STUDY ON PROPERTIES AND APPLICATIONS OF LAPLACE TRANSFORMATION: A REVIEW

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ABSTRACT:

Need of mathematics is increasing in modern life. To explain and for giving proof of their research findings, researchers from all fields of science uses various Mathematical process or tool or model. Laplace transform is one of the major techniques used by scientist and researchers for finding the results to their problems. In this paper we study the properties and broad range of Applications of Laplace transformations in various fields. In this paper we studied how Laplace transform has been used to solve the research problems. The current paper gives theory, problem worked on properties and application of Laplace transform. To present a scientific review on properties and applications of Laplace transformation is the motive of this paper.. The review paper gives a survey on Laplace transformation technique. The solution of numerous studies, allow us to suggest the use of this technique to modeltheir research problem mathematically and to find the solution to the same.

KEYWORDS: Laplace Transform, Properties, Analysis, Differential Equation

INTRODUCTION

This paper deals with a brief overview of what Laplace transform is and its properties and application in the applied science & Engineering and research problems. Laplacetransform will be Denoted by L {f(x) } where f(x) is a function of 'x'.The study of Electronic circuit and solution of linear differential equation (second or higher order) is solved by using laplace transform. This paper tells about the solution of ordinary differential equation and system of ODEs that arise in mathematicalengineering science. It has many applications in Mathematics, Applied sciences and Engineering and helpful for calibrating integral,differential, circuit systems, mechanical systems, avionics systems.

Laplace Transform:

The Laplace Transformation is defind as

$$f(s)=L\{F(x)\}= \int_0^\infty e^{-sx}dx \qquad (1)$$

where F(x) is sectionally continuous on [a,b]

$x \geq 0$ and $|F(x)| \leq Me^{ax}$ for some constant a and M

L{F(x)} exist for all s > a.

Above is existence for Laplace Transformation.

PROPERTIES OF LAPLACE TRANSFORM:-

a**)** Linearity Property:-

$L\{aF_{1(x)}+bF_2(x)\} = a\{F_1(x)\}+bL\{F_2(x)\}$

where a and b are constants

b) Change of scale property:-

if $L\{F(x)\}= f(s)$ then $L\{F(ax)\}= 1\backslash a\ f(s\backslash a)$

c) First shifting property:-

if $L\{F(x)\}= f(s)$ then $L\{e^{-ax}f(x)\} = f(s+a)$

d) Laplace transform of derivatives :-

For first-order derivative:

$L\{f'(x)\}=sL\{f(x)\} - f(0)$

For second-order derivative:

$L\{f'(x)\}=s^2 L\{f(x)\}-sf(0)-f'(0)$

For nth order derivative:

$L\{f^n(t)\}=s^nL\{f(t)\}-s^{n-1}f(0)-s^{n-2}f'(0)- \text{---} -f^{n-1}(0)$

APPILICATIONS OF LAPLACE TRANSFORM

In this section we study about the importance of Laplace transform. The study is on how this method is applied in variety of research problems. Research articles are studied, the theory behind,problem worked on and applications are represented. Methodical study is performed to represent the functionality and the importance of Laplace transformation technique.

(a) Lenses Designed by Transformation Electromagnetics and Fabricated by 3D Dielectric Printing (J. Yi and A. de Lustrac, G.-P. Piau, S. N. Burokur, 2016) [12]

Theory: Introducing the combination of two inventive techniques which are QCTO and3D printing. Two lenses have been invented and used to control the way of EM waves.Problem is based on: Designing of electromagnetic lens for focusingand coordinating applications at microwave frequency by using Quasi-ConformalTransformation Optics (QCTO).

How Laplace Transformation is used: The Laplace Transformation is used to solving Laplace equation that represents the distortion of a medium in a space transformation.

Procedure: For this two lenses have been used. First lens to construct an overall order in phase emission from an array of origin confronted on a cylindrical structure and second lens permited for deflecting a directive rod to an off normal direction. Thus path of EM waves hasbeen commanded by use of two lens.

b) Exponentials and Laplace transforms on ununiform time scales (ManuelD. Ortigueira, Delfim F.M. Torres, Juan J. Trujillo, 2016) [5]

Theory: A nobel approach to explain exponentials and transforms on time scales has been launched. Begining from Nabla and Delta derivatives, equidistant and derived generalformulae have been studied for explaining exponentials as their Eigen functions. Linear systems and related transfer functions and impulse response are also examined and common fractional derivative has been explained on time scales from contortion.

Problem is based on: To compose a logical approach to indication and systems theory on timeperiod.

How Laplace Transformation is helped: Two new Laplace Transform have been described and their all important possessions have been concluded.

Procedure: Two generalized unorder Laplace Transform have been conclude with exponential and is used to review discrete-time linear systems described by difference equations. Establishing of impulse response and transfer function notion gives a joined mathematical framework that helps to approximate the ideal continuous time case whenever the scantling rate is high.

c) Medical approach for the stream of carbon-nanotubes Suspended nanofluids in the existence of Convective state using Laplace transform(Hoda Saleh, Elham Alali, Abdelhalim Ebaid, 2017) [6]

Theory: In nano medicine, attempts of using the Carbon Nano Tubes (CNT) as drug transporter are tackled mainly in the therapy of cancer. These CNTs are introduced into blood which arriv tumor site with the creation of waves propagated by the walls of artery with outer force such as magnetic field or laser rod. The solution declared that the temperature outline are very sensitive concerning the value allocate to the convective guideline.

