INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 6, Issue - 6, June – 2020
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.497
Received Date: 31/05/2020 Acceptance Date: 16/06/2020 Publication Date: 30/06/2020

STUDY ON VARIOUS APPLICATIONS OF LAPLACE TRANSFORM

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Abstract: *For justification of the research work and their findings, researchers use the various Mathematical technique or model. Laplace transform is one of the important and significant tool used by scientist and researchers and mathematicians in finding the solution to their problems. In this paper we study a detailed series of "Applications of Laplace transformations" in various fields and regions. In the present study many research problems have been studied and how Laplace transform can be used to solve the problem are explained. The current paper shows the theory, working procedure of problem and applications of Laplace transform in the problem. The objective of this study is to present a methodical review on applications of Laplace transformation in various fields. As a significant method the technique using Laplace transformation have been used to respond diverse research problems modeled as differential or integral equation. The results of various studies, allow us to propose the use of the technique of Laplace transformation to model their research problem in mathematical form and to find the solution to the same.*

Key Words: *: Laplace transform, Applications, Differential Equation.*

1. INTRODUCTION:

Laplace transform is an integral transform method and useful in solving linear ordinary differential equations. It has very wide applications in various areas of physics, mathematics, electrical engineering, optics, control engineering and signal processing. It can be interpreted as a transformation from the time domain to the frequency domain where inputs and outputs are functions of complex angular frequency.

If there is any function $f(t)$ that satisfies the Dirichlet conditions, then the laplace transformation of f(t) is defined as

$$F(s) = L\{f(t)\} = \int_0^\infty e^{-st} f(t)\,dt$$

Here, s can be a real or a complex quantity. The condition of convergence of integral

$$\int e^{-st} f(t)\,dt \text{ is}$$

is $\int \left| e^{-st} f(t) \right| dt < \infty,\ s = \sigma + j\omega$

There are various types of problem that are very difficult to solve. The Laplace transformation has played a key role in obtaining the solution guided by complex integral function. Laplace transform is simpler in application as Comparing with the other method such as method of variation with constant and undetermined coefficient. Laplace transformation method is applied in solving the IVP (initial value problem) of nth order linear differential equations with constant coefficients [1]. Laplace transformation was introduced by Pierre-Simon Laplace, a French Mathematician and was systematically developed by a british physicist, Oliver Heaviside. Among the various integral transform it is used mostly due to the easiness in understanding and simple in applying. Laplace transformation can be applied to determine the general solution in various problems. To apply the Laplace transform is principal part is to establish the suitable mathematical form for the solution of equations. Laplace transform converts the function from time domain f(t) to frequency domain F(s) and then by inverse Laplace transformation a frequency domain function is again converted to time domain. Therefore, Laplace transform converts differential or integral equations into an algebraic form. The wide choice of application makes Laplace transform as a powerful tool in studying the engineering problems. Laplace transform is extensively used method to solve higher order differential equations. It has many applications in Science, Mathematics and Engineering. It finds the applications in circuit systems, calibrating integral, differential, avionics, mechanical systems and image processing. Next section describes the application of Laplace transform in various fields.

2. Study on Applications of Laplace Transforms (Review of Literature): In this part of the study we take the applications of Laplace transform. The study is about how the technique of Laplace transform is applied in various

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research problems. Many research articles have been studied. The theory behind the problem, worked on and applications are studied and explained. To understand the functionality and the applications of Laplace transform, a systematic study is performed.

2.1. Supervised learning Laplace transform artificial neural networks and using it for automatic classification of geological structures

P. Szymczyk and M. Szymczyk, 2014 [2] gave a method of learning novel Laplace transform artificial neural network (LTANN). The theory of Laplace transformation is utilized in neural networks. Description of the usage of (LTANN) for searching anomalies in geological structures is discussed and explained. This technique is based on well known method of supervised learning and it was accepted into a new type of networks Laplace transform artificial neural network (LTANN).

2.2. New Mathematical nonlinear modular model and using it for switch-mode pulse width modulated converter circuits

Andres Nogueiras et al. [3] gave a new model of pulse width modulation (PWM) process to get behavioural non linear simulation of switch mode power converters. This technique is utilized to aid the simulations of dc to dc converters and VSI to obtain different PWM techniques. The modeling techniques are very efficient. The obtained data from the simulations are found to be valid in place of data found from the other authors in previous works with other mathematical simulation models. Laplace Transform and Heaviside unitary pulse function is applied to obtain a nonlinear Mathematical Model of PWM pulses.

