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# Applications of KUSHRE Transform in Chemical Sciences

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**Abstract- We use Kushare integral transform to solve the problems in chemical sciences.**

**Keywords- Kushare Transform, Integral Transform, Mixing Problems, Problems in Saponification, Chemistry.**

## I. INTRODUCTION

Recently, integral transforms are one of the mostly used simple mathematical tools to obtain the solutions of advance problems of space, science, technology, engineering, commerce and economics. The important feature of these integral transform is to provide exact solution of the problem without lengthy calculations.

Recently, S.R Kushare and D. P. Patil [1] introduce Kushare transform in September 2021.In October 2021, S. S. Khakale and D. P. Patil [2] introduce Soham transform. Emad Kuffi et al [19] developed Emad Sara transform. As researchers are going introducing new integral transforms at the same time many researchers are interested to apply these transforms to various types of problems. In January 2022, R .S. Sanap and D. P. Patil [3] used Kushare transform to solve the problems based on Newton's law of cooling.

In April 2022 D. P. Patil et al. [4] use Kushare transform to solve the problems on growth and decay. In October 2021 D. P. Patil [5] used Sawi transform in Bessel function. D. P. Patil [6] used Sawi transform of error function for evaluating improper integral further, Lpalce and Shenu transforms are used in chemical science by D. P. Patil [7]. Dr. D. P. Patil [8] solved the wave equation by Sawi transform and its convolution theorem. Further Patil [9] also used Mahgoub transform for solving parabolic boundary value problems. Dr. Patil [10] obtains solution of the wave equation by using double Laplace and double Sumudu transform. Dualities between double integral transforms are derived by D. P. Patil [11]. Laplace, Elzaki, and Mahgoub transforms are used for solving system of first order and first degree differential equations by Kushare and Patil [12].Boundary value problems of the system of ordinary differentiable equations are by using Aboodh and Mahgoub transform by D. P. Patil [13]. D. P. Patil [14] study Laplace, Sumudu, Elzaki and Mahgoub transforms comparatively and apply them in Boundary value problems. Parabolic Boundary value problems are also solved by Dinkar Patil [15]. For that he used double Mahgoub transform.

Soham transform is used to obtain the solution of system of differential equations by D. P. Patil et al [16]. D. P. Patil et al also used Soham transform for solving Volterra integral equations of first kind [17]. D. P. Patil et al [18] used Anuj transform to solve Volterra integral equations of first kind. Soham transform is used to solve same equations by D. P. Patil et al [19]. Rathi sisters and D. P. Patil used Soham transform for system of differential equations [20]. Recently, Zankar , Kandekar and D. P. Patil used general integral transform of error function for evaluating improper integrals[21]. Recently, Dinkar Patil, Prerana Thakare and Prajakta Patil [22] used double general integral transform for obtaining the solution of parabolic boundary value problems. Snehal patil, Komal patil and Dinkar Patil [23] used Emad Falih transform for Newton's law of Cooling. D. P. Patil et al [24] used Soham transform for solving Newton's law of cooling. Further, HY transform is used to handling exponential growt and decay problems by Areen Shaikh, Neha More , Jaweria Shaikh and Dinkar Patil [25].

In this paper we use Kushare transform to solve the problems in Chemical Sciences. This paper is organized as follows. Second section is used for preliminaries. Kushare transform is used to solve problems in Chemical Sciences in third section. Fourth section is devoted for conclusion

## II.PRELIMINARY

In this section we state some preliminary concepts required to solve the problems in Chemical sciences by using Kushare transform.

**Definition**: An integral transform said to be KUSHARE transform changes the characterized for capacity of outstanding request to think about capacities in the set A characterized by [1]

A={f(t)/ ∃M, $T_1, T_2$ >0,|f(t)<Me $\frac{|t|}{Tj}$,if t∈$(1)^j$× [0,∞)}……(1)

and is defined as,

K[f(t)]=s(v)=v$\int_0^\infty f(t)e^{-tv^\propto}$dt,>t≥0,$T_1$≤v≤$T_2$….(2)

For a given function in set A, the constant M must be finite number, $T_1, T_2$ may be finite or infinite .

