The Mayan Transform: A Novel Integral Transform of Complex Power Parameters and Applications to Neutrosophic Functions

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Abstract

In this paper, a new type of integral transform with complex power parameters called the "Mayan transform" has been introduced. The definitions of the integral transform and its inverse are given in the classical case and the corresponding neutrosophic case. The classical analytical properties of the Mayan integral transforms are proven; the application of it to some essential functions and neutrosophic functions is introduced and proven. Also, its application to the neutrosophic derivatives (first, second, and third) then the generalization of the application on the Mayan integral transform on the neutrosophic derivatives are given. The worthiness of the introduced integral transform on the actual application is also proven by applying the integral transform in solving two problems: the response of an Undamped forced mechanical oscillator and the response of an undamped forced electrical oscillator.

Keywords: Mayan transform; neutrosophic Mayan Transform; Fourier transform; Neutrosophic Laplace transform; Laplace transform; SEE transform complex SEE transform; Sadik transform; Complex Sadik transform; SEJI transform, Novel Transform; Ordinary differential equations.

1. Introduction

The existence of integral transform had been resining the curiosity of mathematicians from the early years; the suggestion of Laplace transform concludes that curiosity. The suggestion of Laplace transform paved the road to the suggestion of many other transforms, from these transforms are Aboodh, Muhand, Mahoub, El Zaki, Rohit, Gupta, SEE, Complex SEE, Al-Tememe, Complex AL-Tememe, AL-Zughair, extension AL-Zughair, ARA, INEM, EFG, SEA, SEL, Sadik, Complex Sadik, Aleneze, Emad-Sara, Emad-Falih, and AL-Jafari transforms [1, - 19, 21-28]. Some of these transforms have been based on Laplace transforms, while others are standalone. These transforms have been applied and used in many applications in the physical and medical fields, proving their usefulness in transferring singular or systems of complicated differential and integral equations into simpler and algebraically more malleable equations and systems. That transformation, which resulted in simplifying the solution, came from exploiting these transformed properties and theorems to reduce the overall steps to find the final exact solution of the problems.

Some of the suggested integral transforms are designed to deal with complex parameters, and their main goal is the easiness of solution steps in solving complex differential equations; these transforms provide an excellent environment to deal with some modern security-related subjects such as images and video cryptography [1, 2, 7, 10, 12-19].

This work proposed a general transform that addresses complex parameters, although the well-known “AL-Jafari transform” [20] has given a generalization into integral transforms. However, the suggested Mayan transform” is

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not considered a special case from the AL-Jafari transform due to the complexity applied to the parameter exponential of the Mayan transform, which gave the suggested transform its uniqueness.

Neutrosophic real analysis and functions theory was proposed in [29-33], where integrals, spaces, and derivations were discussed by different methods, especially the AH-isometry method. The novel proposed transform will be applied to neutrosophic real functions, derivatives, and neutrosophic integral formulas.

2. Definitions and Properties:

Definition (2.1): The Mayan integral transform of the function $f(t)$ on the interval $(0, \infty)$ is defined as:

$$MA\{f(t)\} = M(v) = \frac{1}{v^{i\beta}} \int_0^\infty e^{-v^{i\alpha}t} f(t)\, dt$$

Where $\alpha, \beta \in \mathbb{Z}, v$ is a parameter, $v > 0$ and $i \in \mathbb{C}, (i^2 = 1)$.

The neutrosophic Mayan integral transform of the function $f(t)$ on the interval $(0, \infty)$ is defined as:

$$MA\{f(t)\} = M(v) = \frac{1}{v^{i\beta}} \int_0^\infty e^{-v^{i\alpha}t} f(t)\, dt$$

Where $\alpha, \beta \in \mathbb{Z}(I), v$ is a parameter, $v > 0$ and $i \in \mathbb{C}, (i^2 = 1)$.

Definition (2.2): The inverse of the Mayan transform is given by:

$$(MA)^{-1}\{M(v)\} = f(t) = \frac{1}{2\pi i} \lim_{\tau\to 0} \int_{\delta-i\tau}^{\delta+i\tau} v^{i\beta} e^{v^{i\alpha}t} M(v) dv\ ,$$

In general, $v = \delta + i\tau$ with δ and τ being real numbers.