Problem based on: An successful analytical process to deduct accurate mathematical modeldescribing the result of a convective heat condition on the flow and the heat transferof carbon nanotube holdover nano fluids in the existence of suction/injection.

How Laplace Transformation is helped : By using Laplace Transform, the heat transferequation is solved and the result is showed in mode of the generalized unfinished gamma function.

Procedure: The stream and heat movement of CNTs are generally defined by order of nonlineardifferential equations. The latest solutions shrink to those in literaured in the non appearance of thesuction/injection and the connective criteria are also proved. SWCNT nanofluids are of lesser temperature than MWCNT nanofluids but it is opposite in case of non appearance of the twProblem worked on: Time of death estimation is a fundamental problem in forensic medicine

d) Time of death approximation from temperature readings only: A Laplace transform method (Marianito R. Rodrigo, 2015) [7]

Theory: In common , death time approximation is executed by utilize a common estimation process is by body cooling. The proposed process also apply the temperature readings also including a specific case which assists for the time of death guesstimate.

Problem based on: Time of death guesstimate is a basic problem in forensic medicine for which result has been given by the proposed method

How Laplace Transformation helps: A new Method for guessing the time of death is executed by utilize Laplace Transformation from only the temperature reading.

Procedure: Proposal of category representation for body cooling which also consist of the well known Marshall-Hoarse model as a spesific case. Solutions of the numerical simulations refister to theoretical and experimental data, show the proposed method accuracy.

e) Analytical Modelling and Characterization of Electromigration Effectsfor Multibranch Adjacent Trees (Hai-Bao Chen, Sheldon X.-D.Tan, Xin Huang, Taeyoung Kim, and ValeriySukharev, 2016) [8]

Theory: A latest modelling and testing technique for EM reliability analysis in Multibranch adjacent trees has been proposed, which are ordinary for practical VLSIinter connect architectures and wiring method

Problem based on: Exact analytical result to the stress development equation has been formed for the straight line three-incurable wires and the cross structred five terminal wires.

How Laplace Transformation is helps: Analytical results for each kind of the adjacent trees have been procured by use of Laplace Transformation.

Procedure: To find a solution of stress evolution equation Laplace Transform technique is used with given BC and IC for the T-shaped terminal adjacent tree. By using LaplaceTransformation, the analytical result in S domain for every branch is given which satisfies the linear system. Again using Inverse Laplace Transformation we obtain an real time domain solution

f) General non linear modal representation of high scale power system

Hasan Modirshanechi and Naserpari, 2003 [9] launch and developed a new method called modalseries method, which gives non linear system response for even zero input in shape of differential equations. It derives and described the behavior of non linear dynamic systems using non linear modal representation.In this Laplace transformation is used for solving non linear differential equations.

g) Analytical procedure for broadband high-electro chemical piezo electric bimorph beams with highly frequency power harvesting Peter

Lloyd woodfield, 2015 [10] obtained the highly frequency responses of multi electro chemical

piezoelectric bimorph beams based on closed form boundary value method from strong form of Hamiltoniansprinciple. Also concludes the Conversion of unutilized mechanical energy to electrical energy by seperable electro mechanical system. Laplace transform is used to obtain new formulae for powerharvesting high frequency responses for multiple bimorph board of different types of connections.

h) Generalized variational principles for heat conduction models on the basis of Laplace transform

For parabolic and hyperbolic heat conduction equations, Classical variational principle never exist P. Szymczyk, M. Szymczyk, 2015 [11] explained and reviwed the principles of those equations. In thisclassical variational principle is characterized to models like Jeffrey model,cattaneo-vernotte model, two temperature models . Laplace transformations are used for deriving classical variational principles.

i) Categorisation of geological structure with help of ground penetration radar and Laplacetransform artificial neural networks

Mikail. F. Lumentat, 2012 [12] tell about a new type of artificial neurons and neural networks. By help of these neural networks and on basis of various types of geological structures, the structure of geologicalsubstance is distinguished. Laplace transform is used more rather then of artificial weights and in linear activationfunction of artificial neuron.

j) Wave propagation and transient reaction of a fluid filled FGM cylinder with rigid core using the inverse Laplace transform

A study on wave propagation and transient reaction of fluid filled Functionally Graded Material (FGM) is described by K. Daneshjou et al., 2017 [13]. Analytical strategy for describing transient response of fluid filled FGM cylindrical carapace with a co-axial rstiff core. Derivation of wave propagation, transient response of fluid filled FGM cylinder with rigid core usingtransform technique carried out.

CONCLUSION

This paper tells how Laplace transformation is used in different field to solve wide range of engineering and research problems. The motive of this paper is to present the clear Study regarding t Laplace Transformation in distinct fields. The Study on Properties and Applications of this Laplace Transformation method shows how it could be useful for finding the solutions for different problems.

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