RESEARCHERID
THOMSON REUTERS

[Bashir, 6(10): October 2019]
DOI- 10.5281/zenodo.3475118

ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

APPLICATIONS OF KAMAL TRANSFORM TO MECHANICS & ELECTRICAL CIRCUITS PROBLEMS

Huda Ibrahim Osman Bashir*[1], Mona Magzoub Mohammed Ahmed Hassan[2], Fatin Ali Mohamed Saeed[3], Nesreen Sirelkhtam Elmki Abdalla[4], Mubarak Dirar Abdallah[5] & Sawsan Ahmed Elhouri Ahmed[6]

[*1]King Khalid University-Faculty of Science and Arts- Math. Department - Ahad Rufida- Saudia Arabia.
[2]University of Jeddah- Faculties of the University BranchAl-kamil Province-Math. Department - Saudia Arabia.
[3]University of hafr albatin- College at Qaryat Alulya-Math. Department- Saudia Arabia.
[4]King Khalid University-Faculty of Science and Arts- Math. Department -Ahad Rufida- Saudia Arabia.
[5]Sudan University of Science &Technology-College of Science-Department of Physics & International University of Africa- College of Science-Department of Physics- Khartoum-Sudan
[6]University of Bahri - College of Applied & Industrial Sciences Department of Physics-Khartoum- Sudan

ABSTRACT

Kamal transform has been utilized to solve second order linear differential equation with constant coefficient. These equations are concerned with a damping mechanical force system and an inductive capacitive electrical circuit. Kamal transform succeeded in solving the differential equations.

I. INTRODUCTION

The behaviors of physical system are described using physical laws. The laws are surely expressed in differential or integral form [1, 2]. The solution of these equation needs to certain mathematical techniques which is sometimes complex [3, 4]. The solution of these equations needs knowing initial or boundary conditions or physical and mathematical constraints' imposed by the physical system [5, 6].

The mathematical techniques used include differential equations, complex and vectors analysis beside tensor analysis and special transforms [7, 8]. These techniques successfully solve many physical problems associated with the behavior of the physical systems. These techniques now are widely used in classical mechanical and quantum mechanical problems. Thus they can suitably described our big visibly seen macro world and atomic beside subatomic invisible micro world [9, 10].

The importance of mathematical techniques encourages many researches in mathematic to propose new techniques for solving physical problems.

Tarig Mohamed Elzaki proposed transform known as Elzaki transformation [11], to solve differential equations concerned with the physical systems, especially mechanical systems. Another transform proposed by Psenthil Kumar and A.Veswana beside Aboodh and Mahjoub transforms [12], in addition to Elzaki transform [13].A new transform is known as Kamal transform [14, 15] is used in to solve a mechanical and electrical problems.

II. KAMAL TRANSFORM

The Kamal transform is defined for the function of the exponential order. We consider functions in the set defined by

$$A = \left\{ f(t): \exists M, k_1, k_2 > 0, |f(t)| < Me^{\frac{|t|}{k_j}} \right\}$$

[Bashir, 6(10): October 2019] ISSN 2348 – 8034
DOI- 10.5281/zenodo.3475118 Impact Factor- 5.070

May be finite ork_1, k_2 where the constant M must be finite number, infinite.

The Kamal transform denoted by the operator M defined by the integral equations

$$k[f(t)] = G(v) = \int_0^\infty f(t)\, e^{-vt} dt, t \geq 0, k_1 \leq v \leq k_2$$

We show in table (1) some of standard function

$f(t$	1	t	t^2	t^3	t^n	e^{at}	e^{-at}	$\sin at$	$\cos at$
$(k(f(t))$	v	v^2	v^3	$6v^4$	$n!\,(v+1)$	$\frac{v}{1-av}$	$\frac{v}{1+av}$	$\frac{av^2}{1-a^2v^2}$	$\frac{v^2}{1+a^2v^2}$

