Linear Homogenous Linear Differential Equations of Third and Fourth order through GeoGebra Software for Engineering Students

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Abstract

Several authors have proposed the use of GeoGebra software for the development of learning in various areas of physical sciences, mathematics and engineering.

We use GeoGebra, because it is a free software, this tells us that it is free for teachers and students. This also present the convenience that can be downloaded and installed on home and universe computers, as well as mobile phone application.

Today, there are many applications of GeoGebra to find the solutions of differential equations. In our case we will see some animated and dynamic constructions of applets of solutions for certain homogeneous linear differential equations with constant coefficients of third and fourth order, which are created in the course of differential equations for engineering careers at the Universidad Antofagasta in Chile.

In previous works [8, 10] is quoted as saying that thanks to GeoGebra, also is possible to obtain the result of the exercise of a function quickly and accurately. It is used for supporting the theory of each concept (straight, exponential) detailed in the mathematical content, ant to verify the results obtained by solving the exercises in a traditional way.

This work is the continuation of the teaching and work project "Interactive animations and creations in linear differential equations of the first order: the case of GeoGebra.

Keywords: GeoGebra, tics, differential equations, animations, education.

1. Introduction

Currently, many teachers show interest, and they are already starting to use various educational technology resources for teaching and learning mathematics [1, 2].

Various authors [1, 3] have proposed the use of GeoGebra software to build creative animations or applets to understand the characteristics of functions in a Cartesian plane. In our case, we will show animated and dynamic constructions of applets as solutions of certain homogeneous linear differential equations with constant coefficients of third and fourth order, which are created in the course of differential equations for the engineering careers o at the University of Antofagasta in Chile

In the XV CIAEM 2019, the work "Triangles in GeoGebra: experience in the development of a didactic unit in geometry", presented by Luis Eduardo Guerra Betancourt, in Zerpa (2010; p. 132) describe the following didactic uses of GeoGebra:

- Support for teacher explanations.

- Support for problem solving by students.

- Tool for the student to conduct research.

- Utility for the creation of interactive activities.

- Tool to make constructions, and to observe properties and characteristics.

- Making complicated flat geometric constructions.

- Calculation and problem solving [6, 7].

García (2014), cited by Colonel Maji Franklin Marcelo, Guilcapi Mosquera Jaime Rodrigo and Vargas Guambo Juan Mario, considers that GeoGebra is a technological resource that can be used in the knowledge of learning. Futhermore this should be included in the planning of a class, as a didactic material for the development of activities [8, 9].

Based on what has been described and explained above, we were motivated to use and create GeoGebra applets as a teaching and a teaching support material for EDO.