The inverse of the neutrosophic Mayan transform is given by:

$$(MA)^{-1}\{M(v)\} = f(t) = \frac{1}{2\pi i} \lim_{\tau\to 0} \int_{\delta-i\tau}^{\delta+i\tau} v^{i\beta} e^{v^{i\alpha}t} M(v) dv\ ,$$

In general, $v = \delta + i\tau$ with δ and τ being real neutrosophic numbers.

Property (2.1): (Linear Property)

Let $Af_1(t)$ and $Bf_2(t)$ have Mayan transform $M_1(v)$ and $M_2(v)$ then the Mayan transform of

$$MA\{Af_1(t) \pm Bf_2(t)\} = A\, MA\{f_1(t)\} + B\, MA\{f_2(t)\}.$$

Where A and B are constants.

Property (2.2): (Shifting Property)

If $MA\{f(t)\} = M(v)$, then $MA\{e^{bt} f(t)\} = \left(1 - v^{-i\beta} b\right) M(v - b)$, where b is a constant.

Proof: From Mayan transform definition,

$$MA\{e^{bt} f(t)\} = \frac{1}{v^{i\beta}} \int_0^\infty e^{-v^{i\alpha}t} e^{bt} f(t) dt\ ,$$

$$= \frac{1}{v^{i\beta}} \int_0^\infty - e^{(v^{i\alpha}-b)t} f(t) dt\ ,$$

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$$=\frac{\left(v^{i\beta}-b\right)}{v^{i\beta}\left(v^{i\beta}-b\right)}\int_0^{\infty} e^{-\left(v^{i\alpha}-b\right)t}f(t)dt\,,$$

$$=\frac{v^{i\beta}-b}{v^{i\beta}}M(v-b)=v^{-i\beta}\left(v^{i\beta}-b\right)M(v-b)\,,$$

$$=\left(1-bv^{-i\beta}\right)M(v-b)\,.$$

3. Mayan Integral and neutrosophic Mayan Integral Transforms of Complex Powers of Parameter for Some Basic Functions

This section presents the most fundamental functions of the Mayans' transformation with their proofs.

(1) If $f(t)=k$ and k is a constant, then $MA\{k\}=kv^{-i(\alpha+\beta)}$.

Proof: By definition, we get:

$$MA\{k\}=\frac{1}{v^{i\beta}}\int_0^{\infty} e^{-v^{i\alpha}t}\,k\,dt=\frac{-k}{v^{i\beta}v^{i\alpha}}\int_0^{\infty} e^{-v^{i\alpha}t}\,dt$$

$$=\frac{-k}{v^{i(\alpha+\beta)}}\left[e^{-v^{i\alpha}t}\right|_0^{\infty}=\frac{-k}{v^{i(\alpha+\beta)}}[0-1]=kv^{-i(\alpha+\beta)}\,,\mathrm{Re}(v)>0\,.$$

(2) If $f(t)=t$, then $MA\{t\}=v^{-i(2\alpha+\beta)}$.

Proof: By the definition, we get:

$$MA\{t\}=\frac{1}{v^{i\beta}}\int_0^{\infty} e^{-v^{i\alpha}t}.\,t\,dt$$

$$=\frac{1}{v^{i\beta}}\left[\frac{-t}{v^{i\alpha}}e^{-v^{i\alpha}t}-\frac{1}{v^{2i\alpha}}e^{-v^{i\alpha}t}\right]_0^{\infty},$$

$$=\frac{1}{v^{i\beta}}\left[(0-0)-\left(0-\frac{1}{v^{2i\alpha}}\right)\right],$$

$$=\frac{1}{v^{i\beta}v^{2i\alpha}}=\frac{1}{v^{i(\beta+2\alpha)}}=v^{-i(2\alpha+\beta)}\,.$$

(3) If $f(t)=t^3$, then $MA\{t^2\}=2v^{-i(3\alpha+\beta)}\,,Re(v)>0$.