Transform of the derivatives
Consider k is Kamal transform then

$$(i)k[f'(t)] = \frac{1}{v}\, G(v) - f(0)$$

$$(ii)k[f''(t)] = \frac{1}{v^2}\, G(v) - \frac{1}{v} f(0) - f'(0)$$

$$(iii)k[f^n(t)] = v^{(-n)} G(v) - \sum_{k=0}^{n-1} v^{(k-n+1)} f^k(0)$$

Application of Kamal Transform to Some Physical Problems

Consider now a particle having of mass 2 grams moves on the x-axis and is attracted a certain point with a force numerically equal to $8x$.If it is initially at rest at O towards origin=10, find its position at any subsequent time assuming

a) No other force acts on it.
b) A damping force numerically equal to 8 times the instantaneous acts velocity.

These problems can be solved by using Kamal Transform.

(a) From Newton's law, the equation of motion of the particle is

$$\frac{d^2X}{dr^2} + 4X = 0 \ or \ 2\frac{d^2X}{dr^2} = -8X \qquad (2)$$

With the initial conditions $X(0) =$ 0and $X(0) = 10$ Taking the Kamal transform of sides of (2), we have

$$k[X''] + 4k[X'] + 4k[X] = 0$$

Using Kamal transform for derivatives, then

$$\frac{1}{v^2} G(v) - \frac{1}{v} X(0) - X'(0) + 4G[X] = 0$$

$$G(v) = \left[\frac{10v}{(2v)^2 + 1)}\right]$$

Take inverse Kamal transform, we get

$$\cos 2t \ 10 = X = 10K^{-1}\left[\frac{v}{(2v)^2 + 1}\right]$$

In this case the equation of motion of the particle is

$$\frac{d^2X}{dt^2} + 4\frac{dX}{dt} + 4X = 0 \quad or \quad 2\frac{d^2X}{dt^2} = -8X - 8\frac{dX}{dt}$$

(3) For damping force with the initial conditions $X'(0)$ and $X(0) = 10$ Taking the Kamal transform of both sides of (3), we have

$$K[X''] + 4K[K'] + 4K[K] = 0$$

Using Kamal transform for derivatives, then

$$\frac{1}{v^2}G(v)-\frac{1}{v}X(0)-X^{'(0)}+4\left(\frac{1}{v}G(v)-X(0)\right)+4G(v)=0$$

Apply the initial conditions, then

$$G(v)=\frac{10v+40v^2}{(2v+1)^2}=\frac{10v}{(2v+1)}+\frac{20v^2}{(2v+1)^2}$$

Take Kamal inverse transform then

$$X=G^{-1}\left[\frac{10v+40v^2}{(2v+1)^2}\right]$$

That implies that

$X=10e^{-2t}+20t^{-2t}$

Another application of Kamal inverse transform can be applied to electrical circuits.

The Kamal transform can also use to determine the charge on the capacitors and currents as functions of time. Here one applied an alternating electro motive force (emf)

$$E\sin\omega t$$

The differential equation for the determination of the current I in the circuit is given as

$$[sin\ R=0]$$

$L\frac{dI}{dt}+\frac{Q}{c}=E\sin\omega t$ (4)

$I=\frac{dQ}{dt}$ (5)

Where $I=0=Q$ also at $t=0$

Taking Kamal transform of both sides of (4) and (5), we have

$n^2=\frac{1}{lc}$, $K[I']+n^2K[Q]=\frac{E}{L}K[\sin\omega t]$ (6)

$\frac{1}{V}K[I]+I(0)+n^2K[Q]=\frac{E}{L}\left(\frac{\omega v^2}{1+\omega^2v^2}\right)$ (7)

Applying the initial conditions, then

$$\frac{1}{V}K[I]+n^2K[Q]=\frac{E}{L}\left(\frac{\omega v^2}{1+\omega^2v^2}\right)$$

$$K[I]=K[Q']=\frac{1}{v}K[Q]-Q(0)$$

$$K[I]=K[Q']=\frac{1}{v}K[Q]$$

$K[Q]=vK[I]$ (8)

