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Implementation of the CST complex Sadik transform to treat population expansion and decay problems

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Abstract

Now with the increasing problems of expansion of the population and decay in the world, researchers are making great efforts to find new ideas and proposals to find successful solutions to solve these problems through the utilization of different integrated transformations. In our paper, the complex Sadik transform is applied to resolve the issues of population expansion and decay.

Subject Classification: *44-XX Integral transforms.*

Keywords: *Complex Sadik integral transform, Inverse of complex Sadik transform, Growth population problems, Decay problems.*

1. Introduction

In this universe, there is a proportion between the growth or decay of quantities with their size. For example, we note that some types of bacteria may double in size during a particular time, which may be minutes or hours. If we know the size of this bacteria after t hours by the x(t), we can represent this information mathematically in the format of a 1st-order differential equation.

$$\frac{dx}{dt} = 2x$$

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Where in the above equation x represents the amount that outgrowth or decays at a ratio proportionate to its volume.

$$\frac{dx}{dt} = rx$$

The above equation is called the statute of naturalistic outgrowth when r>0, but if r < 0, it is known as the statute of decay. Mathematically this type of equation is solved using the separation of the variable method. Thus, the important role of Integral transforms appears in solving differential equations.

Recently, researchers have been interested in integrated transfers and the important role of these transfers in solving many of the problems that we face in our modern life. In[1] presented both S.S.Khakale and D.P. Patil with the concept of the Soham transform. In[2] the Kushare transform has been employed to resolve the problems of outgrowth and decay by Dr. Dinkar, et al. In 2021 the Sawi transform is applied to the Bessel function by Dr. Dinkar[3]. While in[4] Dr. Dinkar to evaluating improper integral further by employing the Sawi transform of the error function. In[5], D.P. Patil used the Lpalce and Shenu transforms in chemical science. In[6] employing the ST and its condition theorem to resolve the wave equation by Dr. Dinkar. More than, in[7] Dr. Dinkar to resolve the parabolic boundary value problems employed the Mahgoub transform. In June 2020, D.P. Patil acquired the solution to the wave equation by employing (the double Laplace & double Sumudu transform) [8]. In[9] by Dr. Dinkar Dualities among the twin integral transforms are derived. While in[10] to convert boundary value problems of the system of ordinary differentiable equations Dr. Dinkar utilized (Aboodh & Mahgoub). In December 2018 Dr. Dinkar studied Mahgoub, Elzaki, Sumudu, and Laplace transforms relatively and apply them to Boundary value problems[11]. Further, D.P. Patil finds the solution to the Parabolic Boundary value problems by utilizing the dual Mahgoub transform[12]. In 2022 Dr. Dinkar, utilized the Soham transform to get resolve a system of differential equations[13]. In[14] Dr. Dinkar employed Soham transform to resolve terra integral equations of the 1st type. In May 2022 Dr. Dinkar [15] employed Anuj transform to resolve terra integral equations of the 1st type. In[16]to solve the telegraph equations Borse, Kapadi, and Patil employed the E.Falih transform. In 2022 Dr. Dinkar Patil et al employed the general integral transform of the error function to evaluate incorrect integrals[17]. Dr. Dinkar et al employed the E.Sara transform to get the resolve to the telegraph equation[18]. In[19] Dinkar Patil et al employ the Emad- Falih Transform to solve Newton's law of cooling. In[20] Dr. Dinkar employs the HY transform for solving Newton's law of cooling**.** Newly to obtain solve the parabolic boundary value problems Dr. Dinkar, utilized a double general integral transform[21]. In June 2022, employ the HY integral transform for the treatment of outgrowth and Decay Issues by Dr. Dinkar [22]. In[23,24,29] Several new integral transformations have been used in solving linear differential equations. In[25] using the SEE (Sadiq, Emad, E.) integral transform to find the general solution of the first order complex differential equations with constant coefficients. In[26], authors suggest the Emad-Sara Transform solves linear ordinary differential equations. In 2022 employed Kushare transform to resolve the Issues based Newton's statute of cooling by R. S. Sanap and D.P. Patil[27]. In[30] presented both S.R Kushare and D.P. Patil with the concept of the Kushare transform. In August 2021, Kushare and Patil used Laplace, Elzaki, and Mahgoub transform to resolve the systems of the 1st-order and 1st-degree differential equations[31].

