Delta Potential Response of Electric Network Circuits

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***Abstract-* The network circuits with delta potential are generally analyzed by adopting Laplace transform method. The paper inquires the network circuits with delta potential by Aboodh transform technique. The purpose of paper is to prove the applicability of Aboodh transform to analyze network circuits with delta potential.**

***Indexed Terms-* Aboodh Transform, Network Circuit, Delta Potential.**

I. INTRODUCTION

Aboodh Transform has been applied in solving boundary value problems in most of the science and engineering disciplines [1, 2, 3,]. It also comes out to be very effective tool to analyze the network circuits with delta potential. The electrical circuits are generally solved by adopting Laplace transform method or matrix method or convolution method or calculus method [4, 5, 6, 7, 8, 9, 10, 11,]. In this paper, we present a new technique called Aboodh transform to analyze network circuits with delta potential.

II. BASIC DEFINITIONS

A. Aboodh Transform

If the function $ћ(y)$, $y \geq 0$ is having an exponential order and is a piecewise continuous function on any interval, then the Aboodh transform of $ћ(y)$ is given by

$$A\{ћ(y)\} = \bar{ћ}(p) = \frac{1}{p}\int_0^\infty e^{-py}\, ћ(y)dy.$$

The Aboodh Transform [1, 2, 3] of some of the functions are given by

- $A\{y^n\} = n!/p^{n+2}$, $where\ n = 0,1,2,..$
- $A\{e^{ay}\} = \frac{1}{p(p-a)}$,
- $A\{sinay\} = \frac{a}{p(a^2+p^2)}$,
- $A\{cosay\} = \frac{1}{a^2+p^2}$,
- $A\{sinhay\} = \frac{a}{p(p^2-a^2)}$,
- $A\{coshay\} = \frac{1}{p^2-a^2}$.
- $A\{\delta(t)\} = 1/p$

The Inverse Aboodh Transform of some of the functions are given by

- $A^{-1}\{p^{n+2}\} = n!/y^n$
  $n = 0,1,2,3,4 \ldots$
- $A^{-1}\{\frac{1}{p(p-a)}\} = e^{ay}$
- $A^{-1}\{\frac{1}{p(a^2+p^2)}\} = \frac{1}{a}\sin ay$
- $A^{-1}\{cosay\} = \cos ay$
- $A^{-1}\{\frac{1}{p(p^2-a^2)}\} = \frac{1}{a}\sin hay$
- $A^{-1}\{\frac{1}{p^2-a^2}\} = \cos hay$

B. Aboodh Transform of Derivatives

The Elzaki Transform [1, 2, 3] of some of the Derivatives of h(y) are given by

- $A\{h'(y)\} = pA\{h(y)\} - h(0)/p$
  $or\ A\{ћ'(y)\} = p\bar{ћ}(p) - ћ(0)/p$,
- $A\{ћ''(y)\} = p^2\bar{ћ}(p) - \frac{ћ'(0)}{p} - ћ(0)$,

and so on

III. MATERIAL AND METHOD

APPLICATIONI:
RLC CIRCUIT WITH DELTA POTENTIAL

$$L\ddot{Q} + R\dot{Q} + \frac{Q}{C} = \varepsilon\, \delta(t)$$

$Where\ L = 1\ henry, R = 6\ ohm,$

$$C = \frac{1}{9}\ farad,$$
$$\varepsilon = 5\ is\ the\ strength\ of\ delta\ potential\ in\ volt$$
$$and\ Q(0) = Q'(0) = 0$$

Solution:

$$\ddot{Q} + 6\dot{Q} + 9Q = 5\delta(t)$$

Applying Aboodh Transform, we have

$$\text{A}\ \{\ddot{Q}\} + 6A\{\dot{Q}\} + 9A\{Q\} = 5/p$$

or

$$p^2\bar{Q}(p) - \frac{Q'(0)}{p} - Q(0) + 6p\bar{Q}(p)$$
$$-6p\frac{Q(0)}{p} + 9\bar{Q}(p) = 5/p$$

or

$$\bar{Q}(p) = \frac{5}{p(9 + 6p + p^2)}$$

or

$$\bar{Q}(p) = \frac{5}{p(3 + p)^2}$$

Hence

$$Q = A^{-1}\left\{\frac{5}{p(3 + p)^2}\right\}$$

or

$$Q = 5te^{-3t}$$

APPLICATION II:
RL CIRCUIT WITH DELTA POTENTIAL

$$L\ddot{Q} + R\dot{Q} = 5\delta(t)$$
$$Where\ L = 1\ \text{henry}, R = 6\ ohm,$$
$$\varepsilon = 5\ is\ the\ strength\ of\ delta\ potential\ in\ volt$$
$$and\ Q(0) = Q'(0) = 0$$

