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Applications of SOHAM Transform in Chemical Sciences

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

Keywords- Soham 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 Dinkar Patil [25].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.

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

1. Preliminary:

In this section we state some preliminaries which are required to use Soham transform in chemical sciences.

2.1 Definition: A new transform called the Soham transform defined for function of exponential order we consider functions in the set B defined by:

B= {f(t): M, k_1, k_2> 0.|f(t)|< Me|t|kj, if t $(-1)^j$ x (0,)} ...(1)

For a given function in the set B, the constant M must be finite number, k1, k2, may be finite or infinite.

Soham transform denoted by the operator (.) defined by the integral equations

[f(t)] = P(v) = 1v0f(t)e-vtdt , is non zero real numbers

t≥0 ,k_{1vk2} ....(2)

Table 1. Soham transform of some functions:

Sr.No.	function	Soham transform
1.	1	1v+1 ,t0
2.	t	1v2+1
3.	eat	1v(v-a)
4.	sinat	av(v2+a2)
5.	cosat	vv(v2+a2)
6.	sinhat	avv2-a2
7.	coshat	vv2-a2

2.2. Soham transform of derivatives:

Theorem: Let P(v) Soham transform of [[f(t)] = P(v)] then :

- [f ' (t)]=v P(v)- 1vf(0)
- [f"(t)]= v2P(v)-v-1 f(0)- 1v f ' (0)
- [f"(t)]=v2p(v)-v-1f(0)-1vf '(0)

2. Applications of Soham transform in Chemical Sciences:

Problem 1: 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, thoroughly 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^ prime (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 hour?

Solution:

Let y(t) be the amount of salt (in kilogram) after t minutes. From the question, we observe that at initial time (i.e t=0), the tank contains 20kg of salt (i.e.y(20)).Our main goal is to find the amount of salt remaining after 30 minus. (i.e. y(30)) .we do this by modeling the problem into a differential equation satisfied by y(t) .

dydt = (rate in – rate out).........(1)

Where (rate in) is the rate at which salt enters the tank and (rate out) is the rate at which salt leaves the tank. We have rate in=(0.03kg/L) (25 L/min) = 0.75 kg/min The tank contains 5000L of liquid, so the concentration at time t is y(t) 5000(measured in kilogram per liter). Since the brine flows out at a rate of 25 L/ Min, we have

Rate out= (y(t)5000) (kgmin) (25)(kgL)

= y(t)200kgmin

Thus from Equation (1)

dydt = o.75 kgmin - y(t)200kgmin

= 34kgmin - y(t)200kgmin

dydt= 34 - y(t)200

dydt +34 = y(t)200 , y(0) = 20 ....(2)

This equation can be generalized

dydt + k y(t) =r...........(3)

Take soham transform on both sides

dydt + k [y(t] =r (1)

vp(v) - 1vf(0)+kp(v) = r 1v+1

P(v) = rv+20v+1v(v+1)(v+k)

= r+20vv+1(v+k)

By partial fraction

r + 20 v = Av+1 + Bv+k

=A(v+k) +B(v+1)

r+20 v = Av+Ak+Bvv

∴ Ak =r A+Bv = 20

Then, A = rk Bv = 20- a

∴ B = 20-rkv

Put the value of A and B

P(v) = rkv+1 + 20-rkv(v+k)

Apply inversion formula

y(t) = rk$^{-1\ \{1v+1}$} +(20-rk) $^{-1}${1v(v+k)}

∴y(t) = rk (1) – (r-20kk)e-kt..........(4)

For exact solution according to the conditions given in the problem put k= 1200 and r= 34

yt= 150-130 e- t200

Half life time can be calculated by replacing (*t*) by 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

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

dxdt = (25 g/L)(1.5 L/min) +(0 g/L)(2 L/min) – (x g/L) (3.5 L/min)+0

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

dxdt + 3.5x = 37.5 ....(5)

For the initial condition of the ordinary differential equation in equation (5) at t=0 , x(0)=50

Apply soham transform in equation (5) on both sides

dxdt + 3.5 [x] =37.5 [1]

v p(v) - 1v f(0)+3.5 p(v) = 37.5 1v+1

p(v) (v+ 3.5)- 50v = 37.5v+1

p(v) = 37.5 +50vv+1(v+3.5)

By partial fraction,

P(v) =Av+1 + Bv+3.5

37.5+50v=A(v+3.5) +B (v+1)

37.5+50v=Av+3.5A+Bv.v

37.5=3.5A, 50 = A+Bv

Bv = 50 -757

B = 2757v

A=37.53.5 i.e. A = 757

Put the values of A & B

P(v) =757v+1 + 2757vv+3.5

Apply inversion formula,

x(t) = 757 $^{-11v+1}$+ 2757$^{-1\ 1v(v+3.5)}$

x(t) = 757(1) + 2757e-3.5t..............(6)

II. CONCLUSION

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

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