}^2,C[0,h])$ da $(x,y)\in\mathbb{R}^2$ o‘zgaruvchilar bo‘yicha Furye almashtirishini belgilaymiz, ya’ni

$$\hat{\hat{f}}(\lambda,\mu,z)=\frac{1}{2\pi}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}e^{i(\lambda x+\mu y)}f(x,y,z)dxdy.$$

Eslatib o‘tamizki, $\hat{\hat{f}}(\cdot,\cdot,z)\in L(R^2,C[0,h])$ barcha $f(\cdot,\cdot,z)\in\mathcal{L}(\mathbb{R}^2,C[0,h])$ lar uchun (q. IX.I teoremaga [3]).

Quyidagi teorema A masalaning yagonalik shartini va aniq yechimini ko‘rsatadi. Bundan tashqari, yechimni umumlashgan Radon almashtirishini teskari formulasi ko‘rinishida ifodalaydi, ya’ni $u=\mathbf{R}^{-1}f$.

Tahlil va natijalar. Theorem 2.1 *$g(x,y)=x^3-3xy^2\neq0$ va $f\in\mathcal{L}(\mathbb{R}^2,C^7[0,h])$ bo‘lsin. Faraz qilaylik $f(x,y,0)=\frac{\partial^i}{\partial z^i}f(x,y,0)=0, i=1,...,7$ barcha $x,y\in\mathbb{R}$, shuningdek, $\hat{\hat{f}}(\lambda,\mu,z)=0$ barcha $\lambda=0$ va $\lambda^2=3\mu^2$ lar uchun hamda $z\in[0,h]$. U holda A masala Ω da $u(x,y,z)$ yagona yechimga ega bo‘ladi.*

Bundan tashqari, agar $f\in\mathcal{L}(\mathbb{R}^2,C^{17}[0,h])$ bo‘lsa, u holda $u(x,y,z)$ funksiya quyidagi ko‘rinishga ega bo‘ladi

$$u(x,y,z)=\frac{1}{44100\sqrt{2}i\pi^2}\int\limits_{-\infty-\infty}^{+\infty+\infty}\frac{e^{-i(\lambda x+\mu y)}}{\lambda(\lambda^2-3\mu^2)(\lambda^2+\mu^2)}\int_0^z(\frac{d^2}{dt^2}+\lambda^2+\mu^2)^9\times$$

$$\times\int_0^t (t-\tau)^4 J_4((t-\tau)\sqrt{\lambda^2+\mu^2})\,\widehat{\widehat{f}}(\lambda,\mu,\tau)d\tau dt d\mu d\lambda, \qquad (2)$$

Bu yerda $J_n(\cdot)$ - n - tartibli birinchi tur Bessel funksiyasi, ya'ni

$$J_n(t)=\sum_{k=0}^{\infty}\frac{(-1)^k t^{2k+n}}{2^{2k+n}k!\Gamma(n+k+1)}.$$

Teoremaning isboti. (1) integralning chap tomonida quyidagi almashtirishlarni bajaramiz:

$$\zeta = z-\sqrt{(x-\xi)^2+(y-\eta)^2}, \zeta'_\xi = \frac{x-\xi}{\sqrt{(x-\xi)^2+(y-\eta)^2}},$$

$$\zeta'_\eta = \frac{y-\eta}{\sqrt{(x-\xi)^2+(y-\eta)^2}}, ds=\sqrt{1+(\zeta'_\xi)^2+(\zeta'_\eta)^2}\,d\xi d\eta$$

va Furye almashtirishini qo'llab, (1) tenglamaga ekvivalent bo'lgan quyidagi tenglamaga olib kelamiz:

$$\hat{\hat{f}}(\lambda,\mu,z)=\sqrt{2}\int_0^{2\pi}\int_0^z e^{i(z-t)(\lambda\cos\varphi+\mu\sin\varphi)}g((z-t)\cos\varphi,(z-t)\sin\varphi)\hat{\hat{u}}(\lambda,\mu,t)(z-t)dtd\varphi. \qquad (3)$$