Proof: By the definition

$$MA\{t^2\}=\frac{1}{v^{i\beta}}\int_0^{\infty} e^{v^{i\alpha}t}t^2dt\,,$$

$$=\frac{1}{v^{i\beta}}\left[-\frac{t^2}{v^{i\alpha}}e^{-v^{i\alpha}t}-\frac{2t}{v^{2i\alpha}}e^{-v^{i\alpha}t}-\frac{2}{v^{3iv}}e^{-v^{i\alpha}t}\right|_0^{\infty},$$

$$=\frac{1}{v^{i\beta}}\left[(0-0-0)-\left(0-0-\frac{2}{v^{3i\alpha}}\right)\right],$$

$$=\frac{2}{v^{i(\beta\alpha+\beta)}}=2v^{-i(3\alpha+\beta)}\,,Re(v)>0\,.$$

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(4) $f(t) = t^3$

Proof:

$$MA\{t^3\} = \frac{1}{v^{i\beta}}\int_0^\infty t^3 e^{-v^{i\alpha}t}dt$$

$$= \frac{1}{v^{i\beta}}\left[\left(\frac{-t^3}{v^{i\alpha}} - \frac{3t^2}{v^{2i\alpha}} - \frac{6t}{v^{3i\alpha}} - \frac{6}{v^{4i\alpha}}\right)e^{-v^{i\alpha}t}\right|_0^\infty$$

$$= \frac{1}{v^{i\beta}}\left[(0) - \left(\frac{6}{v^{4i\alpha}}\right)\right]$$

$$= \frac{6}{v^{i(4\alpha+\beta)}} = 3!\, v^{-(4\alpha+\beta)i}, Re(v) > 0\,.$$

In general, if $f(t) = t^n, n \in \mathbb{N}\ Re(v) > 0$. $MA\{t^n\} = n!\, v^{-i((n+1)\alpha+\beta)}$.

Proof: By Mathematical induction.

(5) If $f(t) = e^{bt}$, where b is a constant then $MA\{e^{bt}\} = \frac{1}{v^{i\beta}(v^{i\alpha}-b)}$.

$$MA\{e^{bt}\} = \frac{1}{v^{i\beta}}\int_0^\infty e^{bt}e^{-v^{i\alpha}t}dt = \frac{1}{v^{i\beta}}\int_0^\infty e^{-(v^{i\alpha}-b)t}dt$$

$$= \frac{-1}{v^{i\beta}(v^{i\alpha}-b)}\left[e^{-(v^{i\alpha}-b)t}\right|_0^\infty = \frac{-1}{v^{i\beta}(v^{i\alpha}-b)}\left[e^{-(v^{i\alpha}-b)t}\right|_0^\infty$$

$$= \frac{-1}{v^{i\beta}(v^{i\alpha}-b)}[0-1] = \frac{1}{v^{i\beta}(v^{i\alpha}-b)}, \mathrm{Re}(v^{i\alpha}-b) > 0\,.$$

(6) $f(t) = \sin(bt)$

Proof:

$$MA\{\sin(bt)\} = \frac{1}{v^{i\beta}}\int_0^\infty \mathrm{e}^{-v^{i\alpha}t}\sin(bt)\,dt$$

$$= \frac{1}{v^{i\beta}}\int_0^\infty \mathrm{e}^{-v^{i\alpha}t}\frac{1}{2i}(e^{ibt}-e^{-ibt})\,dt$$

$$= \frac{1}{2iv^{i\beta}}\left[\int_0^\infty e^{(v^{i\alpha}-ib)t}dt - \int_0^\infty - e^{(v^{i\alpha}+ib)t}dt\right]$$

$$= \frac{-i}{2v^{i\beta}}\cdot\frac{-1}{(v^{i\alpha}-ib)}(0-1) - \frac{-i}{2v^{i\beta}}\cdot\frac{-1}{(v^{i\alpha}+ib)}(0-1)$$

$$= \frac{-i}{2v^{i\beta}(v^{i\alpha}-ib)} + \frac{i}{2v^{i\beta}(v^{i\alpha}+ib)} = \frac{i}{2v^{i\beta}}\left[\frac{-1}{v^{i\alpha}-ib} + \frac{1}{v^{i\alpha}+ib}\right]$$

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$$= \frac{i}{2v^{i\beta}}\left[\frac{-v^{i\alpha} - ib + v^{i\alpha} - ib}{v^{2i\alpha} + b^2}\right] = \frac{i(-2ib)}{2v^{i\beta}(v^{2i\alpha} + b^2)} = \frac{-i^2 v^{-i\beta} b}{(v^{2i\alpha} + b^2)} = \frac{v^{-i\beta} b}{(v^{2i\alpha} + b^2)}.$$

