

Geogebra Applets and Gemini Artificial Intelligence in Separable Variable Differential Equations in Engineering Students of Antofagasta Chile

Abstract

GeoGebra applications are presented here to provide constructivist learning and academic motivation for engineering students in the differential equations course at the University of Antofagasta, Chile. These applications are relevant as they offer an alternative approach to solving differential equations with separable variables, enhancing understanding compared to traditional methods.

The dynamic geometry software, GeoGebra, was chosen for creating these applets due to its free access and the dynamism it offers. Many authors have demonstrated the significant advantages of using this program for teaching mathematics at various levels.

Additionally, a prompt performed using Gemini AI is shown to solve the same differential equation with GeoGebra.

Keywords: Dif. equation, GeoGebra, Engineering education, G.A.I A.

1 Introduction

In this work, GeoGebra will be applied using a constructivist methodology as outlined in Ref. [1]. According to Ref. [2], "The basic principle of constructivist theory is that human learning is constructed. The human mind develops new knowledge from previous knowledge. An equally fundamental assumption is that people learn when they can control their learning and are aware of this control."

Recent research, as supported by Ref. [2], shows that computers facilitate this constructivist learning approach and that technology can enhance motivation [3].

The primary objective of this work is to demonstrate and share the GeoGebra applets and the Gemini AI generated on the computer. This will assist engineering students in the Differential Equations course in finding solutions to separable differential equations, along with vector fields, in a constructivist manner. This study aims to improve their learning experience during the first semester of 2022 and the first semester of 2024 at the Universidad de Antofagasta. This work continues and extends the research presented in Ref. [4,5].

Separable variables with Geogebra Applets.

Next, we will present the GeoGebra applets for differential equations with separable variables, along with their solutions and corresponding vector fields.

You can access them at <https://www.geogebra.org/m/wfvp5ujv>.

Example 1

Let the differentiated equations $\frac{dy}{dx} = (x + a)^n$ and its associated vector field with shown with red color in Figure 1. Then the solution of this equation of separable variables is in blue

$$y = \frac{(x + a)^{n+1}}{n + 1} + C, \quad (1.1)$$

where the values a , n and c are moved by means of sliders.

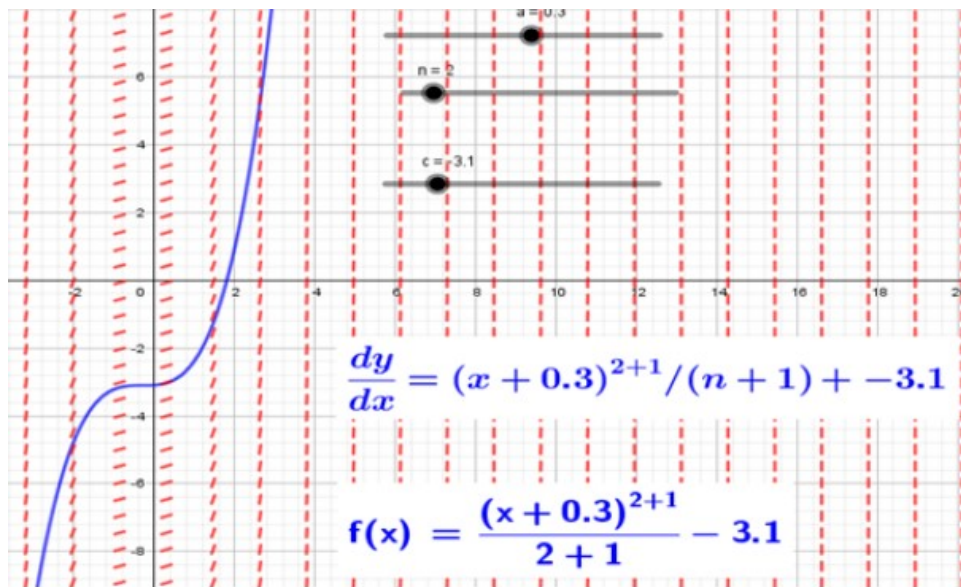


Figure 1: Vector field in red and trajectory in blue

Example 2

Let the differential equation $\frac{dy}{dx} = -\frac{x}{y+n}$ and its associated vector field shown with red color in Figure 2. Then the solution of this equation of separable variables is in blue

$$\frac{dy}{dx} = \frac{x^2}{2} + \frac{1}{2} ((y+n)^2 - n^2) , \quad (1.2)$$

where the values n and c are moved by means of sliders.