**1. Kushare transform of derivatives**:[1]

1] k[f′(t)]=$v^\propto$ s(v)-vf(0)

2]k[f″(t)]=$v^{2\propto}$s(v)-$v^{\propto+1}$ f(0)- v f′(0)

3] k[$f^n$(t)]=$v^{n\propto}$s(v)-$\sum_{k=0}^{n-1} v^{\propto(n-k-1)}f^k$(0)

2. **Kushare transform of some preliminary functions:[1]**

| Sr. No. | Function | Kushare transform of f(t)=k[f(t)] |
|---|---|---|
| 1. | 1 | $\frac{1}{v^{\alpha-1}}$ |
| 2. | $t^n$ | $\frac{\sqrt{n+1}}{v^{\alpha(n+1)-1}}$ |
| 3. | $e^{at}$ | $\frac{v}{v^\propto}$ |
| 4. | sinat | $\frac{av}{v^{2\propto+a^2}}$ |
| 5. | cosat | $\frac{v^{\propto+1}}{v^{2\propto}+a^2}$ |

## III.APPLICATIONS IN CHEMISTRY

In this section we apply Kushare transform to various phenomenon in chemical sciences.

**Problem 1**

Mixing problem is very important in chemical sciences. Consider following mixing problem. A typical mixing problem involves a tank of fixed capacity filled with a throughtly mixed solution of substance (say, salt). A solution of a given concentration enters the tank at a fixed rate and the mixture, throughtly stirred, leaves at a fixed rate, which may differ from the entering rate. If y(t) denotes the amount of substance in the tank at time t, then y'(t) is the rate at which the substance is being added minus the rate at which it is being removed. The mathematical description of this situation often leads to a first order differential equation. A case is presented below. A tank contains 20kg of salt dissolved in 5000L of water. Brine that contains 0.03kg of salt per liter of water enters the tank the rate of 25L/min. The solution is kept throughtly mixed and drains from the tank at the same rate. How much salt remains in the tank after half an hour?

**Solution:**

At initial time t =0, y(t) denote amount of salt. Therefore tank contain 20kg salt i.e. y(20) & amount of salt remaining after 30 min i.e. y(30)

$y'(t) = \frac{dy}{dt} =$ rate of amount of salt

$\frac{dy}{dt}$= rate in - rate out…(3)

Rate in = (0.03kg/L)(25L/min)=0.75 kg/min

Rate out=$\left(\frac{y(t)}{5000}\right)\left(\frac{(kg)}{L}\right)$ (25)$\left(\frac{L}{min}\right)$ = $\frac{y(t)}{200}\frac{kg}{min}$

From equation …(3)

$\frac{dy}{dt}$=0.75 $\frac{kg}{min} - \frac{y(t)}{200}\frac{kg}{min}$ =$\frac{3}{4}\frac{kg}{min} - \frac{y(t)}{200}\frac{kg}{min}$

∴ $\frac{dy}{dt} = \frac{3}{4} \frac{y(t)}{200}$

$\frac{dy}{dt}$ = +$\frac{y(t)}{200}$=$\frac{3}{4}$, y(0)=20…..(4)

This equation can be generalized as

$\frac{dy}{dt} + ky(t)$=r…………….(5)

Takeing Kushare transform on both sides

K{$\frac{dy}{dt}$}+ k K{y(t)}=r K{1}

$v^\alpha$s(v)-vf(0)+Ks(v)=r.$\frac{1}{v^{\propto-1}}$

$\therefore S(v) = \frac{\frac{r}{v^{\propto-1}}+20v}{v^\propto+k}$ =$\frac{r+20v^\propto}{v^{\propto-1}(v^\propto+k)}$

By partial fraction

r+20$v^\propto$=$\frac{A}{v^{\propto-1}}+\frac{B}{v^\propto+k}$

we get A=$\frac{r}{k}$ , B=(20-$\frac{r}{k}$)v

$$\therefore S(v) = \frac{\frac{r}{k}}{v^{\alpha-1}} + \frac{\left(20-\frac{r}{k}\right)v}{v^{\alpha}}$$

Apply inversion formula

$$y(t) = \frac{r}{k}K^{-1}\left\{\frac{1}{v^{\alpha-1}}\right\} + \left(20-\frac{r}{k}\right)K^{-1}\left\{\frac{v}{v^{\alpha}+k}\right\}$$

$$\therefore y(t) = \frac{r}{k}(1) + \left(20-\frac{r}{k}\right)e^{-kt} \qquad (6)$$