2. The proposed CSI is defined for the following,[28]:

$$S_\beta^c[k(t)] = F^c(n^\beta, \alpha) = \frac{1}{n^\alpha}\int_0^\infty k(t)\, e^{-in^\beta t}\, dt$$

Where $n \in C, \beta \in \square^*, \alpha \in R$

2.1 *The CSI Transform for Some Essential Functions,* [28]:

In this part, we will give the CSI transform for some essential functions in the following Table 1:

No	**Function**	**CSI Transform $S_\beta^c[k(t)]=F^c(n)$**
1	$t^m, m \in \mathbb{N}$	$S_\beta^c\{t^m\}=(-i)^{m+1}\frac{m!}{n^{m\beta+(\beta+\alpha)}}$.
2	e^{vt}, v constant	$S_\beta^c\{e^{vt}\}=\frac{-1}{n^\alpha}\left[\frac{v}{n^{2\beta}+v^2} + i\frac{n^\beta}{n^{2\beta}+v^2}\right]$.
3	sin(vt)	$S_\beta^c\{sin(vt)\}=\frac{-v}{n^\alpha(n^{2\beta}-v^2)}$.
4	cos(vt)	$S_\beta^c\{cos(vt)\}=\frac{-in^\beta}{n^\alpha(n^{2\beta}-v^2)}$.
5	sinh(vt)	$S_\beta^c\{sinh(vt)\}=\frac{-v}{n^\alpha(n^{2\beta}+v^2)}$.
6	cosh(vt)	$S_\beta^c\{cosh(vt)\}=\frac{-in^\beta}{n^\alpha(n^{2\beta}+v^2)}$.

2.2 *The Inverse of CSI Transform*, [28]:

If $S_\beta^c[k(t)] = F^c(n)$ is Complex Sadik Transform, then $K(T) = (S_\beta^c)^{-1}[F^c(n)]$ is represented as the inverse of the Complex Sadik Transform (Table 2).

No	The inverse of CSI Transform	Function $K(T)$
1	$(S_\beta^c)^{-1}\left[(-i)^{m+1}\frac{m!}{n^{m\beta+(\beta+\alpha)}}\right]$	t^m.
2	$(S_\beta^c)^{-1}\left[\frac{-1}{n^\alpha}\left[\frac{v}{n^{2\beta}+v^2}+i\frac{n^\beta}{n^{2\beta}+v^2}\right]\right]$	e^{vt}.
3	$(S_\beta^c)^{-1}\left[\frac{-v}{n^\alpha(n^{2\beta}-v^2)}\right]$	sin(vt).
4	$(S_\beta^c)^{-1}\left[\frac{-in^\beta}{n^\alpha(n^{2\beta}-v^2)}\right]$	cos(vt).
5	$(S_\beta^c)^{-1}\left[\frac{-v}{n^\alpha(n^{2\beta}+v^2)}\right]$	sinh(vt).
6	$(S_\beta^c)^{-1}\left[\frac{-in^\beta}{n^\alpha(n^{2\beta}+v^2)}\right]$	cosh(vt).

3. The CSI Transform of Derivatives,[28]:

Let g(t) be a continuous function and piecewise continuous on any interval, in this part, we are giving the CSI transform of Derivatives of the g(t) are represented in Table 3:

No	The Derivatives
1	The 1st derivative $S_\beta^c[g'(t)]=\frac{1}{n^\alpha}\int_0^\infty g'(t)\,e^{-in^\beta t}dt = S_\beta^c[g'(t)] = in^\beta F^c(n)-\frac{g(0)}{n^\alpha}$.
2	The 2nd derivative $S_\beta^c[g''(t)]=\left(in^\beta\right)^2F^c(n)-\frac{g'(0)}{n^\alpha}-\frac{in^\beta g(0)}{n^\alpha}$.
3	The 3rd derivative $S_\beta^c[g'''(t)]=\left(in^\beta\right)^3F^c(n)-\frac{1}{n^\alpha}\left[g''(0)+in^\beta g'(0)+\left(in^\beta\right)^2g(0)\right]$.
4	In general $S_\beta^c[g^{(z)}(t)]=\left(in^\beta\right)^zF^c(n)-\frac{1}{n^\alpha}\left[g^{(z-1)}(0)+in^\beta g^{(z-2)}(0)+\left(in^\beta\right)^2g^{(z-3)}(0)+\cdots+\left(in^\beta\right)^{(z-2)}g'(0)+\left(in^\beta\right)^{(z-1)}g(0)\right]$.

