The Maple Computer Algebra System

1. Introduction

Maple is the computer algebra system (CAS) which the Department of Mathematical Sciences at SVSU has adopted for its courses. A computer algebra system is capable of symbolic calculations in mathematics, numerical computations, and graphing. We tell how to open Maple, then we discuss applications of these three types of actions after first describing Maple's use as a simple calculator.

To open Maple in Windows, click on the *Start* icon. In the resulting menu click on *Programs;* then click on *Maple*. The Maple program will now be loaded, and a blank Maple worksheet will appear.

2. Maple as a Calculator

To use Maple as a calculator, type numbers as usual, but employ these symbols for operations: + for addition, - for subtraction, * for multiplication, / for division, and ^ for exponentiaton. Note that the symbol for multiplication must be used every time multiplication is intended--simple juxtaposition does not suffice to cause it. Each command must be concluded by a semicolon.

```
> 2+3;
        5
> 5/8-3/7;
        11
        --
        56
> 2^5;
        32
```

Maple uses two types of numbers: exact and floating point decimals. The preceding examples were exact. To change two floating-point decimals, either add a decimal point to a number or use the **evalf** command. We show both ways by repeating a previous example.

```
> evalf(5/8-3/7);
                .1964285714
> 5./8-3/7;
                .1964285714
```

Observe that only one number need be floating-point to render the entire computation floating-point.

3. Symbolic Calculations

Let us enter a trinomial.

```
> f:= 2*x+4*y-17*z;
                    f := 2 x + 4 y - 17 z
```

Observe the device for assigning the name f to the given trinomial. Also notice how multiplication is written explicitly in the command although this does not appear in the "prettyprinted" output. ("Prettyprinting" refers to output in the ususal mathematical symbols. This should **always** be done by one means or another so that correctness of data entry can be verified.)

Now let us raise the foregoing trinomial to the fifth power.

```
> f ^ 5;
> expand(%);
> sort(%);
```

Other algebraic operations can be performed in a similar way. Here are some examples.

Example:

```
> 'factor((x ^ 2+1) ^ 2-4*x ^ 2)';
>%;
```

Note that in the foregoing example, by enclosing the command with single quotes we caused our command to be prettyprinted without executing the command; the next command caused the command to be executed.

Example:

```
> f:=(x+1)/(x ^ 2-x-2)-(x ^ 2-1)/(x ^ 2-5*x+6);
simplify(%);
```

Maple can solve equations and systems of equations. Study the examples below to learn the technique. Remember to *always* prettyprint the equation before attempting to solve it.

Example:

```
> eq:=sqrt(x+5)+sqrt(x-5)=10;
>solve(eq,x);
```

Example:

```
> eq:=4/(x+1)-3/(x+2)=1;
>solve(eq,x);
```

Example:

```
> eqsys:={x+y+z+w=6,2*x+3*y-w=0,x+2*y-z+w=0};

> solve(eqsys,{x,y,z,w});
```

4. Graphing with Maple

Maple can plot all sorts of graphs. We introduce you to a few of them here.

To plot a simple graph, with default settings used entirely:

```
> f:=x^2;
>plot(f,x);
```

To plot a graph in which we control the ranges (horizontal and vertical), change the color of the graph, and direct the plotting engine to permit a discontinuity:

```
> f:=(2*x^2-x-1)/(x^3-2*x^2-x-2);
> plot(f,x=-4..8,y=-10..10,color=black,discont=true);
```

In the foregoing graph, labeling the function *y* rather than *f* would have led to failure because in the plot command y would serve two purposes.

To plot a piecewise-defined curve:

```
> f:=piecewise(x<-2,x^2,x>=-2 and x<3,x,exp(x));
> simplify(%);
> plot(f,x=-5..5,y=-3..50,discont=true);
```

Plotting some graphs requires tools that are not loaded by default. They are contained in the **plots** package that needs to be loaded by request as follows. (Note that the load command is followed by a full colon. This prevents unnecessary material from being displayed.)

```
>with(plots):
```

To plot an animation:

```
> f:=m*x^2;
> animate(f,x=-3..3,m=-5..5);
```

To plot a graph in three dimensions:

```
> f:=cos(0.5*x)*sin(y);
> plot3d(f,x=-6..6,y=-6..6);
```