(7) $f(t) = \cos(bt)$

Proof:

$$MA\{\cos(bt)\} = \frac{1}{v^{i\beta}}\int_0^\infty e^{-v^{i\alpha}t}\cos(bt)\,dt\,\frac{1}{2v^{i\beta}}\int_0^\infty e^{-v^{i\alpha}t}\cdot(e^{ibt} + e^{-ibt})\,dt$$

$$= \frac{1}{2v^{i\beta}}\int_0^\infty e^{-(v^{i\alpha}-ib)t}dt + \frac{1}{2v^{i\beta}}\int_0^\infty e^{-(v^{i\alpha}+ib)t}dt$$

$$= \frac{1}{2v^{i\beta}}\cdot\frac{-1}{(v^{i\alpha} - ib)}[0-1] + \frac{1}{2v^{i\beta}}\cdot\frac{-1}{(v^{i\alpha} + ib)}[0-1]$$

$$= \frac{1}{2v^{i\beta}}\cdot\frac{1}{v^{i\alpha} - ib} + \frac{1}{2v^{i\beta}}\frac{1}{v^{i\alpha} + ib} = \frac{1}{2v^{i\beta}}\left[\frac{1}{v^{i\alpha} - ib} + \frac{1}{v^{i\alpha} + ib}\right]$$

$$= \frac{1}{2v^{i\beta}}\left[\frac{v^{i\alpha} + ib + v^{i\alpha} - ib}{v^{2i\alpha} + b^2}\right] = \frac{2v^{i\alpha}}{2v^{i\beta}(v^{2i\alpha} + b^2)} = \frac{v^{i\alpha}}{v^{i\beta}(v^{2i\alpha} + b^2)}$$

(8) $f(t) = \sinh(bt)$

Proof:

$$MA\{\sinh(bt)\} = \frac{1}{v^{i\beta}}\int_0^\infty e^{-v^{i\alpha}t}\sinh(bt)\,dt = \frac{1}{2v^{i\beta}}\int_0^\infty e^{-v^{i\alpha}t}(e^{bt} - e^{-bt})dt$$

$$= \frac{1}{2v^{i\beta}}\int_0^\infty - e^{(v^{i\alpha}-b)t}\,dt - \frac{1}{2v^{i\beta}}\int_0^\infty e^{-(v^{i\alpha}+b)t}dt$$

$$= \frac{-1}{2v^{i\beta}(v^{i\alpha} - b)}[0-1] + \frac{1}{2v^{i\beta}(v^{i\alpha} + b)}[0-1]$$

$$= \frac{1}{2v^{i\beta}}\left[\frac{1}{(v^{i\alpha} - b)} - \frac{1}{(v^{i\alpha} + b)}\right] = \frac{1}{2v^{i\beta}}\left[\frac{v^{i\alpha} + b - v^{i\alpha} + b}{v^{2i\alpha} - b^2}\right]$$

$$= \frac{b}{v^{i\beta}(v^{2i\alpha} - b^2)},\quad \mathrm{Re}(v^{2i\alpha} - b^2) > 0\,.$$

(9) $f(t) = \cosh(bt)$

Proof:

$$MA\{\cosh(bt)\} = \frac{1}{v^{i\beta}}\int_0^\infty e^{-v^{i\alpha}t}\cosh(bt)\,dt$$

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$$= \frac{1}{2v^{i\beta}} \int_0^\infty e^{-v^{i\alpha} t} \left(e^{bt} + e^{-bt}\right) dt = \frac{1}{2v^{i\beta}} \left[\int_0^\infty e^{-(v^{i\alpha} - b)t} dt + \int_0^\infty e^{-(v^{i\alpha} + b)t} dt \right.$$

$$= \frac{1}{2v^{i\beta}} \left[\frac{-1}{(v^{i\alpha} - b)} (0 - 1) + \frac{-1}{v^{i\alpha} + b} (0 - 1) \right]$$

$$= \frac{1}{2v^{i\beta}} \left[\frac{1}{v^{i\alpha} - b} + \frac{1}{v^{i\alpha} + b} \right] = \frac{1}{2v^{i\beta}} \left[\frac{v^{i\alpha} + b + v^{i\alpha} - b}{v^{2i\alpha} - b^2} \right]$$

$$= \frac{v^{i\alpha}}{v^{i\beta} (v^{2i\alpha} - b^2)}, \quad \mathrm{Re}(v^{2i\alpha} - b^2) > 0 .$$

4. Mayan Integral Transform of Derivatives

The Mayan integral transform for derivatives is presented in this section:

Theorem (4.1)

Let $M(v)$ is the Mayan transform of $[MA\{f(t)\} = M(v)]$, then the novel complex power integral transform "Mayan Transform."

