Maple: A Comprehensive Tool for Introductory ODEs

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The number of software packages available for use in an introductory course in differential equations is rapidly increasing. Many of these tools focus on numerical or graphical information. Analytical information, essential for an introductory course, can be more difficult to obtain from a computer. The only way to combine the analytic, graphic, and numeric information in a single tool is to use a computer algebra system. Of the several choices available, my favorite is Maple.

The graphical features of Maple are useful throughout the course. At the outset they are highly effective when describing differential equations and their solutions (direction fields). In addition to displaying the solution to an initial value problem, the graphics are also very useful for phase-plane, steady-state, and other qualitative analysis.

One benefit derived from using the symbolic features of Maple is seen when discussing classical solution techniques – students are able to concentrate on the general concepts and the theory, not on the details of the manipulations. The symbolic solutions can also be effective during the exploration of the structure of solutions to linear differential equations (*e.g.*, superposition).

In addition to Maple's built-in routines (*e.g.*, Fehlberg fourth-fifth order Runge-Kutta method) for computing numerical solutions, the Maple programming language is a nice environment in which students can implement other numerical methods. This directly supports the discussion of error analysis and convergence properties.

Applications of differential equations to engineering and the sciences also benefit from the diverse strengths of Maple. Groups of students have used Maple to support extended projects involving such topics as modelling, linearization, parameter estimation, and process control

These benefits do not come without some effort. It takes time for students to become comfortable with Maple. Also, some of the answers reported by Maple are incorrect, or incomplete. While these situations are frustrating, they can often be utilized as examples for a comparison of different solution techniques.

In conclusion, Maple contributes to all aspects of an introductory course in differential equations. The combination of graphical, symbolical, and numerical tools creates a user-friendly environment for the analysis and application of differential equations. It should also be emphasized that all of these investigations are performed by the students; they are no longer just passive observers of a lecture.

Maple is available on a wide variety of operating systems, including UNIX, Macintosh (system 6.0.7 or higher, 13-15MB on hard disk, 4MB of RAM, floating-point coprocessor is optional), MS Windows (386 or higher, 12-18MB on hard disk, 4MB or RAM, math coprocessor is optional), MS DOS, NeXT, VMS, Ultrix, and UNICOS. Campus-wide site licenses are available from Waterloo Maple Software. In addition, the Student Edition, for either Macintosh or MS Windows, can be purchased from Brooks/Cole for less than $100.