An Interactive Application (Maplet) for II-Order Ordinary Differential Equations

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***Abstract*—the main purpose of this paper is to propose a Maplet interactive application that is used to find general solutions, to find Initial Value Problems (IVPs) and to depict 2-D and 3-D graphics as well of the II-Order Ordinary Homogeneous/Non-homogeneous Differential Equations (ODEs). Furthermore, to make 2-D, 3-D graphing of solutions and how they can be used as effective educational tools for both students and instructors.**

***Keywords*—Interactive Application; Maplet; Ordinary Differential Equations; Homogeneous Nonhomogeneous Differential Equations; Initial Value Problems**

I. INTRODUCTION

Differential Equations are among the most important tools used in producing models in the physical sciences, biological sciences, and engineering [1]. Especially, Ordinary Differential Equations are playing an ever more important role in the physical, biological sciences and some other social sciences as well. Furthermore, ODEs are encountered in numerous applications in many fields including mechanics, potential theory, geophysics, electricity and magnetism, kinetic, biology, mechanics, optimization, optimal control systems, communication, mathematical economics, population genetics, mathematical problems of equilibrium, and heat transfer problems.

From few types of the differential equations, the more frequently investigated differential equations are ODEs. However, in this paper, II-Order Ordinary Homogeneous and Nonhomogeneous Differential Equations are considered.

II. MOTIVATION

The definition of Differential equations and II-Order Ordinary constant coefficient differential equations are defined entirely in the literature [2]-[10].

There are some methods to obtain exact and approximate solutions of II-Order Ordinary constant coefficient differential equations, such as The Method of Undetermined Coefficients or Guessing Method [2], The Method of Variations of Parameters [3], Finite Difference Method [4]-[7]. In this work the application of these methods will be considered.

III. USING MAPLET

In recent years a remarkable number of interactive tools have been created to display mathematics over the internet using any browser. Two most known software are web Mathematica (see [8, 9] and MapleNet see [10]). Educators engaging in the use of the internet in teaching Mathematics are using interactive tools to present and discover mathematical concept.

Virtualizing differential equation concepts enhance the ability of the student to comprehend the dynamic of the three dimensional mathematical concept. We have created an application with Maplets that contains 2-D and 3-D graphics for the concept covered in the ordinary differential equations course by keeping this philosophy in mind.

Computer algebra systems (CAS) like Maple and others are changing the way we study, teach and apply mathematics. Each of those systems combines extensive collection of mathematical functionalities, a graphical and computational environment, a programming language and many other features in one software package, making it possible to perform sophisticated mathematical computations with a single or a sequence of commands. Nowadays, Maple and Matlab are probably the two most successful CAS, along with Matlab that is mainly built for efficient numerical computations.

Maple is a product of Maple Soft, one of the leading providers of software tools for mathematical, engineering and scientific computing. It consists of rich and user-friendly interfaces along with a large collection of functionalities for manipulating mathematical expressions and numbers. Moreover, Maple comes with a simple programming language that is capable of being used to implement developed algorithms for scientific computing. It is a perfect platform for introducing scientific computing, basic programming, mathematical experimentation and simulation.

A Maplet consists of one or more windows which interact with the user by means of buttons, checkboxes, text fields, and other standard graphical controls. Maple is a powerful problem-solving environment capable of doing quite advanced mathematics, but the price of this power is considerable complexity. With a Maplet, this complexity can be retained but

978-1-4799-4106-3/14/$31.00 © 2014 IEEE

restrained: a simple menu interface, tailored to a specific task or problem [8].

The Maplets packages of Maple allow designing graphics interfaces with the capability to interact with the mathematical kernel. With this tool we have developed a Maplet application of II-Order ODEs with constant coefficient. The Maplets are generated basically using Maple code and then displayed over the web as JSP application thorough MapleNet. The use of Maple thorough MapleNet gives the user with access to the internet using any browser the interactive capabilities of the animations.

The advantage of using interactive tools such as the Maplets is that it takes away the somehow complicated code to investigate the concept. The Maplet as well as other similar applications allow the user to enter minimum information. The main goal of the application is for the user to experiment and discover mathematical concept, develop the perception and make conjectures.