4. Applications of the CSI in Inhabitance Expansion and Decay Issues:

In here part we get the CSI transform of population expansion and decay problems:

4.1 *The CSI (Complex Sadik Integral Transform) in population expansion Problems:*

In this part, we employ CSI transform for the population expansion problem as follows:

The population expansion for example (an increase of flora, a calling, a member, a type) can be represented by a differential equation of the 1st order,

$$\frac{dI}{dT} = Y.I. \ (1)$$

With the foremost stipulation,

$$I(T_\circ) = I_\circ \ (2)$$

While the $Y > 0$, I represent the quantity of inhabitance in time T & $I_\circ$ reflects the basic habitation number in time $T_\circ$. Put the CSI Transform to use on both sides of the equation (1).

$$S_\beta^c\{\frac{dI}{dT}\} = S_\beta^c\{Y.I(T)\}.$$

Using the first derivative's CSI transform property in the equation above,

$$-\frac{I(0)}{n^\alpha} + in^\beta F^c(n) = YF^c(n).$$

Since, $T_\circ$=0, I=$I_\circ$ $(in^\beta - Y)F^c(n) = \frac{I_\circ}{n^\alpha}$,

Then $F^c(n) = \frac{I_\circ}{n^\alpha(in^\beta - Y)}$.

$$F^c(n) = S_\beta^c\{I(T)\} = \frac{I_\circ}{n^\alpha(in^\beta - Y)}.$$

Then $S_\beta^c\{I(T)\} = \frac{I_\circ}{n^\alpha(in^\beta - Y)}$.

Now, we take the inverse of the CSI transform on both sides, and we obtain:

$$I(T) = I_\circ(S_\beta^c)^{-1}\left[\frac{1}{n^\alpha(in^\beta - Y)}\right] = I_\circ(S_\beta^c)^{-1}\left[\frac{1}{n^\alpha(in^\beta - Y)}\,\frac{in^\beta + Y}{in^\beta + Y}\right],$$

$$= I_\circ(S_\beta^c)^{-1}\left(\frac{1}{n^\alpha}\left[\frac{Y}{(n^{2\beta} + Y^2)} + i\,\frac{n^\beta}{(n^{2\beta} + Y^2)}\right]\right) = I_\circ e^{YT}.$$

This represents the required inhabitance in the time T.

4.2 *The CSIT for Decay Issues:*

Here, we employ CSI for the Decay Issues can be represented as follows:

The case of decay of material is governed by a linear differential equation of the 1st order.

$$\frac{dI}{dT} = -Y.I. \ (3)$$

With the initial condition

$$I(T_\circ) = I_\circ \ (4)$$

While I belongs to the quantity of material in time T; Y represents a positive veritable numeral & $I_\circ$ represents the elementary quantity of the material in time, $T_\circ$. In (3), the (-) signal, to the *(*Right Hand Side*)* of the equation is possessed because the cluster, of material, is decrescent with time so that derivative $\frac{dI}{dT}$ should be negative.

Using the CSI transform on both sides of equation (4)

$$S_\beta^c\left\{\frac{dI}{dT}\right\} = -Y.(S_\beta^c)\{I(T)\} - \frac{I(0)}{n^\alpha} + in^\beta F^c(n) = -YF^c(n).$$

Since, $T_\circ=0$, $I=I_\circ$ $(in^\beta + Y)F^c(n) = \frac{I_\circ}{n^\alpha}$,

Then $F^c(n) = \frac{I_\circ}{n^\alpha(in^\beta+Y)}$.

$$F^c(n) = S_\beta^c\{I(T)\} = \frac{I_\circ}{n^\alpha(in^\beta+Y)}.$$

Then $S_\beta^c\{I(T)\} = \frac{I_\circ}{n^\alpha(in^\beta+Y)}$.

Now, we take the inverse of the CSI transform on both sides, and we obtain:

$$I(T) = I_\circ(S_\beta^c)^{-1}\left[\frac{1}{n^\alpha(in^\beta+Y)}\right] = I_\circ(S_\beta^c)^{-1}\left[\frac{1}{n^\alpha(in^\beta+Y)}\,\frac{Y-in^\beta}{Y-in^\beta}\right],$$

$$= I_\circ(S_\beta^c)^{-1}\left(\frac{1}{n^\alpha}\left[\frac{Y}{(n^{2\beta}+Y^2)} - i\frac{n^\beta}{(n^{2\beta}+Y^2)}\right]\right)$$

$$= I_\circ(S_\beta^c)^{-1}\left(\frac{-1}{n^\alpha}\left[\frac{-Y}{(n^{2\beta}+Y^2)} + i\frac{n^\beta}{(n^{2\beta}+Y^2)}\right]\right) = I_\circ e^{-YT}.$$

This represents the required substance at the time T.