2. The GeoGebra applets of Differential Equations

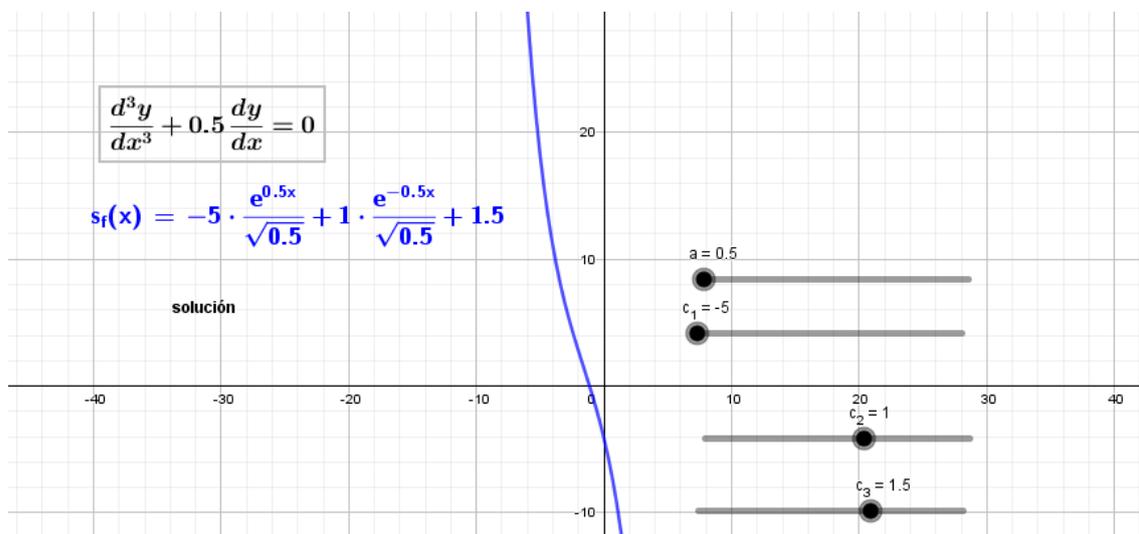Below we will show some examples of GeoGebra applied to differential equations and their solutions.
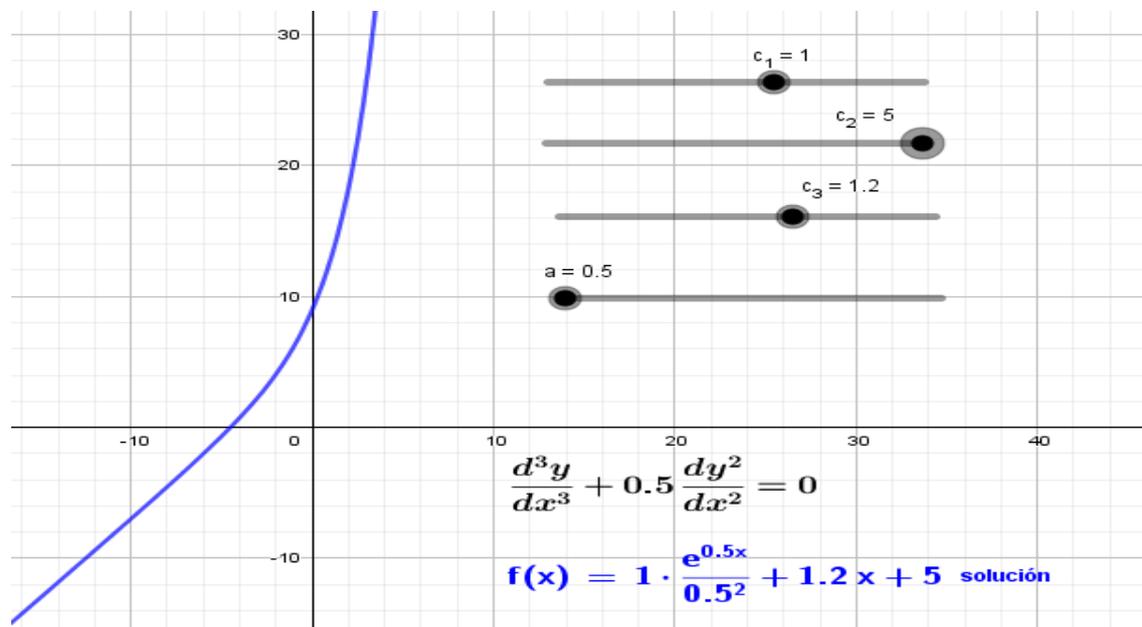
https://www.geogebra.org/m/htvxdvar

Example 1.

Be

$$\frac{d^3y}{dx^3} + a \cdot \frac{dy}{dx} = 0$$

where "a" moves between 0.5 and 2.

Figure 1: The solutions with its graph are in blue.