Solution:

$$\ddot{Q} + 6\dot{Q} = 5\delta(t)$$

Applying Aboodh Transform, we have

$$A\{\ddot{Q}\} + 6A\{\dot{Q}\} = 5/p$$

or

$$p^2\bar{Q}(p) - \frac{Q'(0)}{p} - Q(0) + 6p\bar{Q}(p)$$
$$-6p\frac{Q(0)}{p} = 5/p$$

or

$$\bar{Q}(p) = \frac{5}{p(6p + p^2)}$$

or

$$\bar{Q}(p) = \frac{5}{6}\left[\frac{1}{p^2} - \frac{1}{p(p + 6)}\right]$$

Hence

$$Q = \frac{5}{6}A^{-1}\left\{\left[\frac{1}{p^2} - \frac{1}{p(p + 6)}\right]\right\}$$

or

$$Q = \frac{5}{6} - \frac{5}{6}e^{-6t}$$

APPLICATION III:
RC CIRCUIT WITH DELTA POTENTIAL

$$R\dot{Q} + \frac{Q}{C} = 5\delta(t)$$
$$Where\ R = 6\ ohm,$$
$$C = \frac{1}{9}\ farad,$$
$$\varepsilon = 5\ is\ the\ strength\ of\ delta\ potential\ in\ volt$$
$$and\ Q(0) = 0$$

Solution:

$$6\dot{Q} + 9Q = 5\delta(t)$$

Applying Aboodh Transform, we have

$$6A\{\dot{Q}\} + 9A\{Q\} = 5/p$$

or

$$6p\bar{Q}(p) - 6p\frac{Q(0)}{p} + 9\bar{Q}(p) = 5/p$$

or

$$\bar{Q}(p) = \frac{5}{p(9 + 6p)}$$

or

$$\bar{Q}(p) = \frac{5}{6p(9/6 + p)}$$

Hence

$$Q = A^{-1}\left\{\frac{5}{6p(9/6 + p)}\right\}$$

or

$$Q = \frac{5}{6}e^{-1.5t}$$

CONCLUSION

In this paper, we have successfully analyzed the network circuits with delta potential by Aboodh Transform. It may be finished that the technique is accomplished in analyzing the network circuits with delta potential.

REFRENCES

[1] P. Senthil Kumar, S. Vasuki, Applications of Aboodh Transform to Mechanics, Electrical Circuit Problems, International Journal for Research in Engineering Application & Management (IJREAM) *ISSN : 2454-9150* Vol-04, Issue-06, Sep 2018

[2] Mohand M. Abdelrahim Mahgoub, Khalid Suliman Aboodh, Abdelbagy A.Alshikh, On The Solution of Ordinary Differential Equation with Variable Coefficients using Aboodh Transform, Advances in Theoretical and Applied Mathematics ISSN 0973-4554 Volume 11, Number 4 (2016), pp. 383-389

[3] Mohamed Elarabi Benattia , Kacem Belghaba, Application Of Aboodh Transform For Solving First Order Constant Coefficients Complex Equation, General Letters in Mathematics Vol. 6, No. 1, Mar 2019, pp.28-34

[4] Network Analysis by M. E. Van Valkenburg, 2014, Edition 3rd

[5] Rohit Gupta, Rahul Gupta, Matrix method for deriving the response of a series Ł- C- R network connected to an excitation voltage source of constant potential, Pramana Research Journal, Volume 8, Issue 10, 2018.

[6] Rohit Gupta, Rahul Gupta, Sonica Rajput, Convolution Method for the Complete Response of a Series Ł-R Network Connected to an Excitation Source of Sinusoidal Potential‖, International Journal of Research in Electronics And Computer Engineering, IJRECE Vol. 7, issue 1 (January-March 2019), pp. 658-661.

[7] Network Analysis and synthesis by Dr. J. S. Chitode and Dr. R.M. Jalnekar.

[8] Rohit Gupta, Rahul Gupta, Sonica Rajput, Response of a parallel Ł- C- $\mathcal{R}$ network connected to an excitation source providing a constant current by matrix method‖, International Journal for Research in Engineering Application & Management (IJREAM),Vol-04, Issue-07, Oct 2018, pp. 212-217.

[9] Rohit Gupta, Loveneesh Talwar, Rahul Gupta, Analysis of network circuit with steady voltage source, and with steady current source via convolution method, International Journal Of Scientific & Technology Research Volume 8, Issue 11, November 2019.

[10] Electrical Engineering Fundamentals by Dr. Vincent Del Toro.2nd edition.

[11] Dinesh Verma, Yuvraj Singh, Rohit Gupta, Response of Electrical Networks with Delta Potential via Mohand Transform, International Research Journal of Innovations Engineering and Technology, volume 2, issue 2, pp. 41-43, February 2020.