(i) $\mathrm{MA}\{f'(t)\} = \frac{-f(0)}{v^{i\beta}} + v^{i\alpha} M(v) = v^{i\alpha} M(V) - \frac{f(0)}{v^{i\beta}}$.

Proof:

$$\mathrm{MA}\{f'(t)\} = \frac{1}{v^{i\beta}} \int_0^\infty e^{-v^{i\alpha} t} f'(t) dt$$

Integrating by parts

Let $u = e^{-v^{i\alpha} t}$, $dv = f'(t)dt$

$du = -v^{i\alpha} e^{-v^{i\alpha} t} dt$, $v = f(t)$.

$$\mathrm{MA}\{f'(t)\} = \frac{1}{v^{i\beta}} \left[e^{-v^{i\alpha} t} \cdot f(t) \Big|_0^\infty + v^{i\alpha} \int_0^\infty f(t) e^{-v^{i\alpha} t} dt \right]$$

$$= \frac{1}{v^{i\beta}} \left(0 - f(0)\right) + v^{i\alpha} \frac{1}{v^{i\beta}} \int_0^\infty e^{-v^{i\alpha} t} f(t) dt$$

$$= \frac{-f(0)}{v^{i\beta}} + v^{i\alpha} M(v) .$$

(ii) $MA\{f''(t)\} = v^{2i\alpha} M(v) - \frac{v^{i\alpha} f(0)}{v^{i\beta}} - \frac{f'(0)}{v^{i\beta}}$.

Proof:

$$\mathrm{MA}\{f''(t)\} = \frac{1}{v^{i\beta}} \int_0^\infty e^{-v^{i\alpha} t} f''(t) dt .$$

Integrating by parts:

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Let $u = e^{-v^{i\alpha}t}, dv = f''(t)dt$,

$du = -v^{i\alpha}e^{-v^{i\alpha}t}dt$, $v = f'(t)$

$$MA\{f''(t)\} = \frac{1}{v^{i\beta}}\left[e^{-v^{i\alpha}}f'(t)\Big|_0^\infty + v^{i\alpha}\int_0^\infty e^{-v^{i\alpha}t}f'(t)dt\right]$$

$$MA\{f''(t)\} = \frac{-f'(0)}{v^{i\beta}} + v^{i\alpha}MA\{f(t)\}$$

$$= \frac{-f'(0)}{v^{i\beta}} + v^{i\alpha}\left[\frac{-f(0)}{v^{i\beta}} + v^{i\alpha}M(V)\right]$$

$$= v^{2i\alpha}M(v) - \frac{f(0)}{v^{i\beta}}v^{i\alpha} - \frac{f'(0)}{v^{i\beta}}$$

(iii) $MA\{f'''(t)\} = V^{3i\alpha}M(v) - \frac{v^{i\alpha}f(0)}{v^{i\beta}} - \frac{v^{i\alpha}f'(0)}{v^{i\beta}} - \frac{f''(0)}{v^{i\beta}}$

Proof:

$MA\{f'''(t)\} = \frac{1}{v^{i\beta}}\int_0^\infty e^{-v^{i\alpha}t}f'''(t)dt$.

Integrating by parts:

$u = e^{-v^{i\alpha}t}$, $dv = f'''(t)dt$,

du $= -v^{i\alpha}e^{-v^{i\alpha}t}dt$, $v = f''(t)$.

$$\text{MA}\{f'''(t)\} = \frac{1}{v^{i\beta}}\left[e^{-v^{i\alpha}t}f''(t)\Big|_0^\infty + v^{i\alpha}\int_0^\infty e^{-v^{i\alpha}t}f''(t)dt\right]$$

$$= \frac{1}{v^{i\beta}}\left[\left(0 - f''(0)\right) + v^{i\alpha}MA\{f''(t)\}\right.,$$

$$= \frac{-f''(0)}{v^{i\beta}} + v^{i\alpha}\left[v^{2i\alpha}M(v) - \frac{f(0)v^{i\alpha}}{v^{i\beta}} - \frac{f(0)}{v^{i\beta}}\right]$$

$$= v^{3i\alpha}M(v) - \frac{v^{i\alpha}f(0)}{v^{i\beta}} - \frac{v^{i\alpha}f'(0)}{v^{i\beta}} - \frac{f''(0)}{v^{i\beta}}.$$