IV. MAPLET OF II-ORDER ORDINARY CONSTANT COEFFICIENT DIFFERENTIAL EQUATIONS

Figure 1.The main display of the Maplet. There are different panels with buttons on the main display of the Maplet, as solution steps, answer panel, message panel, 2-D graph panel and 3-D graph panel. The user can control all features of the Maplet using main display. User can enter the inputs of the II-Order ODEs with constant coefficients. It is possible to create random examples or user's own problem, to see solutions step by step, to preview, to see hints, to see 2-D and 3-D graphs of solutions.

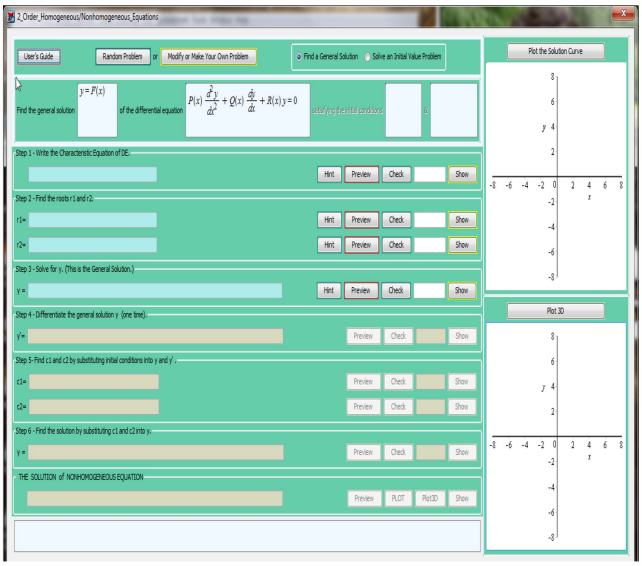

Fig. 1.Main display of the Maplet

Figure 2 is also main display but with an example. It is possible to create random problem or user's own problem on this display. If the equation is homogeneous, then solution ends with step 3 and the panel 3 shows the general solution. Steps 4, 5, and 6 are used to find exact solution if the equation is an IVP. THE SOLUTION OF NONHOMOGENEOUS panel is used to see solution if the equation is a Nonhomogeneous II-Order ODE with constant coefficients. The 2-D and 3-D graphics can be seen on the right-hand side of the main display of the Maplet. Finally, some messages that are motivational messages for users can be seen at the bottom of the main display of Maplet.

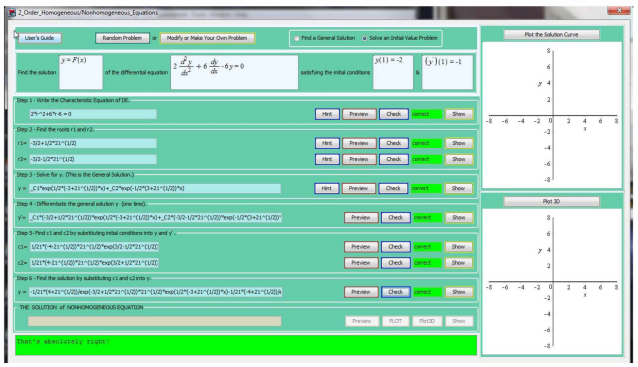

Fig. 2 .Main window of the Maplet with an Example

Figure 3 is the panel that is possible to see solutions steps of the DE. There can be seen the answers after each step of calculations of course in Maple coding system. There are also "Hint", "Preview" "Check" and "Show" buttons on the panel. The Hint button gives some information about the operation which is performing. The "Preview" button displays the mathematical view of the answer. Check bottom shows if the entered expression by the user is correct or incorrect and the "Show" button are shows the correct expression for the current step. Here step 1 indicates the characteristic equation of the DE. Step 2 gives the roots of the characteristic equation. Step 3 shows the general solution of the DE. This is the last step if the equation is homogeneous.

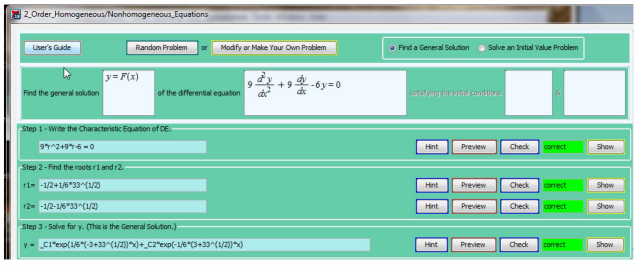

Fig. 3 .Solution steps for the DE

Figure 4 is the messages panel that motivates the user for solving or to manipulate by their selves the next time.