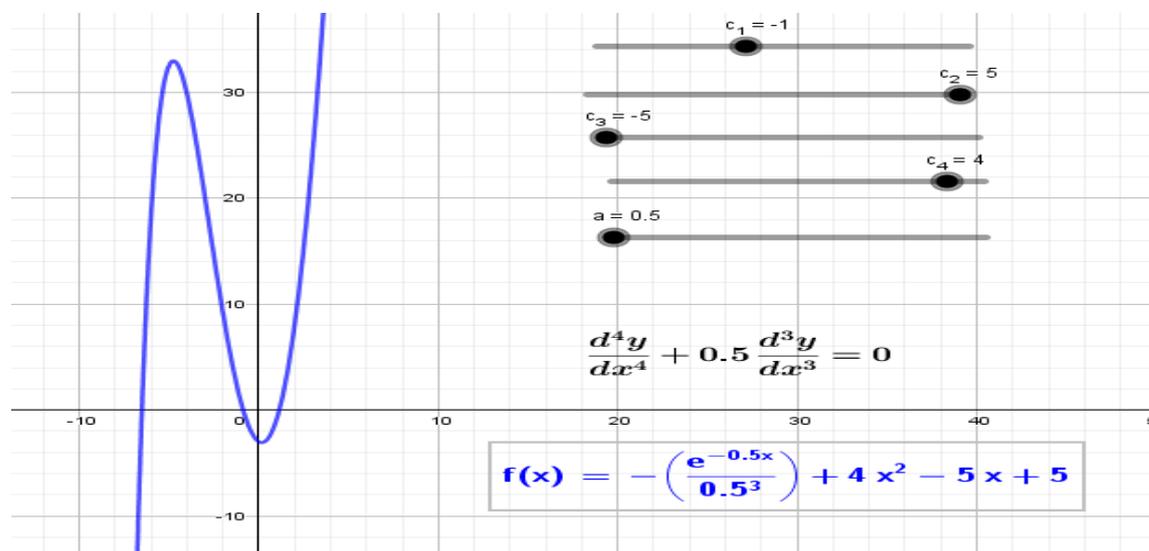The values c_1, c_2 and c_3 are between -5 and 5.

Example 2.

Be

$$\frac{d^3y}{dx^3} + a \cdot \frac{d^2y}{dx^2} = 0$$

Where "a" moves between 0.5 and 2.

Figure 2: The solutions with its graph are in blue.

$c_1 = 1$

$c_2 = 5$

$c_3 = 1.2$

$a = 0.5$

$$\frac{d^3y}{dx^3} + 0.5\frac{dy^2}{dx^2} = 0$$

$$f(x) = 1 \cdot \frac{e^{0.5x}}{0.5^2} + 1.2\,x + 5 \quad \text{solución}$$

The values c_1, c_2 and c_3 are between -5 and 5.

Example 3.

Be

$$\frac{d^4y}{dx^4} + a \cdot \frac{d^3y}{dx^3} = 0$$

Where "a" moves between 0.5 and 2.

10

Figure 3: The solutions with its graph in blue.

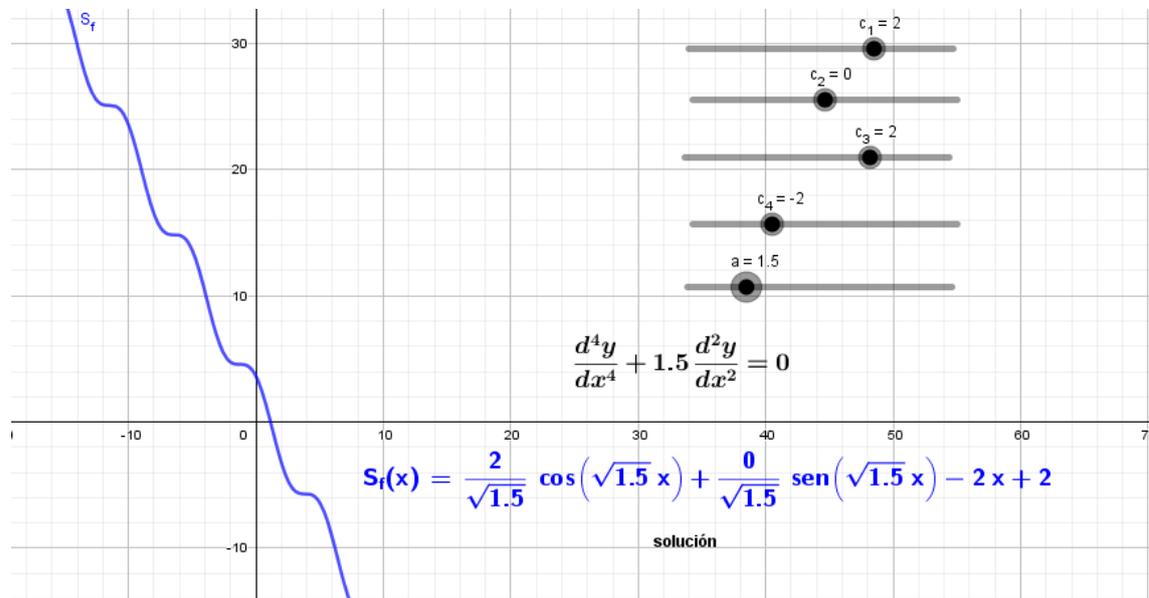The values c_1, c_2 and c_3 are between -5 and 5.