For exact solution according to the conditions given in the problem put $k = \frac{1}{200}$ and $r = \frac{3}{4}$

$$y(t) = 150 - 130\,e^{-\frac{t}{200}}$$

Half life time can be calculated by replacing $(t)$ by $\frac{y(0)}{2}$ in above equation

**Problem 2**

**Application in Organic chemistry: Saponification**

To produce "homemade" soap, the local ordinance requires that the minimum concentration level for sodium chloride waste in any liquid that is discharged into the environment must not exceed 11.00g/L. Sodium chloride laden liquid water is the major waste of the process. The company has only one 15-liter tank for waste storage. On filling the waste tank, the tank contained 15 liters of water and 750 grams of sodium chloride. To continue production and meet local ordinance, it is desired to pump in fresh water into the tank at the rate of 2.0 liters per minute while waste salt water containing 25 grams of salt per liter is added at the rate of 1.5 liters per minute.

To keep the solution level at 15 liters, 3.5 liters per minute of the waste is discharged. In sketch of the flow suppose A represents the waste stream from the process, B is the fresh water stream and C is the discharge stream to the environment, and here, it is assumed that as the two streams, A and B enter into the tank, instantaneously the chloride concentration in the tank changes to the exit concentration, x . The material (sodium chloride) balance on the tank system can be written as:

Accumulation = input – output + removal by reaction

Solution:

Noting that no chemical reaction occurs in the storage tank, the above equation can be written as

$\frac{dy}{dt}$=(25g/L)(1.5L/min)+(0g/L).(2L/min)-(xg/L).(3.5L/min) +0

=37.5g/min +0-3.5xg/min

Therefore,$\frac{dx}{dt}$+3.5x=37.5.....(7)

For the initial condition of the ordinary diff. equ (7) at t=0 the salt conc. in the tank was given as 750g/L i.e 50g/L

By using kushare transform in equation (7).

K{$\frac{dx}{dt}$}+3.5K{x}=37.5 K{1}

$v^{\alpha}$s(v)-f(0)+3.5 s(v)=37.5$\frac{1}{v^{\alpha-1}}$

S(v)($v^{\alpha}+3.5$)-50v= $\frac{37.5}{v^{\alpha-1}}$

S(v)=$\frac{37.5+50v(v^{\alpha-1})}{v^{\alpha-1}(v^{\alpha}+3.5)}$

By partial fraction,

$$S(v) = \frac{A}{v^{\alpha-1}} + \frac{B}{v^{\alpha}+3.5}$$

We get A=$\frac{75}{7}$, B=$\frac{275}{7}$v

Put the values of A & B

$$S(v) = \frac{\frac{75}{7}}{v^{\alpha-1}} + \frac{\frac{275}{7}v}{v^{\alpha}+3.5}$$

Applying inversion formula,

$$X(t) = \frac{75}{7}\mathrm{K}^{-1}\left\{\frac{1}{v^{\alpha-1}}\right\} + \frac{275}{7}\mathrm{K}^{-1}\left\{\frac{v}{v^{\alpha}+1}\right\}$$

$$X(t) = \frac{75}{7}(1) + \frac{275}{7}e^{-3.5t} \qquad (8)$$

## IV.CONCLUSION

Kushare integral transform is successfully applied in various branches of chemical sciences.

## REFERENCES

[1]. S. R. Kushare, D. P. Patil and A. M. Takale, The new integral transform Kushare transform, International Journal of Advanced in Engineering and Management,Vol. 3,Issue 9,September 2021, pp.1589-1592 .

[2]. D. P. Patil and S. S. Khakale, The new integral transform "Soham transform", International Journal of Advances in Engineering and Management, Vol. 3,Issue 10,October 2021, pp.126-132.

[3]. R. S. Sanap and D. P. Patil, Kushare integral transform for Newton's Law of cooling, International Journal of Advances in Engineering and Management,Vol. 4,Issue 1,January 2022 pp. 166-170.