Fig. 4 .Solution panel of the Maplet

Figure 5 is the main menu panel. There are the buttons "User's guide", "Random Problem", and "Modify or Make

Own Problem" on the panel. User's guide panel gives some hints about the use of Maplet. Random Problem creates random problems about II-Order ODEs. User can create his/her own problem by using the "Modify or Make Your Own Problem" button. Here also there are two checkboxes "Find general solution" and "Solve an Initial Value Problem". User can chose which one he/she wants. User also can see the De and initial conditions of the problem on the main menu panel.

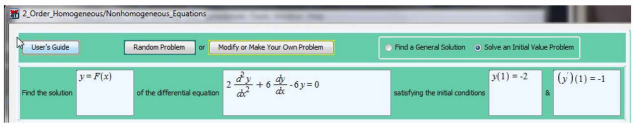

Fig. 5 .Main menu panel

Figure 6 is the "Preview" panel of the Maplet. Mathematical view of the expression which is given in the Maple syntax can be seen in this panel.

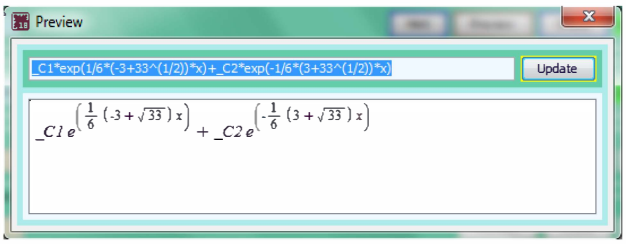

Fig. 6 .The message panel of the Maplet

Figure 7 is the 2-D graphing panel of the Maplet with "Plot the Solution Curve" button. In this panel user can create 2-D plot of the solution of the given ODE with constant coefficient.

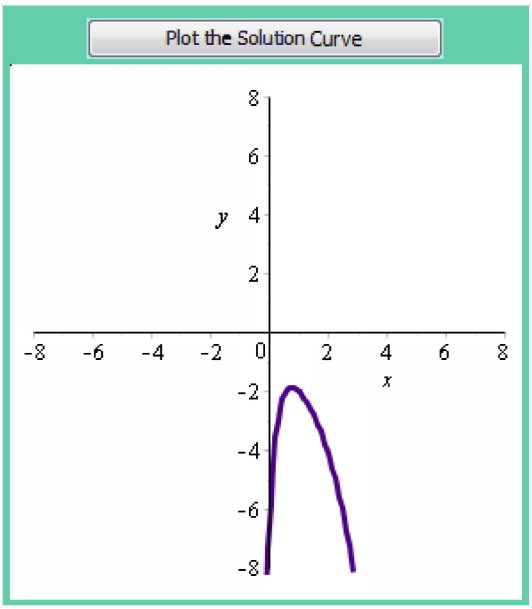

Fig. 7 .2-D graphing panel of the Maplet

Figure 8 is the 3-D graphing panel of the Maplet with "Plot 3D" button. User can create and control the 3-D graph of the solution of the II-Order Ordinary Differential Equation with constant coefficient.

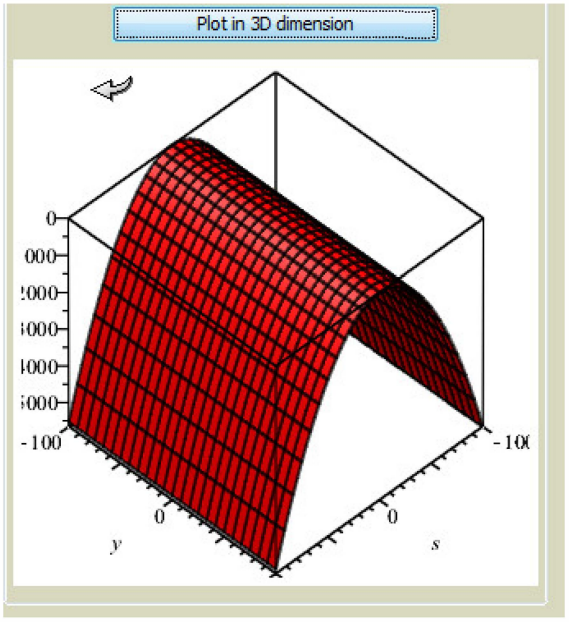

Fig. 8 .3-D graphing panel of the Maplet

Figure 9 is the "Modify or Make Your Own Problem" panel of the Maplet. By this panel user can enter his/her own differential equations just by entering constant coefficients a, b, c, initial conditions for IVP or Q(x) if the equation is Nonhomogeneous. After making these changings user push the "Update Problem and Close" button.