Example 4.

Be

$$\frac{d^4y}{dx^4} + a \cdot \frac{d^2y}{dx^2} = 0$$

Where "a" moves between 0.5 and 2.

Figure 4: The solutions with its graph in blue.

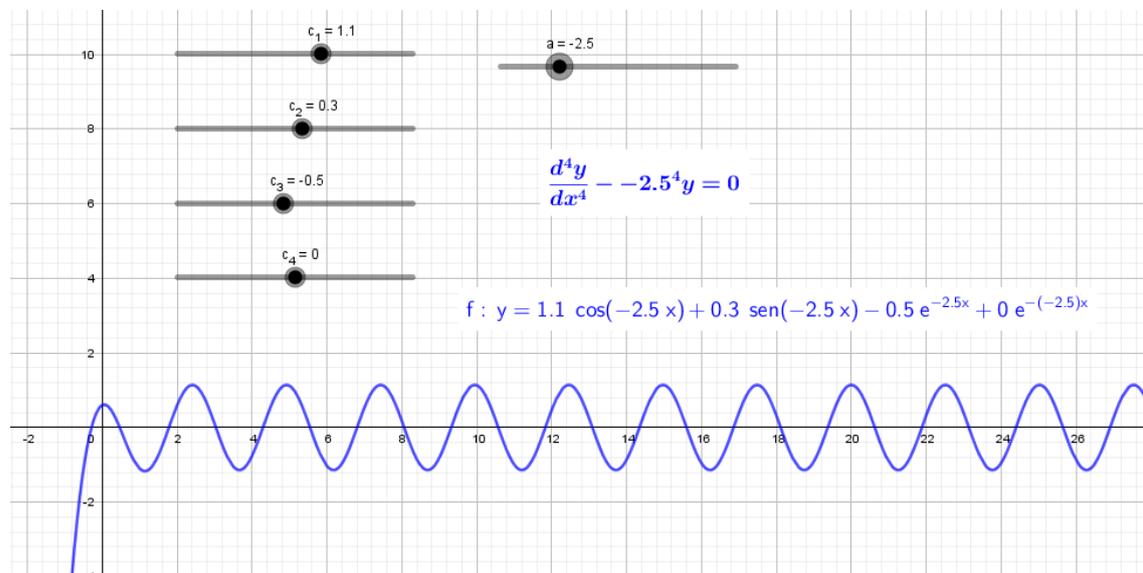The values c_1, c_2 and c_3 are between -5 and 5.

Example 5.

Be

$$\frac{d^4y}{dx^4} - a^4 y = 0$$

Where "a" moves between 0.5 and 2.

Figure 5: The solutions with its graph in blue.