5. Applications

In this part, we dissolve several cases of inhabitance expansion and decay.

Application 5.1: The inhabitance of any city expands depending on the number of people living in it. If the inhabitance manifolded in the next two or three years so that the inhabitance becomes 20000 people, what is the estimated number of the city's inhabitance at the beginning?

The solving:

Mathematically: This case can be mentioned as the following:

$$\frac{dI}{dT} = Y.I. \ (5)$$

While the I represent the numeral of inhabitance existent in the city at any time T and Y are the constants of proportion. Deem, that $I_\circ$ represents the numeral of inhabitance originally existent in the city at the time, $T=0$.

Using CSI on both sides of equation (5).

$$S_\beta^c\{\frac{dI}{dT}\} = S_\beta^c\{Y.I(T)\}.$$

By utilizing the property of the CSI transform of the 1st derivative of the above equation,

$$-\frac{I(0)}{n^\alpha} + in^\beta F^c(n) = YF^c(n).$$

Since, $T_{\circ}$=0, I=$I_{\circ}$ $(in^{\beta} - Y)F^{c}(n) = \frac{I_{\circ}}{n^{\alpha}}$,

Then $F^{c}(n) = \frac{I_{\circ}}{n^{\alpha}(in^{\beta}-Y)}$.

$$F^{c}(n) = \frac{I_{\circ}}{n^{\alpha}(in^{\beta}-Y)}.$$

$$F^{c}(n) = S_{\beta}^{c}\{I(T)\} = \frac{I_{\circ}}{n^{\alpha}(in^{\beta}-Y)}.$$

Then $S_{\beta}^{c}\{I(T)\} = \frac{I_{\circ}}{n^{\alpha}(in^{\beta}-Y)}$.

Now, we take the inverse of the CSI transform on both sides, and we get:

$$I(T) = I_{\circ}(S_{\beta}^{c})^{-1}\left[\frac{1}{n^{\alpha}(in^{\beta}-Y)}\right],$$

Then

$$I(T) = I_{\circ}e^{YT}. \ (6)$$

Now, at $= 2, I = 2\,I_{\circ}$,

$$2\,I_{\circ} = I_{\circ}e^{YT},$$

$$2 = e^{YT},$$

$$Y = \frac{1}{2}\log_{e} 2,$$

$$Y=0.3466.$$

Now, put this value T=3, I=20000 in equation (6), then

$$20000 = I_{\circ}e^{3Y},$$

$$20000 = I_{\circ}e^{3(0.3466)},$$

$$20000 = I_{\circ}(2.8287\ ),$$

Then $I_{\circ}$ = 7070.3857≈7070.

This represents the numeral of individuals required to live in the city at first.

Application 5.2: It is known that radioactive materials decompose at a rate commensurate with the amount present. At first, there is 100 mg of radioactive materials. Note in the following two hours that the radioactive materials have lost 10% of their original mass. What is the half-life of the radioactive material?

The solving: Mathematically: This case can be mentioned as the following:

$$\frac{dI}{dT} = -Y.I. \ (7)$$

Where I reference the quantity of radioactive material in time T & Y represent the proportionality constant. Deem, $I_{\circ}$ as the primary quantity of radioactive material in time T =0.

Using CSIT on both sides of equation (7).

$$S_\beta^c\left\{\frac{dI}{dT}\right\} = -Y.(S_\beta^c)\{\,I(T)\}.$$

Now, using the CSIT property of the derivative of a function, on the above equation:

$$-\frac{I(0)}{n^\alpha} + in^\beta F^c(n) = -YF^c(n).$$

Since, $T_\circ$=0, I=$I_\circ$ $(in^\beta + Y)F^c(n) = \frac{I_\circ}{n^\alpha}$,

Then $F^c(n) = \frac{I_\circ}{n^\alpha(in^\beta+Y)}$,

$$F^c(n) = S_\beta^c\{I(T)\} = \frac{I_\circ}{n^\alpha(in^\beta+Y)},$$

So $S_\beta^c\{I(T)\} = \frac{I_\circ}{n^\alpha(in^\beta+Y)}$.