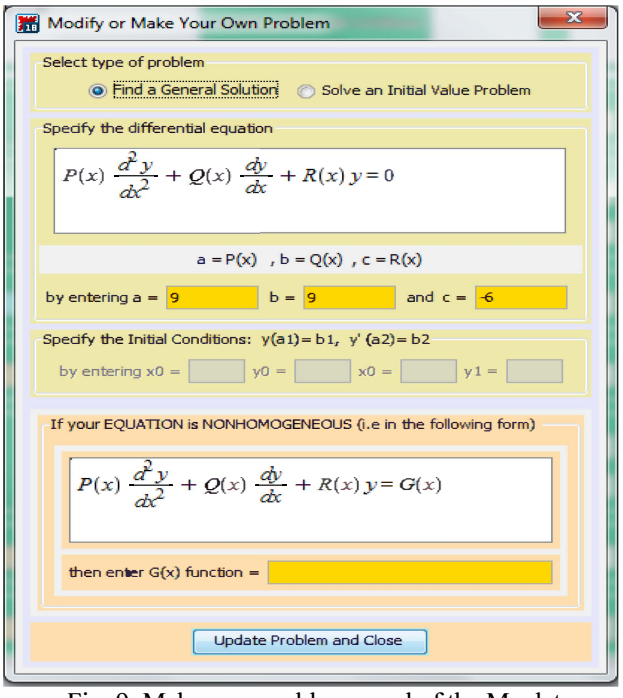

Fig. 9 .Make own problem panel of the Maplet

Figure 10 is the "HELP MENU" panel of the application. User can get some general information about the use of the Maplet and general notations about used differential equations.

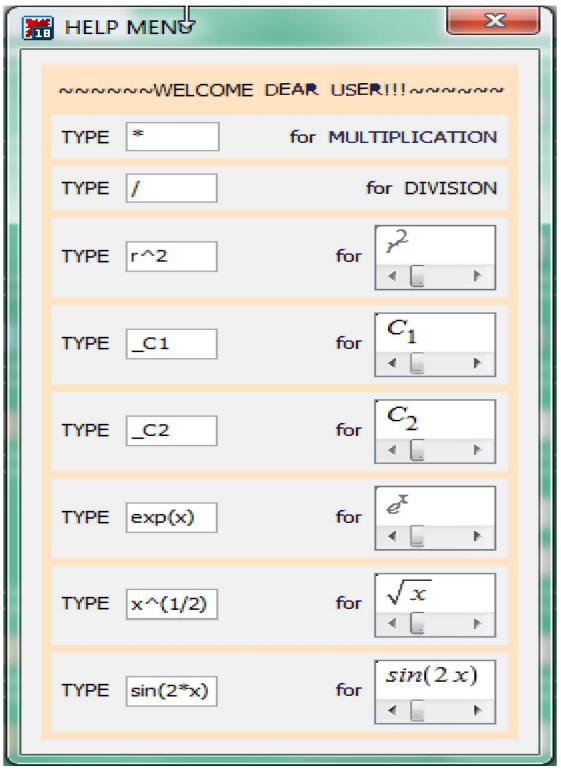

Fig. 10 .USER GUIDE panel of the application

V. CONCLUSION

The combinations of the Maplet, as part of the lectures carries to the classroom the dynamic of three dimensional mathematical objects to create a more active way of teaching differential equations. The interfaces provide the instructor and student with simulations bringing differential equations concept alive. The interactive Maplets enable the user to control his/her self-studies and by help of the graphics user can improve his/her understanding of mathematical concepts.

ACKNOWLEDGMENT

I would like to convey my gratefulness to Mr. Moussa Mahamat who is corresponding author of this paper and at the same time chair of the 11.ICECCO conference and at the same time my ally. He spent his valuable time to write this paper with me although his overloaded works relational to the conference. He shared his expertise with me very generously.

I hope we are going to go on to work together for our future career development.

Above all, I am (always) grateful to my wife, H. Kubra, for her love, steadfast support, and patience during the writing of this paper and at all other times.

We welcome any question, comments, and suggestions for improvement of the paper.

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