The values c_1, c_2, c_3 and c_4 are between -5 and 5.
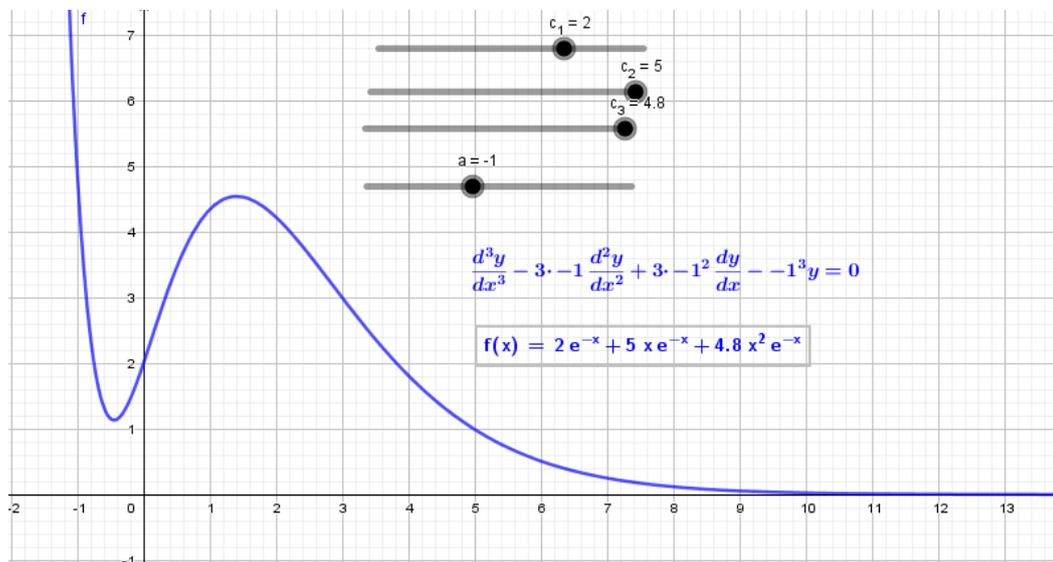
Example 6.

Be

$$\frac{d^3y}{dx^3} - 3a\frac{d^2y}{dx^2} + 3a^2\frac{dy}{dx} - a^3\, y = 0$$

Where "a" moves between 0.5 and 2.
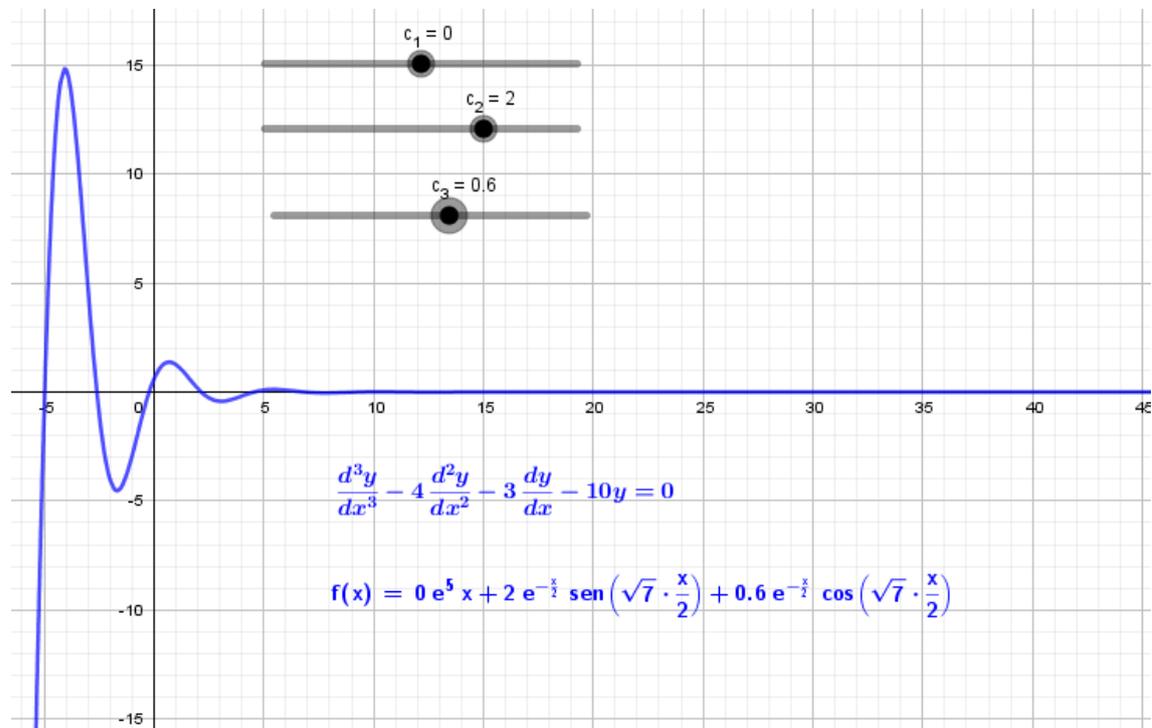
Figure 6: The solutions with its graph in blue.