From (7), (8), we get

$$K[I]=\frac{E}{L}\left(\frac{\omega v^2}{1+\omega^2v^2}\right)\left(\frac{V}{1+n^2v^2}\right)$$

$$=\frac{E\omega}{L}\left(\frac{1}{(n^2-\omega^2)}\right)(\cos\omega t-\cos nt)$$

Examples (2 4.2)

Given $x(0)=0$, solve $L\frac{dx}{dt}+Rx=Ee^{-at}$

ISSN 2348 – 8034
Impact Factor- 5.070

Solution:

Take Kamal transform of both side of the above equation, we get

$$K[x'] + \frac{R}{L}K[x] = \frac{E}{L}K[e^{-at}]$$

$$\frac{1}{V}\ K[x] - x(0) + \frac{R}{L}K[x] = \frac{E}{L}K\left[\frac{v}{(1+av)}\right]$$

Applying the initial conditions

$$K[x] = E\left(\frac{v}{1+av}\frac{v}{L+Rv}\right)$$

$$x = K^{-1}\left(\frac{Ev^2}{(1+av)(L+Rv)}\right)$$

$$x = \frac{E}{R-La}\left[e^{-at} - e^{-\frac{R}{L}t}\right]$$

III. CONCLUSION

Kamal transform has been successfully used to solve mechanical damping force equation, beside inductive capacitive electrical system. Both systems are described by second order linear differential equations. The solution obtained is agreed with the ordinary conventional solutions.

REFERENCES

1. *R.Shankar, Principle of Quantum Mechanics, 1994, Springer, New York, America.*
2. *Gray E.Bowman, Essential Quantum Mechanics, Northern Arizona University, New York (2008).*
3. *Karl Svozil, Mathematical Methods of Theoretical Physics, 2019, Edition Funzl.*
4. *Derek, F. Lawden, an Introduction to Tensor Calculus and Relativity, John Wiley and Sons, New York, (1972).*
5. *David McMahon, Quantum Mechanics Demystified, McGraw Hill, USA (2006).*
6. *A.A.F.J.Levi, Applied Quantum Mechanics, University of South California, Cambridge University press (2003)*
7. *James Ward Brown, Ruel V.Churchill, 2009, Complex Variable and Applications, McGraw-Hill, New York, America.*
8. *A.R. Vasishtha and R.K.Gupta, Integral Transforms, Krishna Prakashan Media (p)Ltd., Meerut, 2002.*
9. *Benjamin Crowell, Newtonian Physics, Fullerton, California (2008)*
10. *Mohammad Reza Pahlavani, Theoretical Concept of Quantum Mechanics, 2012, Janeza Trdine.*
11. *Tarig.M.Elzaki., 2011, " The New Integral Transform Elzaki Transform ‘, Global Journal of Pure and Applied Mathematics, 7(1), pp.57-64.*
12. *Khalid Suliman Aboodh., "The New Integral Transform Aboodh Transform ", Global Journal of Pure and Applied Mathematics, 9(1), pp.35-43.*
13. *Tarig M.Elzaki, Salih M.Elzaki, and Elsayed A.Elnour, 2012,"Applications of New Transform Elzaki Transform to Mechanics, Electrical Circuits and Beams Problems", Global Journal of Mathematical Sciences: Theory and practical, vol.4, No.1, pp.25-34, 2012.*
14. *Mohand M.Abdelrahim Mahgoub., 2016,"The New Integral Transform Kamal Transform", Advances in Theoretical and Applied Mathematics, 11(4), pp.391-398.*
15. *Abdelilah Kamal .H.Sedeeg. 2016,"The New Integral Transform Kamal Transform", Advances in Theoretical and AppliedMathematics,11(4),pp.451-458.*