Bu yerda vazn funksiya $g(x,y)=x^3-3xy^2$ ekanligidan, quyidagiga ega bo'lamiz:

$$g((z-t)\cos\phi,(z-t)\sin\phi)=(z-t)^3\cos 3\phi.$$

Natijada (3) tenglama quyidagi ko'rinishga ega bo'ladi:

$$\hat{\hat{f}}(\lambda,\mu,z)=\int_0^z G(\lambda,\mu,z-t)\hat{\hat{u}}(\lambda,\mu,t)dt, \qquad (4)$$

bu yerda

$$G(\lambda,\mu,z-t)=\sqrt{2}(z-t)^4\int_0^{2\pi}e^{i(z-t)(\lambda\cos\phi+\mu\sin\phi)}\cos 3\phi d\phi.$$

Ushbu tenglikdan

$$\lambda\cos\phi+\mu\sin\phi=\sqrt{\lambda^2+\mu^2}\cos(\phi-\psi),\quad \cos\psi=\frac{\lambda}{\sqrt{\lambda^2+\mu^2}}$$

$\phi=\theta+\psi$ almashtirishni olsak,

$$G(\lambda,\mu,z-t)=\sqrt{2}(z-t)^4\int_0^{2\pi}e^{i(z-t)\sqrt{\lambda^2+\mu^2}\cos\theta}\cos 3(\theta+\psi)d\theta.$$

Ushbu formulalardan

$$\cos(3\theta+3\psi)=\cos 3\theta\cos 3\psi-\sin 3\theta\sin 3\psi,$$

$$e^{iA\cos\theta}=\cos(A\cos\theta)+i\sin(A\cos\theta),$$

va quyidagi integral tengliklardan foydalanib,

$$\int_0^{2\pi}\sin(A\cos\theta)\sin 3\theta d\theta=2\int_0^{\pi}\sin(A\cos\theta)\sin 3\theta d\theta,$$

$$\int_0^{2\pi}\sin(A\cos\theta)\cos 3\theta d\theta=2\int_0^{\pi}\sin(A\cos\theta)\cos 3\theta d\theta,$$

$$\int_0^{2\pi}\cos(A\cos\theta)\sin 3\theta d\theta=0,\quad \int_0^{2\pi}\cos(A\cos\theta)\cos 3\theta d\theta=0,$$

Ushbu funksiyaga ega bo'lamiz:

$$G(\lambda,\mu,z-t)=2\sqrt{2}i(z-t)^4\{\cos 3\psi\int_0^{\pi}\sin((z-t)\sqrt{\lambda^2+\mu^2}\cos\theta)\cos 3\theta d\theta$$

$$-\sin 3\psi \int_0^{\pi} \sin((z-t)\sqrt{\lambda^2+\mu^2}\cos\theta)\sin 3\theta d\theta\}.$$

Quyida [22, 419-420 betl]dagi formuladan

$$\int_0^{\pi} \sin(A\cos\theta)\cos(n\theta)d\theta = \pi \sin\frac{n\pi}{2} J_n(A),$$

foydalanib, ushbu funksiyaga ega bo‘lamiz:

$$G(\lambda,\mu,z-t) = 2\sqrt{2}i\pi \frac{\lambda(3\mu^2-\lambda^2)}{(\lambda^2+\mu^2)^{\frac{3}{2}}}(z-t)^4 J_3((z-t)\sqrt{\lambda^2+\mu^2}).$$

Bu funksiyani (4) olib borib qo‘ysak, quyidagi tenglamag ega bo‘lamiz:

$$\hat{\hat{f}}(\lambda,\mu,z) = 2\sqrt{2}i\pi \frac{\lambda(3\mu^2-\lambda^2)}{(\lambda^2+\mu^2)^{\frac{3}{2}}} \int_0^z (z-t)^4 J_3((z-t)\sqrt{\lambda^2+\mu^2})\hat{\hat{u}}(\lambda,\mu,t)dt. \quad (5)$$

Bu (5) tenglamaning yechimi [23, 1.8-1 bo‘limdagi] formuladan quyidagicha bo‘ladi:

$$\hat{\hat{u}}(\lambda,\mu,z) = \frac{1}{22050\sqrt{2}i\pi\lambda(3\mu^2-\lambda^2)(\lambda^2+\mu^2)} \int_0^z (\frac{d^2}{dt^2}+\lambda^2+\mu^2)^9 \times$$
$$\times \int_0^t (t-\tau)^4 J_4((t-\tau)\sqrt{\lambda^2+\mu^2})\hat{\hat{f}}(\lambda,\mu,\tau)d\tau dt, \quad (6)$$

barcha $f \in \mathcal{L}(\mathbb{R}^2, C^{17}[0,h])$ uchun.

