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Geogebra in the visualization of integrating factors in non-exact differential equations

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Abstract. In the present work, integrating factors used in the solution of non-exact differential equations will be shown with general examples through software application of dynamic geometry GeoGebra. Now these applets are part of the teaching support material in the engineering careers of the University of Antofagasta on 2020.

Keywords: GeoGebra, ticts, exact equations, integrating factors.

1. Introduction

Nowadays there are several investigations, that support the different benefits of the GeoGebra software [1-4]. In particular, in Ref [3], it is written that GeoGebra allows that, “the students think mathematically and they increase their level of understanding, and in this way they are able to solve problems of the daily life”.

In Ref. [3], they say that the advantages in using this software are the following ones:

- i) The coordinates can be introduced in the equations directly.
- ii) It allows to handle functions, and it offers a variety of own commands
- iii) It has also active windows for graphic views, algebraic views, input bar and data sheets.
- iv) It allows also to identify the singular points of a function as roots or extreme values.

It is very easy to learn and it presents a pleasant working environment. The students can make their graphics with high quality. They can also modify it in a simple way to increase the visual performance. Because of this, it is that the GeoGebra applets are used to treat the non-exact differential equations together with their integrating factor and to obtain general solutions.



All of this applets were designed for the differential equation courses as a continuation and extension of: “Resolving non-homogeneous linear differential equations using the indetermined method coefficients and variation of parameters by means of GeoGebra” [4]

2. Applets and integrating factor in differential equations

In the next link the following applets are availables for its use and download:

<https://www.geogebra.org/m/dda-bmvir>

Next we will show the examples, which are developed in these applets.

Example 1

Let

$$x^{n-1}ydx + (x^n + (n + 1)y^n - a)dy = 0, \tag{1}$$

whose integrating factor in red is y^{n-1} , and the solution in blue is $\frac{x^n y^n}{n} + (n + 1)\frac{y^{2n}}{2n} - a\frac{y^n}{n} = c$, in Figure 1.

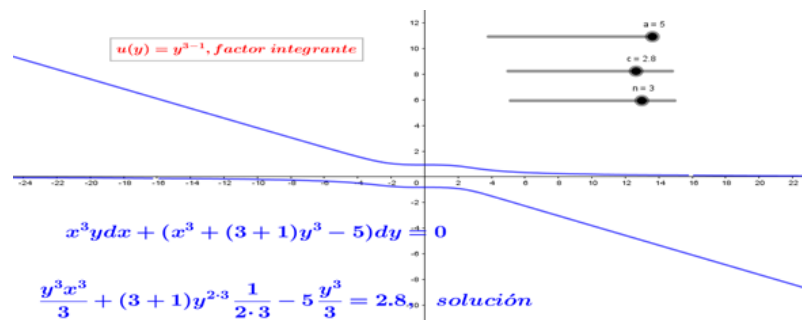


Figure 1. Solution of equation presented in Example 1.

where a, c and n vary between (-5) and 5.

Example 2

Let

$$(y^n + x)dx + xy^{n-1}dy = 0, \tag{2}$$

whose integrating factor in red is x^{n-1} and the solution in blue is $\frac{x^n y^n}{n} + \frac{x^{n+1}}{n+1} = c$, in Figure 2.

where c and n vary between (-5) and 5.

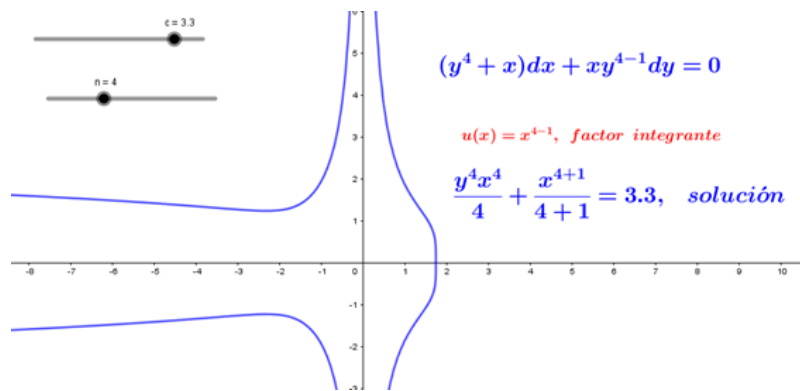


Figure 2. Solution of equation presented in Example 2.

Example 3

Let

$$(-2nxy + x)dx + dy = 0, \tag{3}$$

whose integrating factor in red is e^{-nx^2} and the solution in blue is $ye^{-nx^2} = c$, in Figure 3.

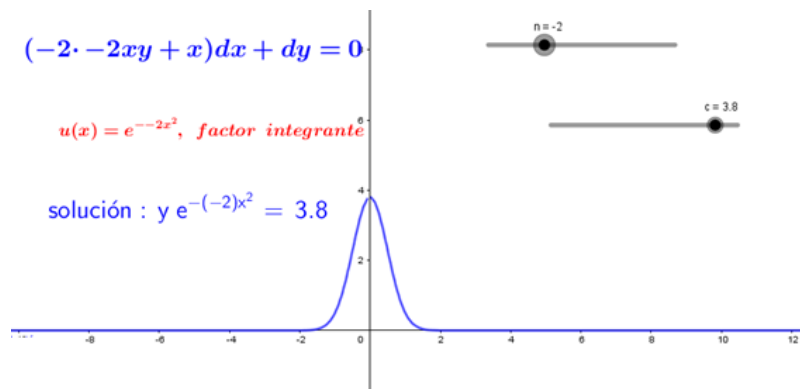


Figure 3. Solution of equation presented in Example 3.

where c and n vary between (-5) and 5 .

Example 4

Let

$$(y^n - x)dx - n(x + n)y^{n-1}dy = 0, \quad (4)$$

whose integrating factor in red is $(x + n)^{-2}$ and the solution in blue is $\frac{y^n}{x+n} + \ln(x + n) = c$, in Figure 4.

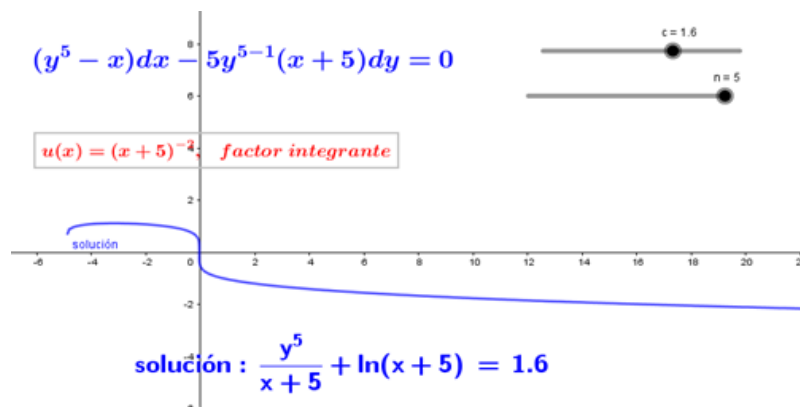


Figure 4. Solution of equation presented in Example 4.

where c and n vary between (-5) and 5 .

3. Conclusion

The propose of this paper has been to share and to show how the applets of GeoGebra can be designed for contents that one would have thought very difficult to do. Also to share this support material for students and professors. And finally to colaborate in the process of teaching and learning of the non-exact differential equations with integrating factors.

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