Since, T=0, $I_\circ$ =*100*.

Then $S_\beta^c\{I(T)\} = \frac{100}{n^\alpha(in^\beta+Y)}$.

Now, we take the inverse of the CSI transform on both sides, and we get:

$$I(T) = 100(S_\beta^c)^{-1}\left[\frac{1}{n^\alpha(in^\beta+Y)}\right],$$

$$I(T) = 100e^{-YT}. \quad (8)$$

Now, by the case provided in the problem at T=2, the radio-active material has missed 10 % of its genuine mass of 100 milligrams.

So, I=100−10=90

$$90=100e^{-2Y},$$

$$e^{-2Y} = 0.9,$$

$$-2Y = \log_e 0.9,$$

$$Y = \frac{-1}{2}\log_e 0.9.$$

Then Y = 0.0527.

We desired a half-time of radioactive material (T) when

$$I=\frac{I_\circ}{2}=\frac{100}{2} = 50,$$

Substitute this value into (8),

$$50 = 100e^{-YT},$$

$$50=100e^{-0.0527T},$$

$$0.5=e^{-0.0527T},$$

$$-0.0527T= \log_e (0.5),$$

$$-0.0527T= -0.6932.$$

So T=13.1537 *hours*.

This is the desired half-life time for the radioactive material.

8. Discussion and Conclusion

In this work, we have succeeded in developing the complex Sadik integral transform to solve the linear differential equations of inhabitants' outgrowth and decay Issues. The presented implementations display the impact of complex Sadik integral transform to solve inhabitants' outgrowth and decay problems.

References

[1] D.P. Patil, S.S. Khakale, The new integral transform Soham transform, *International Journal of Advances in Engineering and Management*, 3(10), 126-132 (2021), http://dx.doi.org/10.35629/5252-0310126132.

[2] D.P. Patil, P.S. Nikam, S.D. Shirsath, A. T. Aher, Kushare transform for solving the problems on growth and decay, *Journal of Engineering Technologies and Innovative Research*, 9(4), 317-323 (2022).

[3] D.P. Patil, Applications of Sawi transform in Bessel Functions, *Aayushi International Interdisciplinary Research Journal*, Special No. 86, 171-175.

[4] D.P. Patil, Application of Sawi transform of error function for evaluating improper integrals, *Journal of Research and Development*, 11(20), 41-45 (2021), http://dx.doi.org/10.2139/ssrn.4094229.

[5] D.P. Patil, Application of integral transform (Laplace and Shehu) in chemical sciences, *Aayushi International Interdisciplinary Research Journal*, Special No. 88, 437-441 (2022), http://dx.doi.org/10.2139/ssrn.4006213.

[6] D.P. Patil, Sawi transform and conution theorem for initial Boundary Value Problems(wave equation), *Journal of Research and Development*, 11(14), 133-136 (2021).

[7] D.P. Patil, Application of Mahgoub transform in parabolic boundary value problems, *International Journal of Current Advanced Research*, 9(4(c)), 21949-21957 (2020), http://dx.doi.org/10.24327/ijcar.2020.21951.4323.

[8] D.P. Patil, Solution of wave equation by double Laplace and double Sumudu transform, *Vidyabharti International Interdisciplinary Research Journal*, Special IV CIMs 2021, 135-138 (2021).

[9] D.P. Patil, Dualities between double integral transforms, *International Journal of Advanced Research in Science, Engineering and Technology*, 7(6), 74-82 (2020).

[10] D.P. Patil, Aboodh and Mahgoub transform in boundary Value problems of System of ordinary differential equations, *International Journal of Advanced Research in Science, communication and Technology*, 6(1), 67-75 (2021), http://dx.doi.org/10.48175/IJARSCT-1361.

[11] D.P. Patil, Comparative study of Laplace, Sumudu, Aboodh, Elzaki and Mahgoub transforms and Applications in boundary value problems, *International Journal of Research and Analytical Reviews*, 5(4), December 2018.

[12] D.P. Patil, Double Mahgoub transform for the solution of parabolic boundary value Problems, *Journal of Engineering mathematics and statistics*, 4(2), 28-36 (2020).

[13] D.P. Patil, S. Rathi, S. Rathi, The new integral transform Soham thransform for system of differential equations, *International Journal of Advances in Engineering and Management*, 4(5), 1675-1678 (2022).

