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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 theteaching support material in the eigineering careers of the University of Antofagasta on 2020.

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

1. Introduction

Nowadayshere are several investigations, that support the differents benefits of the GeoGebra software [1-4]. In particular, in Ref [3], it is written that GeoGebra allows that, "the students think mathematicaly and they increase theirs level of understanding, and in this way the are ables 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 directely.
ii) It allows to handle functions, and it offers a variety of own commands
iii) It has also actives 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 theirs 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 theirs integrating factor and to obtain general solutions.

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All of this applets were desingned 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 develloped 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.

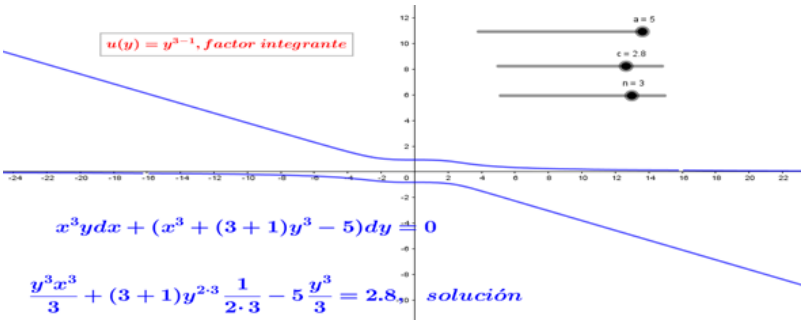

Figure 1. Solution of equation presented in Example 1.

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.

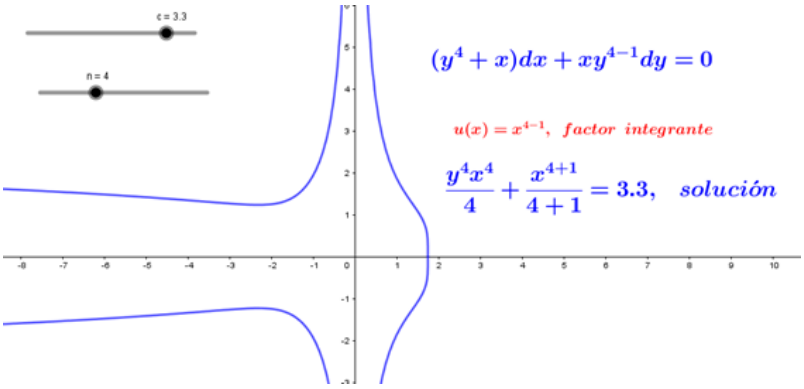

Figure 2. Solution of equation presented in Example 2.

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.

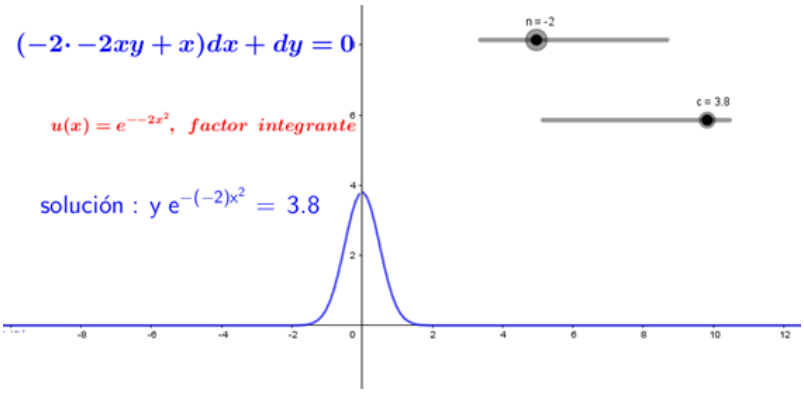

Figure 3. Solution of equation presented in Example 3.

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

Example 4
Let

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

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.

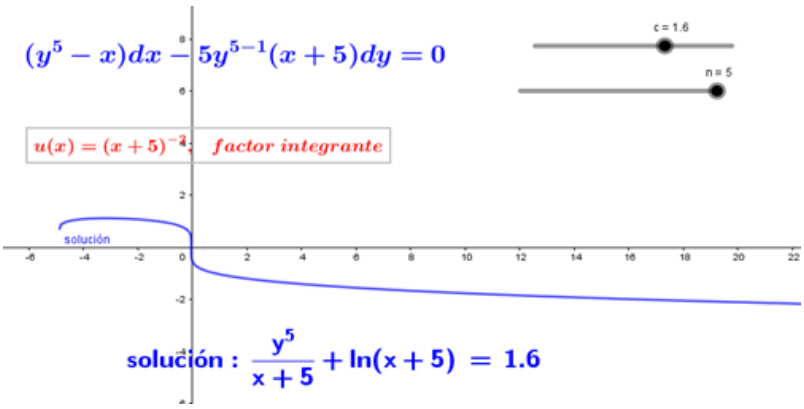

Figure 4. Solution of equation presented in Example 4.

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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