2.3. General non linear modal demonstration of large scale power system

A method called modal series method which shows non linear system response for even zero input in form of differential equations was given by Hasan Modirshanechi and Naserpari [4]. It derives and represents the behavior of non linear dynamic systems with the use of non linear modal representation. Here the Laplace transformation is applied to solve non linear differential equations. Three stage back to back high voltage direct current converters, Modeling of high voltage direct current converters and voltage source converters are demonstrated by Siriya Skolthanarat [5]. It has more features then the two level converters. It corrects the phenomenon like power quality, first swing stability and voltage. Laplace transform derive the designs of PI type compensators.

2.4. Solutions of fractional order electrical circuits by Laplace transform and method of non standard finite difference

WK Zahra et al., 2017 [6] studied Fractional linear electrical systems and gave new constraints for generalization of RL and RC circuits. The systems of classical electrical and fractional electrical have been compared. Fractional Calculus is used to solve Fractional linear electrical systems. Solution for fractional models of RL and RC circuits are derived by Laplace Transform.

This Fractional modeling gives more accurate representation of real inductor and real Capacitor.

2.5. Laplace transforms for Transient analytical solution for the problem of motion of a vibrating cylinder in the stokes regime

A solution for the problem of transient decay of moment of vibrational cylinder was discovered by Shu-Nan Li and Bing-Yang Cao [7]. Moment of elastic cylinder is also studied discussed. It also have applications in viscosity measurements. To derive the analytical solutions for moment of elastic cylinder in Newtonian fluid the technique of Laplace transformation is applied.

2.6. Inverse Laplace transform for the problem of Wave propagation and transient response of a fluid filled Functionally Graded Material (FGM) cylinder with rigid core

A study for the problem of wave propagation and transient response of fluid filled Functionally Graded Material (FGM) was discovered by K. Daneshjou et al. [8]. Analytical methodology for deriving transient response of fluid filled FGM cylindrical shell with a co-axial rigid core was developed. To study the problem Inverse Laplace transform is used. A derivation of wave propagation and transient response of fluid filled FGM cylinder with rigid core by Laplace transform was done.

2.7. Laplace transform with finite differential method for the analysis of pressure transient of coalbed methane reservoir

Lei Wang et al. [9] have emphasized the mathematical model of coalbed methane based on fractal geometry. Fractal medium are obtained by using Langmuir isotherm, Fick's diffusion law and Adsorption formula. Wellbore storage effect and skin effect are considered and mathematical equation is obtained. Laplace transform technique is used as a finite difference method for solving reduced mathematical equations of the study.

2.8. Electrochemical disturbance propagation and oscillation in power systems

A study of the problem of electromechanical disturbance propagation and oscillation based on a multi segment uniform change power system was found by Delin wang and Xiaoru Wang [10]. Power oscillation and frequency are derived and obtained from the electromechanical disturbance propagation. the analytical expressions of Bessel functions reveal that . The theory that electromechanical disturbance propagates along the chain power systems revealed by the analytical expressions of Bessel functions. A power system, electromechanical power oscillations is induced by electromechanical disturbance propagation and the oscillation frequency modes could be obtained by a grid structures and parameters. Laplace Transformation was used to find a derivation of Machine rotors angle with power increments at all bases under a unit step function disturbance.

2.9. Laplace transformation for Fast-varying and transient non-linear equations for micro structure fibers

Jing Huang et al. [11] discovered the problem of fast varying field in micro structure fibers (photonic crystal fibers) described by the transient non-linear equation. Quick evolution of the field in micro structure fibers was explained by the transient non-linear equation in which the frequency and wave number depends on time. New frequencies were induced and amplified by non-linear effects. Second order differential of the field to transmission distance can't be removed, which will induce an oscillation along Z in the resonance condition to explain the principle of photonic crystal fiber metamaterials, this property can be utilized. Volterra series integration and Laplace transformation are the two methods used to solve the transient non-linear equations.

2.10. Using Laplace transform in Medical application for the problem of flow of carbon-nanotube suspended nanofluids in the presence of convective condition

The use of CNT's in Medical sciences was studied by Hodasaleh et al. [12] these are used for cancer treatment by sending them to tumor sites by action of waves propagated by walls of artery. The equations for heat flow in CNT's are derived and analysed. Method of Laplace transform is applied for solving heat transfer equations of CNT's.

2.11. Laplace transforms for the fast algorithm of parabolic PDE-based inverse problems

Tania Bakhos et al. [13] suggested a new method to solve parabolic partial differential equations effectively. Parameters are approximated for large scale weakly non linear inverse problems where the governing equations are linear time dependent. Laplace Transform is used to solve parabolic partial differential equations. This improves the storage and computational cost.

3. CONCLUSION:

The main aim of this paper is to give a brief idea about the applications of Laplace transforms in various areas and how it is applied to solve various types of equations in problems in science, Engineering, Medical and other fields. In this paper some of the applications of Laplace transforms in various fields are studied and explained. This present study of the paper offers an insights and thoroughly comprehensive review. This study makes a general perception of the research progresses, leaning to assist the development and solution to various research problems.

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