[14] D.P. Patil, Y. S. Suryawanshi, M. D. Nehete, Application of Soham transform for solving terra integral equations of first kind, *International Advanced Research Journal in Science, Engineering and Technology*, 9(4) (2022).

[15] D.P. Patil, P.D. Shinde, G.K. Tile, terra integral equations of first kind by using Anuj transform, *International Journal of Advences in Engineering and Management*, 4(5), 917-920 (2022).

[16] D.P. Patil, S. Borse, D. Kapadi, Applications of Emad-Falih transform for general solution of telegraph equation, *International Journal of Advanced Research in Science, Engineering and Technology*, 9(6), 19450-19454 (2022).

[17] D.P. Patil, K.S. Kandekar, T.V. Zankar, Application of general integral transform of error function for evaluating improper integrals, *International Journal of Advances in Engineering and Management*, 4(6), 242-246 (2022), http://dx.doi.org/10.35629/5252-0406242246.

[18] D.P. Patil, Shweta Vispute and Gauri Jadhav, Applications of E.Sara transform for general solution of telegraph equation, *International Advanced Research Journal in Science, Engineering and Management*, 9(6), 127-132 (2022).

[19] D.P. Patil, S. A. Patil, K. J. Patil, Newton's law of cooling by, Emad- Falih Transform, *International Journal of Advances in Engineering and Management*, 4(6), 1515- 1519 (2022), http://dx.doi.org/10.35629/5252-040615151519.

[20] D.P. Patil, J. P. Gangurde, S. N. Wagh, T. P. Bachhav, Applications of the HY transform for Newton's law of cooling, *International Journal of Research and Analytical Reviews*, 9(2), 740-745 (2022).

[21] D.P. Patil, Prerana Thakare, Prajakta Patil, A double general integral transform for the solution of parabolic boundary value problems,

International Advanced Research in Science, Engineering and Technology, 9(6), 82-90 (2022).

[22] D.P. Patil, A.F.Shaikh, N. More, J. Shaikh, The HY integral transform for handling growth and Decay problems, *Journal of Emerging Technology and Innovative Research*, 9(6), 334-343 (2022).

[23] E.Sabah Abbas, E.A. Kuffi, A.A. Jawad, New integral Kuffi-Abbas-Jawad KA J transform and its application on ordinary differential equations, *Journal of Interdisciplinary Mathematics*, 1-7 (2022), https://doi.org/10.1080/09720502.2022.2046339.

[24] E.Kuffi, S.F. Maktoof, Emad-Falih Transform a new integral transform, *Journal of Interdisciplinary Mathematics*, 24:8, 2381-2390, (2021), https://doi.org/10.1080/09720502.2021.1995194.

[25] E. Kuffi, R.H. Buti, Solution of first order constant coefficients complex differential equations by SEE transform method, *Journal of Interdisciplinary Mathematics*, 25(6), 1835–1843 (2022), https://doi.org /10.1080/09720502.2022.2052574.

[26] E.A. Mansour, E.A. Kuffi, S.A. Mehdi, Complex SEE integral transform in solving Abel's integral equation, *Journal of Interdisciplinary Mathematics*, 1-8 (2022), https://doi.org/10.1080/09720502.2022.204 0847.

[27] R.S. Sanap, D.P. Patil, Kushare Integral Transform for Newton's Law of Cooling, *International Journal of Advances in Engineering and Management*, 4, Issue, 166-170 (2022), https://doi.org/10.35629/5252-0401166170.

[28] S.M. Turq, E.A. Kuffi, The New Complex Integral Transform Complex Sadik Transform and It's Applications, *Ibn Al Haitham Journal for Pure and Applied Science*, (2022).

[29] S.F. Maktoof, E. Kuffi, E.S. Abbas, Emad- Sara Transform a new integral transform, *Journal of Interdisciplinary Mathematics*, 1-10 (2021), http://dx.doi.org/10.1080/09720502.2021.1963523.

[30] S.R. Kushare, D.P. Patil, A.M. Takate, The new integral transform Kushare transform, *International Journal of Advanced in Engineering and Management*, 3(9), 1589-1592 (2021).

[31] S.R. Kushare, D.P. Patil, A.M. Takale, Comparison between Laplace, Elzaki and Mabgoub transforms for solving System of First order and First degree differential equations, *Vidyabharti International Interdisciplinary Research Journal*, Special IVCIMS 2021, 139-144 (2021), http://dx.doi.org/10.2139/ssrn.3936407.