

## Project 13.5b: 3-D Graphics, Lines and Planes

### Objective

The objective of this project is to introduce some basic 3-dimensional graphics commands and to illustrate them in the context of lines and planes.

### Narrative

If you have not already done so, read Section 13.5 in the text.

In this project we introduce the commands `implicitplot3d` and `setoptions3d` in Maple's `plots` package. The command `implicitplot3d` allows us to plot the graph of a surface defined implicitly by an equation in  $x$ ,  $y$ , and  $z$ , over specified ranges of  $x$ ,  $y$ , and  $z$ . The command `setoptions3d` allows us to set certain options to 3-dimensional plotting commands so that we do not have to repeatedly type them.

While certain options will be specified in the projects in this course, it may be necessary to modify some options because of differences in hardware and software. (For example, a graphic that looks great on the screen and on someone else's printer may turn out so poorly on your printer that it is not acceptable.) *Consult your instructor if you run into a problem, and listen to your instructor for directions on to handle problems that you and others may run into.*

### Tasks <sup>1</sup>

1. a) Type the command lines below into Maple in the order in which they are listed; they produce a graphic of a plane.

```
> # Project 13.5b: 3-D Graphics, Lines and Planes
> # Task 1a
> restart: with(plots):
> implicitplot3d(x/2+y/3+z/4=1,x=-2..2,y=-3..3,z=0..4,style=hidden,shading=none,
    axes=normal,projection=normal,scaling=constrained,orientation=[10,60]);
```

Note the options to `implicitplot3d`.

- b) Continue by typing the command lines below into Maple in the order in which they are listed:

```
> # Task 1b
> implicitplot3d(x/2+y/3+z/4=1,x=-2..2,y=-3..3,z=0..4);
```

Note the absence of options to `implicitplot3d`.

c) Now click on the graphic you created in part (b), and use the tools that appear at the top of the screen to get *exactly* the same graphic you got in part (a). Note that the orientation is specified by the angles  $\theta$  and  $\phi$  in the menu bar, and that you can change  $\theta$  and  $\phi$  by retyping their values, by using the up- and down-indicator arrows, or by clicking on the graphic and dragging the image.

2. a) Type the command lines below into Maple in the order in which they are listed.

```
> # Task 2
> setoptions3d(axes=normal,scaling=constrained,color=blue,orientation=[-6,45]);
```

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<sup>1</sup>Since some parts of the code you will use in this course require large amounts of RAM, you may need to consult your local computer guru to find out how to boost the available RAM on your computer.

The affect of the `setoptions3d` command is to set certain options so that they do not have to be repeatedly typed in a Maple session.

b) Continue by typing the command lines below into Maple in the order in which they are listed. They illustrate a line segment and the projection planes whose intersection is the line segment. (The *projection planes* of a line or line segment in 3-space are the planes parallel to the coordinate axes whose intersection is the line or line segment.)

```
> plot0 := spacecurve([2*t,3*t,4*t],t=0..1,shading=none,color=red,thickness=3):
> display(plot0,axes=normal);
> plot1 := implicitplot3d(y=1.5*x,x=0..2,y=0..3,z=0..4,color=blue,shading=none):
> display({plot0,plot1},axes=normal);
> plot2 := implicitplot3d(z=2*x,x=0..2,y=0..3,z=0..4,color=green,shading=none):
> plot3 := implicitplot3d(z=4*y/3,x=0..2,y=0..3,z=0..4,color=yellow,shading=none):
> display({plot0,plot1,plot2,plot3},axes=normal);
```

At this time, make a hard-copy of your typed input and Maple's responses. Then, ...

3. a) Label by hand the positive  $x$ -,  $y$ -, and  $z$ -coordinate axes on the first graphic you drew in Task 1.
- b) On the graphic you created in part (b), label (by hand) each projection plane with its equation, and highlight (by hand) the line segment.

### **Comments**

In general, you can specify certain options *before* you draw a graphic or *after* you draw a graphic; in part (a) of Task 1, you specified the options *before* you drew the graphic, and in part (c) you selected the options *after* you drew the graphic. The importance of knowing how to specify options *after* you have drawn a graphic is that you will not always know how to specify the options you want *before* you draw a graphic; and at those times you will need to specify them interactively after you have drawn the graphic. Also, in future projects, although a default set of display options may at times specified, you may (depending on the hardware you're using) need to modify them to get an acceptable hard-copy.