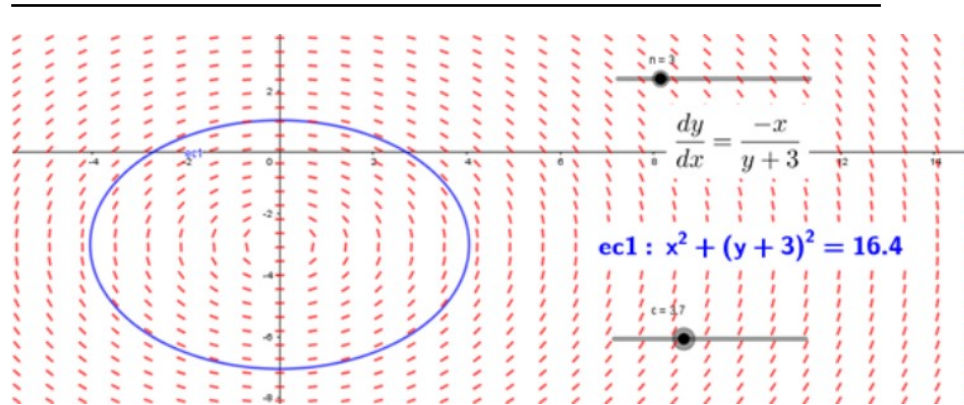


Figure 2: Vector field in red and trajectory in blue

Example 3

Let the differential equation $\frac{dy}{dx} = xy^n$ and its associated vector field shown with red color in Figure 3. Then the solution of this equation of separable variables is in blue

$$y^{1-n} = (1-n) \left[\frac{x^2}{2} + c \right], \quad (1.3)$$

where the values n and c are moved by means of sliders.

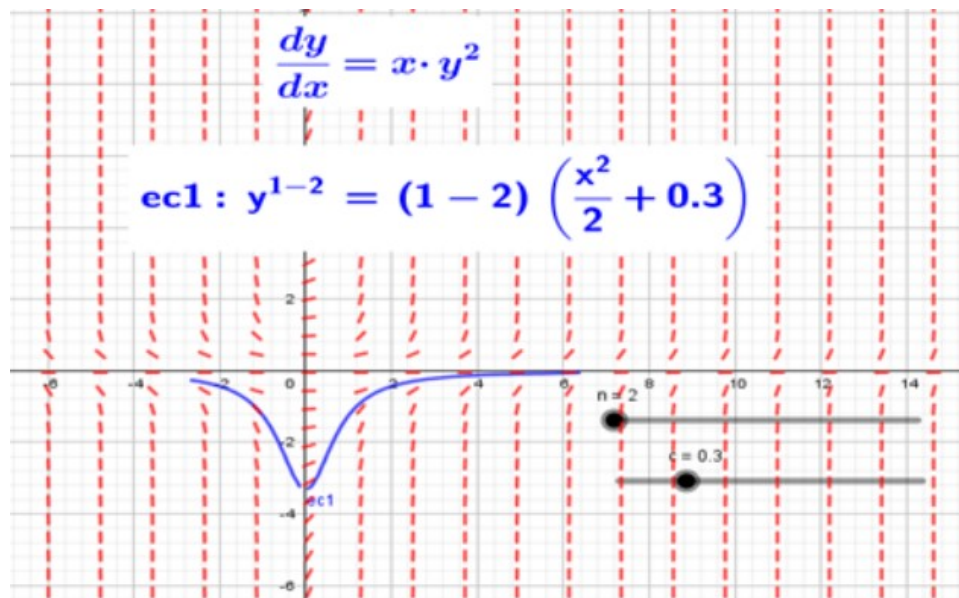


Figure 3: Vector field in red and trajectory in blue.

Example 4

Let the differential equation $\frac{dy}{dx} = yx^n$ and its associated vector field shown with red color in Figure 4. Then the solution of this equation of separable variables is in blue

$$\ln y = \frac{x^{n+1}}{n+1} + c, \quad (1.4)$$

where the values n and c they move by means of sliders.