Natijada (6) tenglamaga μ va λ o‘zgaruvchilar bo‘yicha teskari Furye almashtirishini qo‘llab, (2) tenglamani olamiz

Xulosa va takliflar. Ushbu maqolada uch o‘lchovli fazoda maxsus ko‘rinishdagi vazn funksiyali umumlashgan Radon almashtirishining teskari masalasi o‘rganildi. Tadqiqot davomida bu masalaning yagonaligi isbotlandi va aniq teskari almashtirish formulasi keltirildi. Tahlil shuni ko‘rsatdiki, konuslar oilasi bo‘yicha olingan integrallar asosida funksiyani tiklash uchun Furye almashtirishidan samarali foydalanish mumkin. Bu natijalar integral geometriya, tomografiya, geofizika va boshqa qo‘llanma sohalarda teskari masalalarni hal qilishda muhim nazariy asos bo‘lib xizmat qiladi. Keltirilgan formulalar kelgusida ushbu turdagi almashtirishlar asosida sonli usullarni ishlab chiqish va qo‘llash imkonini beradi.

Foydalanilgan adabiyotlar ro‘yxati:

[1]. Лаврентьев М.М., Савельев Л.Я. Теория операторов и некорректные задачи. Издательство Института математики. Москва, 1999, 702 с.

[2]. Кабанихин С.И. Обратные и некорректные задачи. Сибирское научное издательство. 2009, 512 с.

[3]. Reed M., Simon B. Methods of Modern Mathematical Physics: Functional Analysis. Rev. ed. Academic press, 1980, 400 p.

[4]. Helgason S. Integral Geometry and Radon Transform. Springer, New York, 2011, 301 p.

[5]. Natterer F. The mathematics of computerized tomography. Classics in Mathematics. Society for Industrial and Applied Mathematics. New York, 2001, 184 p.

[6]. Anikonov D.S., Kipriyanov Y.A. An underdetermined problem of integral geometry for the generalized Radon transform. J. Appl. Industr. Math. 2016, № 10(1), c. 21–28 p.

[7]. Anikonov D.S., Konovalova D.S. An integral geometry underdetermined problem for a family of curves. Siberian Math. J. 2015, № 56(2), c. 217–230 p.

[8]. Goncharov F.O. An iterative inversion of weighted Radon transforms along hyperplanes", Inverse Problems. 2017, № 33, 124005 p.

[9]. Goncharov F.O., Novikov R.G. An analog of Chang inversion formula for weighted Radon transforms in multidimensions", EJMCA, 2016, № 4 (2), 23–32 p.

[10]. Goncharov F.O., Novikov R.G. An example of non-uniqueness for the weighted Radon transforms along hyperplanes in multidimensions. Inverse Problem, 2018, № 34, 054001 p.

[11]. Goncharov F.O., Novikov R.G. An example of non-uniqueness for Radon transforms with continuous positive rotation invariant weights. Journal of Geometric Analysis. 2018, № 25 (4), 3807–3828 p.

[12]. Zekeriya Ustaoglu. A generalization on the solvability of integral geometry problems along plane curves. Boundary Value Problems volume. 2013, № 202, 293–314 p.

[13]. Begmatov A.Kh., Muminov M.E., Ochilov Z.H. The problem of integral geometry of Volterra type with a weight function of a special type. Mathematics and Statistics. 2015, № 3, 113–120 p.

[14]. Golgeleyen I. An integral geometry problem along geodesics and a computational approach. An. Univ. Ovidius Constanta. ser. Mat., 2010, 1259–1274 p.

[15]. Frikel J., Quinto E.T. Limited data problems for the generalized Radon transform in Rn. /SIAM J. Math. Anal. 2016, № 48(4), 2301–2318 p.

[16]. Homan A., Zhou H. Injectivity and stability for a generic class of generalized Radon transforms. J. Geom. Anal. 2017, № 27(2), 1515–1529 p.

[17]. Ilmavirta J., Monkko'nen K. Unique continuation of the normal operator of the x-ray transform and applications in geophysics. Inverse Problems. 2020, № 36(4), 045014 p.

