**A PATIENT'S BLOOD GLUCOSE CONCENTRATION ESTIMATION DURING A CONTINUOUS INTRAVENOUS INJECTION USING LAPLACE TRANSFORM**

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**ABSTRACT:** Due to its ability to provide precise findings of the problems without requiring time-consuming calculation effort, integral transform methods are currently the main choice of researchers for figuring out the solutions to difficulties in science and engineering. In this chapter, the authors employ the Laplace transform to estimate the patient's blood glucose level during a continuous intravenous infusion. To do this, authors first create a mathematical model of the issue using the initial condition and a linear Volterra integral equation. Then, using the principles of the Laplace transform, the authors apply the Laplace transform to this to determine the patient's necessary blood glucose concentration.

The chapter's findings demonstrate that the proposed method “The Laplace Transform” delivers a precise solution without the need for time-consuming calculation. The findings of this chapter are extremely helpful in the medical sector at the time of surgery for determining the amount of time needed to keep the patient's blood glucose levels normal. **KEYWORDS:** Laplace Transform; Inverse Laplace Transform; Blood Glucose Concentration; Estimation; Intravenous Injection.

**1. INTRODUCTION:** Integral equations can be used to describe a variety of engineering and scientific issues, including the problems with electric circuits, viscoelasticity, radiation transmission, population dynamics, disease spread, and tumor growth [1-3]. Different integral transforms, including Laplace, Kamal, Mahgoub (Laplace-Carson), Mohand, Aboodh, and Shehu, were employed by Aggarwal and other researchers [4–9] to solve the problem of the linear Volterra integral equation of second kind (LVIESK).

Taylor's series approach was used by Aggarwal et al. [10] to solve the non-homogeneous LVIESK. Researchers have recently become very interested in creating new integral transforms because they are simple to use and provide accurate solutions to problems (Sumudu [11], Natural [12], Elzaki [13], Aboodh [14], Mahgoub [15], Kamal [16], ZZ [17], Mohand [18], Sadik [19], Shehu [20], Sawi [21], Upadhyay [22], Jafari [23], and Anuj [24]). Sawi decomposition method was created by Higazy et al. [25] and used to solve the Volterra integral equation problem.

Aggarwal and other researchers [26–33] created the connection between the recognized integral transforms. Higazy and Aggarwal [34] took the Sawi transform into consideration and addressed the chemical science issue. El-Mesady et al.'s [35] use of the Jafari transform allowed them to provide a solution to a medical science difficulty. Higazy et al. [36] used the Shehu transform to comprehensively solve the infections model of HIV-1.

This chapter's major goal is to use the Laplace transform to ascertain a patient's blood glucose level during continuous intravenous injection.

**2. NOMENCLATURE OF SYMBOLS**

, Laplace transform operator;

, inverse Laplace transform operator;

, the set of natural numbers;

, belongs to;

, the usual factorial notation;

, the classical Gamma function;

, the set of real numbers

, blood glucose concentration of a patient at any time

, constant velocity of elimination

, the rate of infusion

, volume in which glucose is distributed

, initial concentration of the glucose in the blood

**3. DEFINITION OF LAPLACE TRANSFORM:**

If is a piecewise continuous exponential order function then its Laplace transform is defined as [24]

(1)

**4.CONDITIONS FOR THE EXISTENCE OF LAPLACE TRANSFORM:** The Laplace transform of i.e. exists for if

1) is continuous,

2) exists i.e. finite .

**NOTE:** The aforementioned prerequisites are required but not essential for the function 's Laplace transform to exist.

**5. LINEAR PROPERTY OF LAPLACE TRANSFORM [4]:** If and are constants and and are functions with Laplace transforms, then

**6. CONVOLUTION THEOREM OF LAPLACE TRANSFORM [4]:** If and then

,

where convolution of and is denoted byand it is defined by

.

**7. INVERSE** **LAPLACE TRANSFORM:**

The inverse Laplace transform of denoted by, is another function having the property that

**Table-1:** Fundamental functions and their Laplace transform [24]

|  |  |  |
| --- | --- | --- |
| S.N. |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |

**Table-2:** Inverse Laplace transformations of fundamental functions

|  |  |  |
| --- | --- | --- |
| S.N. |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |

**8. A PATIENT'S BLOOD GLUCOSE CONCENTRATION ESTIMATION DURING A CONTINUOUS INTRAVENOUS INJECTION USING LAPLACE TRANSFORMRM:** The linear Volterra integral equation gives the patient's blood glucose level during continuous intravenous administration at any time as [25]:

(4)

If we apply the Laplace transform to both sides of (4), we get

(5)

Using the Laplace transform's linear property in (5), we are able to

(6)

Using the Laplace transform’s convolution theorem in (6), we obtain

(7)

Operating inverse Laplace transform on both sides of (7) gives

(8)

Equation (8) provides the necessary expression for a patient's blood glucose level during continuous intravenous injection at any time . **9. CONCLUSIONS:** By using the Laplace transform on the problem's mathematical model, the authors were able to arrive at a precise analytical solution to the problem of calculating a patient's blood glucose level during continuous intravenous injections. The answer to this issue will greatly assist our doctors in figuring out the precise level of the patient's blood glucose during continuous intravenous injection at any given moment. The findings of this study indicate that the Laplace transform can be used to identify a problem's solution in the medical area in a very effective, simple, and easy-to-apply manner.

**DATA AVAILABILITY:** The datasets used in this chapter, according to the authors, are readily available from the author upon request.

**CONFLICTS OF INTEREST:** The contributors don't have any competing interests.

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