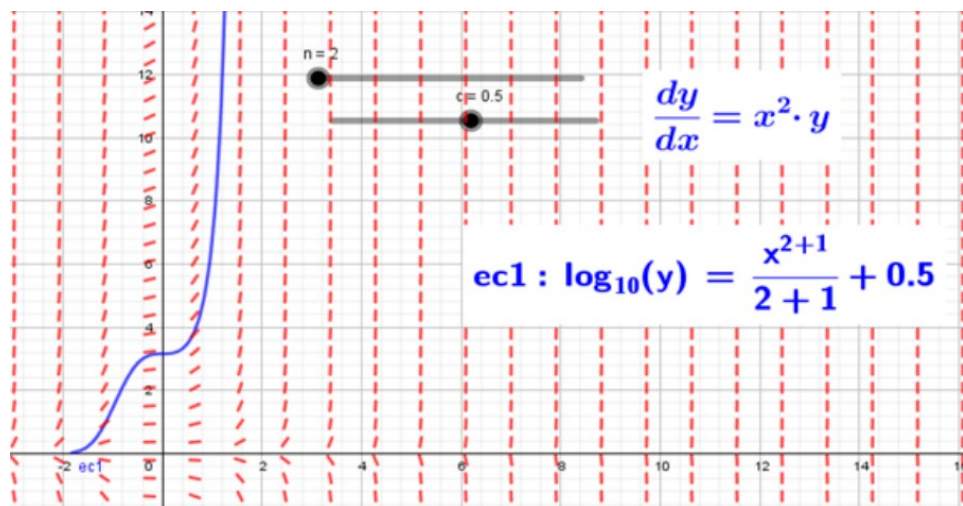


Figure 4: Vector field in red and trajectory in blue.

Example 5

Let the differential equation $\frac{dy}{dx} = \frac{\cos(ax)}{\sin(ax)}$ and its associated vector field shown with red color in Figure 5. Then the solution of this equation of separable variables is in blue

$$\sin(ax) + \cos(ay) = c, \quad (1.5)$$

where the values a and c they move by means of sliders.

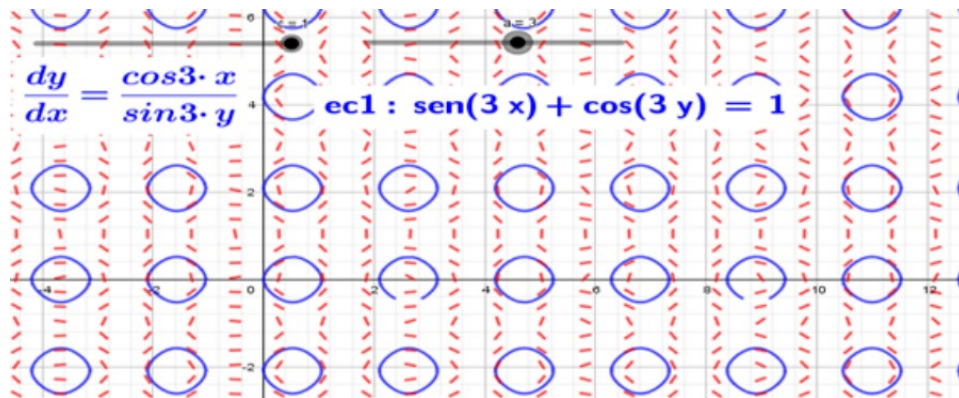


Figure 5: Vector field in red and trajectory in blue.

Now using the Gemini AI in the solution of this differential equation we have:

Gemini ▾

Probar Gemini Advanced

Solve by separable variables step by step $dy/dx = \cos(x)/\sin(y)$

Answer

The differential equation is separable: $\cos(x) dx = \sin(y) dy$ [1].

To solve it, we integrate both sides of the equation:

$$\int \cos(x) dx = \int \sin(y) dy$$

This gives:

$$\sin(x) = -\cos(y) + C$$

where C is the constant of integration.

Press / to open the commands menu

2 Conclusion

Providing this study material to engineering students in the differential equations course at the Universidad de Antofagasta was highly motivating for them, as it allowed them to see animated solutions and their corresponding vector fields in real-time.

While other software and AI tools offer similar functionalities,

GeoGebra's advantage lies in its free access and compatibility with smartphones, tablets, and laptops.

The challenge we face as educators is to extend this idea of interactive and educational materials—using GeoGebra and AI—to other areas of mathematics and various disciplines at different universities. This would make learning more engaging and enjoyable for students.

References

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