Differential Equations and Dynamical Systems, a dynamic approach with TI-Nspire-CAS

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Abstract

A vast majority of applications of calculus in different sciences consists of models with systems of differential equations e.g. dynamical systems, as any perusal of the current literature will indicate. In addition, as Henri Poincaré showed, the fundamental laws of nature are, from a mathematical point of view, differential equations. Therefore, in our opinion, differential equations and dynamical systems should be at the center of every introductory calculus course and this can be accomplished through the application of technology. It is now possible to solve differential equations numerically and graphically with little manual effort, allowing them to take their rightful place in an introductory course. The development of conceptual understanding rather than algebraic technique is important. We designed an introductory calculus course based on these principles. We will show, how this course is structured. It begins with a simple model (Newton's law of cooling) which leads -at first more intuitively- to the fundamental concepts of derivative (rate of change), differential equation, Euler's Method, model and dynamical system. We introduce the derivative in the original and general sense as flux and not through the traditional slope of a tangent line. The central chapters are dedicated to differential equations and dynamical systems, introducing the graphical method of state plane analysis. With the TI-Nspire technology direction fields and trajectories can be represented graphically and thanks to the sliders it is even possible to experimentally investigate the impact of the variation of the parameters. This can enhance a deep understanding of the systems under consideration. We will demonstrate the power of these methods with some impressive examples. With the focus on dynamical systems the great significance of calculus can be far better demonstrated than with the traditional approach to introducing calculus.