In general

$$\text{MA}\left\{f^{(m)}(t)\right\} = V^{mi\alpha}M(v) - \sum_{k=0}^{m-1}\frac{f^{((m-1)-k)ki\alpha}(0)v}{v^{i\beta}}.$$

5. Applications of the Mayan Integral Transform

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The applicability of the proposed Mayan integral transform is presented by using it in two problems that exist in the real-life environment, which are an undamped forces mechanical oscillator and the response of an undamped forces electrical oscillator.

Problem (5.1): (Response of An Undamped Forced Mechanical Oscillator)

Consider the following linear second-order ordinary differential equations for the forced mechanical oscillator:

$$\frac{d^2X}{dt^2} + \mu_0^2 X(t) = \frac{F}{m}\cos(\mu t)\,.$$

The oscillator's natural frequency, denoted by $\mu_0 = \left(\frac{k}{m}\right)^{\frac{1}{2}}$,, has the following initial boundary conditions (I.B.C.s):

$$X(0) = X'(0) = 0\,.$$

Taking the Mayan integral transform to above differential equations:

$$MA\left\{\frac{d^2X}{dt}\right\} + \mu_0^2 M\{v\} = \frac{F}{m} ME\{\cos(\mu t)\}\,,$$

$$v^{2i\alpha}M(v) - \frac{v^{i\alpha}X(0)}{v^{i\beta}} - \frac{X'(0)}{v^{i\beta}} + \mu_0^2 M(v) = \frac{F}{m}\frac{v^{i\alpha}}{v^{i\beta}(v^{2i\alpha}+\mu^2)}\,,$$

$$v^{2i\alpha}M(v) + \mu_0^2 M(v) = \frac{F}{m}\frac{v^{i\alpha}}{v^{i\beta}(v^{2i\alpha}+\mu^2)}\,,$$

$$M(V) = \frac{F}{m}\frac{v^{i\alpha}}{v^{i\beta}(v^{2i\alpha}+\mu^2)(v^{2i\alpha}+\mu_0^2)}\,,$$

$$M(v) = \frac{F}{m}\frac{v^{i\alpha}}{v^{i\beta}}\left[\frac{-1}{(v^{2i\alpha}+\mu^2)(\mu^2-\mu_0^2)} + \frac{1}{(v^{2i\alpha}+\mu_0^2)(\mu^2-\mu_0)}\right]$$

$$M(v) = \frac{Fv^{i\alpha}}{mv^{i\beta}(\mu^2-\mu_0^2)}\left[\frac{-1}{v^{i\alpha}+\mu^2} + \frac{1}{v^{i\alpha}+\mu_0^2}\right],$$

$$M(v) = \frac{F}{m(\mu^2-\mu_0^2)}\left[\frac{-v^{i\alpha}}{v^{i\beta}(v^{i\alpha}+\mu^2)} + \frac{v^{i\alpha}}{v^{i\beta}(v^{i\alpha}+\mu_0^2)}\right],$$

Taking the inverse transformation gives:

$$X(t) = \frac{F}{m(\mu^2-\mu_0^2)}[-\cos(\mu t) + \cos(\mu_0 t)]\,,$$

$$X(t) = \frac{F}{m(\mu^2-\mu_0^2)}[\cos(\mu_0 t) - \cos(\mu t)]\,,$$

$$X(t) = \frac{F}{m(\mu^2-\mu_0^2)}\left[-2\sin\left(\frac{(\mu_0+\mu)t}{2}\right)\sin\left(\frac{(\mu_0-\mu)t}{2}\right)\right],$$

$$X(t) = \frac{-2F}{m(\mu^2-\mu_0^2)}\left[\sin\left(\frac{(\mu_0+\mu)t}{2}\right)\sin\left(\frac{(\mu_0-\mu)t}{2}\right)\right],$$

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$$X(t) = \frac{2F}{m(\mu_0^2 - \mu^2)}\left[\sin\left(\frac{(\mu_0 + \mu)t}{2}\right)\sin\left(\frac{(\mu_0 - \mu)t}{2}\right)\right],$$

or because $\sin(-x) = -\sin\ x$.