[18]. Ilmavirta J. On Radon transforms on tori. J. Fourier Anal. Appl. 2015, № 21(2), 370–382 p.

[19]. Railo J. Fourier Analysis of Periodic Radon Transforms. Journal of Fourier Analysis and Applications. 2020, № 26(4), 64 p.

[20]. Reichelt T. A comparison theorem between Radon and Fourier-Laplace transforms for D-modules. Ann. Inst. Fourier (Grenoble). 2015, № 65(4), 1577–1616 p.

[21]. Muminov M.I., Ochilov Z.Kh. An inversion formula for the weighted Radon transform along family of cones. Nanosystems: Physics, Chemistry, Mathematics. 2023, № 14 (1), 1–6 p.

[22]. Gradsteyn I.S., Ryzhik I.M. Table of integrals, series, and products. Academic Press. 2007, 1108 p.

[23]. Polyanin A.D., Manzhirov A.V. Handbook of Integral Equations. CRC Press LLC, N.W. Corporate Blvd., Boca Raton, Florida. 2000, 1082 p.

Abloqulov Sherzodjon Zokir o'g'li (Toshkent Kimyo-texnologiya instituti "Oliy matematika" kafedrasi katta o'qituvchisi (PhD),
Ruzimov Anvarbek Shuxratovich (Urganch Innovatsion university NTM "Pedagogika va boshlang'ich ta'lim metodikasi" kafedrasi katta o'qituvchisi (PhD),
Saidov Yuldash Razzakovich (Urganch Innovatsion university NTM "Pedagogika va boshlang'ich ta'lim metodikasi" kafedrasi dotsenti)

QARSHILIKLI ERKINLIK DARAJASI BIRGA TENG BO'LGAN MEXANIK SISTEMANING ERKIN TEBRANISHI

Annotatsiya. *Bu ishda Kulon qarshilikli erkinlik darajasi birga teng bo'lgan mexanik sistemaning erkin tebranishi masalasi yechilgan. Mexanik sistemaning tebranishlar tenglamasi Nyutonning ikkinchi qonuni orqali olingan. Olingan tebranishlar tenglamasi Laplasning integral almashtirishi orqali yechiladi. Sonli natijalar olinib tahlil qilingan.*

Kalit so'zlar*: erkinlik darajasi, Laplasning integral almashtirishi, inersiya kuchi, Nyutonning ikkinchi qonuni, erkin tebranishlar chastotasi.*

Аблокулов Шерзоджон Зокир угли (старший преподаватель (PhD) кафедры "Высшая математика" Ташкентского химико-технологического института),
Рузимов Анварбек Шухратович (старший преподаватель (PhD) кафедры "Педагогики и методики начального образования" Ургенчского инновационного университета),
Саидов Юлдаш Раззакович (доцент кафедры "Педагогики и методики начального образования" Ургенчского инновационного университета)

Аннотация. *В данной работе решена задача о свободных колебаниях механической системы с кулоновским сопротивлением степени свободы, равной единице. Уравнение колебаний механической системы получено с использованием второго закона Ньютона. Полученное уравнение колебаний решено с использованием интегрального преобразования Лапласа. Получены и проанализированы численные результаты.*

Ключевые слова*: степени свободы, интегральное преобразование Лапласа, инерционная сила, второй закон Ньютона, частота свободных колебаний.*

Ablokulov Sherzodjon Zokir ugli (Senior teacher (PhD) of the "Higher Mathematics" department of the Tashkent Institute of Chemical Technology),
Ruzimov Anvarbek Shukhratovich (Senior Lecturer (PhD) at the Department of Pedagogy and Methodological Primary Education at Urgench Innovation University),
Saidov Yuldash Razzakovich (Associate Professor of the Department of Pedagogy and Methods of Primary Education at Urgench Innovation University)

Annotation. *In this work, the problem of free oscillations of a mechanical system with a Coulomb resistance degree of freedom equal to one is solved. The oscillation equation of the mechanical system is obtained using Newton's second law. The obtained oscillation equation is solved using Laplace's integral transformation. Numerical results are obtained and analyzed.*

Keywords: *degrees of freedom, Laplace's integral transformation, inertial force, Newton's second*