$$\frac{d^3y}{dx^3} - 3\cdot-1\frac{d^2y}{dx^2} + 3\cdot-1^2\frac{dy}{dx} - -1^3 y = 0$$

$$f(x) = 2\,e^{-x} + 5\,x\,e^{-x} + 4.8\,x^2\,e^{-x}$$

The values c_1, c_2, and c_3 are between -5 and 5.

Example 7.

Be

$$\frac{d^3y}{dx^3} - 4\cdot\frac{d^2y}{dx^2} - 3\frac{dy}{dx} - 10\,y = 0$$
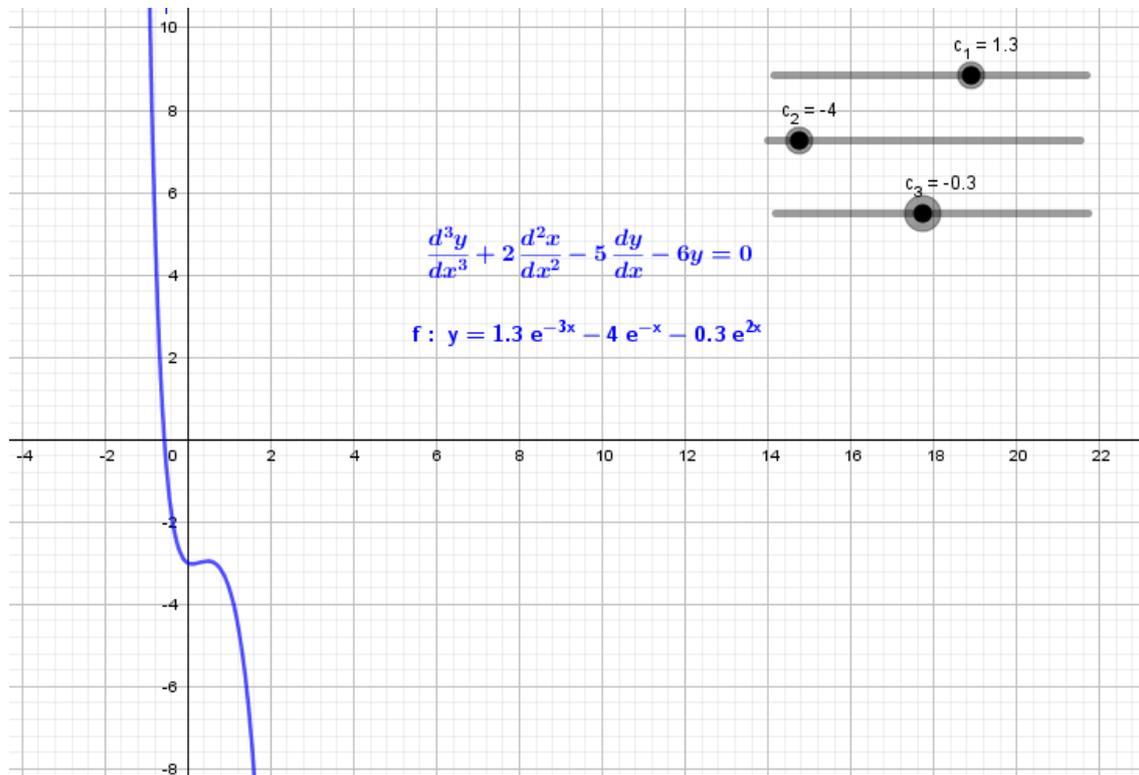
Figure 7: The solutions with its graph in blue.