[4]. D. P. Patil, P. S. Nikam, S. D. Shirsath and A. T. Aher, Kushare transform for solving the problems on growth and decay, Journal of Engineering Technologies and Innovative Research, Vol. 9,Issue 4,April 2022,pp.h317-h323.

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

[6]. D. P. Patil, Application of Sawi transform of error function for evaluating improper integrals, Journal of Research and Development, Vol. 11,Issue 20,June 2021,pp.41-45.

[7]. D. P. Patil, Application of integral transform ( Laplace and Shehu) in chemical sciences, Aayushi International Interdisciplinary Research Journal, Special issue No. 88,pp.437-441.

[8]. D. P. Patil, Sawi transform and convolution theorem for initial Boundary Value Problems(wave equation), Journal of Research and Development, Vol.11, Issue 14, June 2021, pp. 133-136.

[9]. D. P. Patil, Application of Mahgoub transform in parabolic boundary value problems, International Journal of Current Advanced Research, Vol.9 Issue 4(c), April 2020,pp.21949-21957.

[10]. D. P. Patil, Solution of wave equation by double Laplace and double Sumudu transform, Vidyabharti International Interdisciplinary Research Journal, Special Issue IV CIMs 2021, August 2021, pp.135-138.

[11]. D. P. Patil, Dualities between double integral transforms, International Advanced Journal in Science, Engineering and Technology, Vol.7, Issue 6, June 2020, pp. 74-82.

[12]. 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 Issue IVCIMS 2021, August 2021, pp. 139-144.

[13]. 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, Vol.6, Issue 1, June 2021, pp. 67-75.

[14]. 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, Vol. 5,Issue 4,December 2018.

[15]. D. P. Patil, Double Mahgoub transform for the solution of parabolic boundary value Problems, Journal of Engineering mathematics and statistics,Vol.4, Issue 2,May 2020,pp.28-36..

[16]. D. P. Patil, Shweta Rathi and Shrutika Rathi, The new integral transform Soham thransform for system of differential equations, International Journal of Advances in Engineering and Management, Vol. 4, Issue 5 , May 2022, PP. 1675-1678.

[17]. D. P. Patil, Y. S. Suryawanshi, M. D. Nehete, Application of Soham transform for solving Volterra integral equations of first kind, International Advanced Research Journal in Science , Engineering and Technology, Vol. 9, Issue 4, April 2022

[18]. D. P. Patil, P. D. Shinde and G. K. Tile, Volterra integral equations of first kind by using Anuj transform, International Journal of Advances in Engineering and Management, Vol. 4, Issue 5 , May 2022, pp. 917-920.

[19]. D. P. Patil, Y. S. Suryawanshi and M. D. Nehete, Application of Soham transform for solving Volterra integral equations of first kind, International Advanced Research Journal in Science , Engineering and Technology, Vol. 9, Issue 4, April2022.

[20]. Dinkar P. Patil, Shweta D. Rathi and Shrutika D. Rathi, The new integral transform " Soham transform" for system of differential equations, International Journal of Advances in Engineering and Management, Vol. 4, Issue 5, May 2022, pp. 1675-1678.

[21]. D. P. Patil, K. S. Kandekar and T. V. Zankar, Application of general integral transform of error function for evaluating improper integrals, International Journal of Advances in Engineering and Management, Vol. 4, Issue 6, June 2022.

[22]. Dinkar Patil, Prerana Thakare and Prajakta Patil, A double general integral transform for the solution of parabolic boundary value problems, International Advanced Research in Science, Engineering and Technology, Vol. 9, Issue 6, June 2022, pp. 82-90.

[23]. D. P. Patil, S. A. Patil and K. J. Patil, Newton's law of cooling by Emad- Falih transform, International Journal of Advances in Engineering and Management, Vol. 4, Issue 6, June 2022, pp. 1515-1519.

[24]. D. P. Patil, D. S. Shirsath and V. S. Gangurde, Application of Soham transform in Newton's law of cooling, International Journal of Research in Engineering and Science, Vol. 10, Issue 6, (2022) pp. 1299- 1303.

[25]. Dinkar Patil, Areen Fatema Shaikh, Neha More and Jaweria Shaikh, The HY integral transform for handling growth and Decay problems, Journal of Emerging Technology and Innovative Research, Vol. 9, Issue 6, June 2022, pp. f334-f 343.