The resulting equation is the exact solution that is required.

$$X(t) = \frac{2F}{m(\mu^2 - \mu_0^2)}\sin\left(\frac{(\mu + \mu_0)t}{2}\right) sin\left(\frac{(\mu - \mu_0)t}{2}\right).$$

Problem (5.2): (Response of An Undamped Forced Electrical Oscillator)

Consider the following second-order ordinary differential equation with constant coefficients of the forced electrical oscillator:

$$\mathrm{L}\frac{d^2Q(t)}{dt^2} + R\frac{dQ(t)}{dt} + \frac{1}{C}Q(t) = V\cos(\mu t)\,.$$

The above equation can be written as:

$$\frac{d^2Q(t)}{dt^2} + \frac{R}{L}\frac{dQ(t)}{dt} + \mu_0^2 Q(t) = \frac{V}{L}\cos(\mu t)\,.$$

For an undamped forced electrical oscillator resistance $R = 0$,

$$Q''(t) + \mu_0^2 Q(t) = \frac{V}{L}\cos(\mu t)\,.$$

Where $\mu_0 = \left(\frac{1}{CL}\right)^{\frac{1}{2}}$ and $Q(t)$ is the instantaneous charge. With I·B·Cs are $Q(0) = Q'(0) = 0$.

Taking the Mayan integral transform to the above equation:

$$MA\{Q''(t)\} + \mu_0^2 MA\{Q(t)\} = \frac{V}{L}MA\{\cos(\mu(t)\}$$

$$V^{2i\alpha}M(V) - \frac{V^{i\alpha}Q(0)}{V^{i\beta}} - \frac{\mathrm{Q}'(0)}{V^{i\beta}} + \mu_0^2 M(v) = \frac{V}{L}\cdot\frac{V^{i\alpha}}{V^{i\beta}(V^{2i\alpha} + \mu^2)}.$$

$$V^{2i\alpha}M(v) + \mu_0^2 M(V) = \frac{V}{L}\cdot\frac{V^{i\alpha}}{V^{i\beta}(V^{2i\alpha} + \mu^2)},$$

$$M(v) = \frac{V}{L}\cdot\frac{V^{i\alpha}}{V^{i\beta}(V^{2i\alpha} + \mu^2)(V^{2i\alpha} + \mu_0^2)}.$$

After simple computations:

$$M(v) = \frac{V}{L}\cdot\frac{V^{i\alpha}}{V^{i\beta}}\left[\frac{1}{(V^{i\alpha} + \mu^2)(V^{2i\alpha} + \mu_0)}\right],$$

$$M(v) = \frac{V}{L}\cdot\frac{1}{\mu^2 - \mu_0^2}\left\{\frac{V^{i\alpha}}{V^{i\beta}}\left[\frac{-1}{V^{2i\alpha} + \mu^2} + \frac{1}{V^{2i\alpha} + \mu_0^2}\right]\right\}.$$

Taking the inverse transformation gives:

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$$Q(t) = \frac{V}{L(\mu_0^2 - \mu^2)}[-\cos(\mu t) + \cos(\mu_0 t)]\,,$$

$$Q(t) = \frac{2v}{L(\mu_0^2 - \mu^2)} \sin\left(\frac{\mu_0 + \mu t}{2}\right) \cdot \sin\left(\left(\frac{\mu_0 - \mu}{2}\right)t\right).$$

Or because $\sin(-x) = -\sin\ x$, the acquired exact solution is resulted:

$$Q(t) = \frac{2v}{L(\mu^2 - \mu_0^2)} \sin\left(\frac{(\mu + \mu_0)t}{2}\right) \cdot \sin\left(\frac{(\mu - \mu_0)t}{2}\right).$$

6. Conclusion

A new integral transform of complex powers of parameter "Mayan Transform", and neutrosophic "Mayan transform" with its fundamental properties and application on essential functions and derivatives has been introduced and applied to two real-life problems: the response of an undamped forced mechanical oscillator and the response of an undamped forced electrical oscillator. The application of the Mayan transform has proven the simplicity and capability of this transform in solving ordinary differential equations, giving this integral transform superb usability in many scientific fields as a powerful transform.

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