The values c_1, c_2, and c_3 are between -5 and 5.

Example 8.

Be

$$\frac{d^3y}{dx^3}+2\cdot\frac{d^2y}{dx^2}-5\frac{dy}{dx}-6\,y=0$$

Figure 8: The solutions with its graph in blue.

The values c_1, c_2, and c_3 are between -5 and 5.

Example 9.

Be

$$\frac{d^3y}{dx^3} - 3 \cdot \frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 12\, y = 0$$

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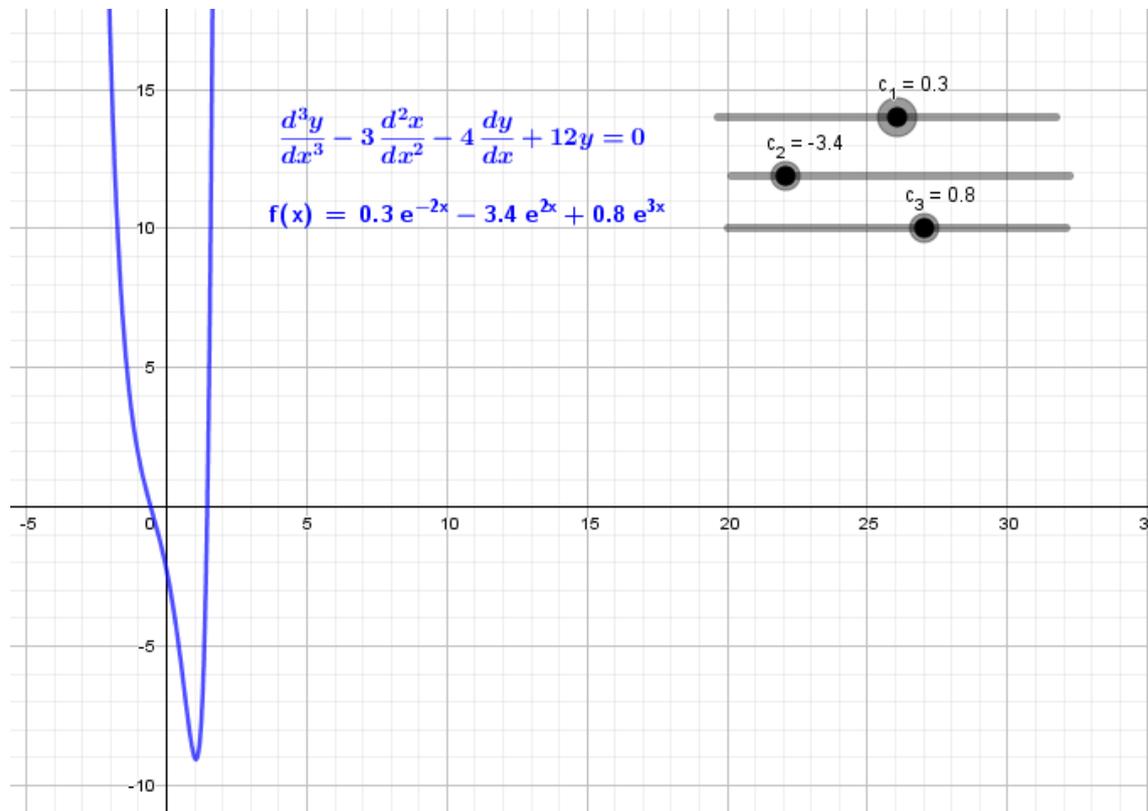*Figure 9: The solutions with its graph in blue.*

The values c_1, c_2, and c_3 are between -5 and 5.

Example 9.

Be

$$\frac{d^3y}{dx^3} - 3 \cdot \frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 12\,y = 0$$
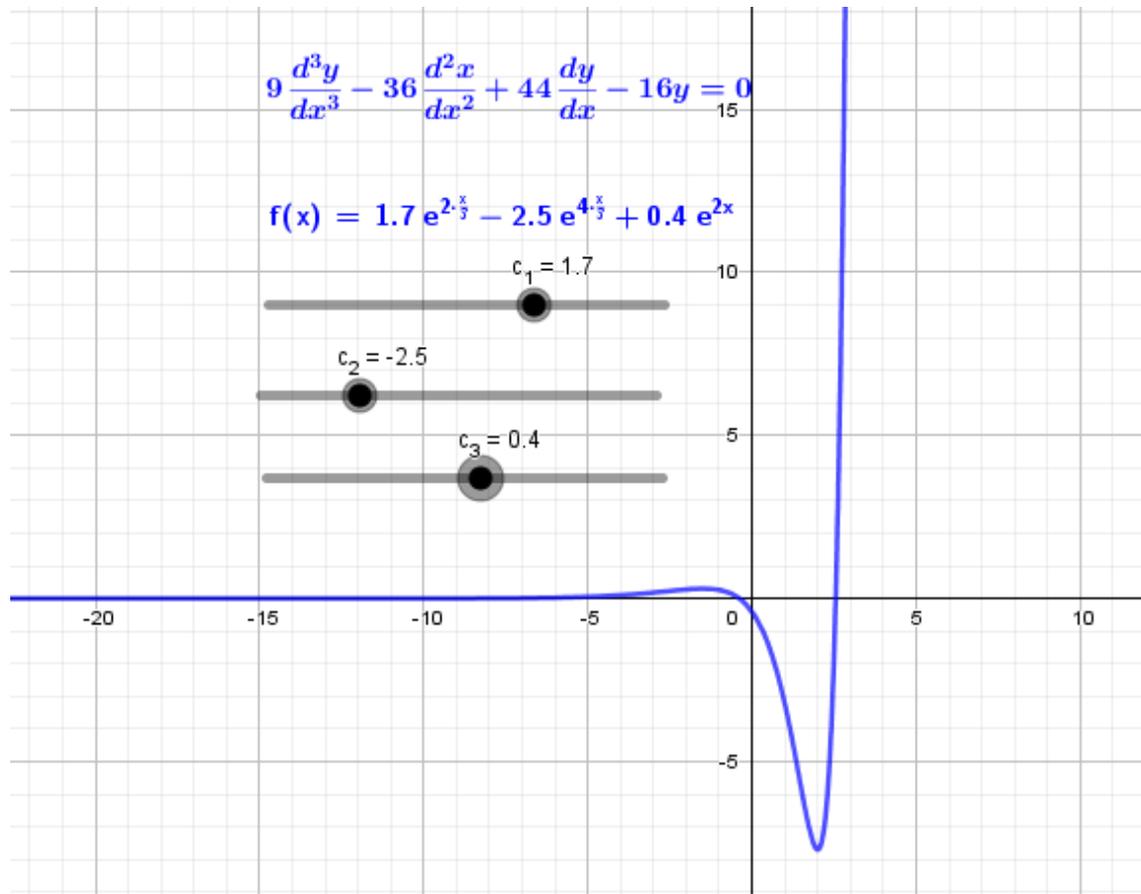
Figure 10: The solutions with its graph in blue.

The values c_1, c_2, and c_3 are between -5 and 5.

Conclusion

The main purpose of this work has been to motivate, and to generate support material for engineering students from various universities, especially those in Antofagasta. In this way they can appreciate and interactively to visualize the differential equations of the third and forth order with their solutions through GeoGebra applets, and with this help in your math learning process.

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