Lab 6: Vector Functions in Two Dimensions

In Lab 2 we studied lines in two dimensions. These were defined as vector-valued functions. This lab continues that study.

Step 1

Copy the **/math235/notebooks/Lab6** notebook into your own **notebooks** subdirectory. Open the main cell of the notebook to see the section headings.

Step 2

Launch the *WriteNow* text processor. Insert your name and your lab partner's name at the top, change the heading to read **Lab 6: Vector Functions in Two Dimensions**, and change the section headings to **Graphs**, **The Velocity Vector**, and **Polar Coordinates**. Save your WriteNow file as **Lab6** in your **reports** subdirectory.

Step 3

Begin working through the notebook. Be sure to open all subcells, execute all *Mathematica* commands, and to work all exercises. You may wish to refer to the Appendix at the end of this Lab; it lists most of the *Mathematica* commands that you might need in the notebook.

After completing each section, write a description in your lab report of what you learned. Copy *Mathematica* commands and graphics from your notebook wherever needed.

Step 4

One of the objectives of these labs is to learn to discover mathematics on your own. This is easy to do with *Mathematica*. All you need is to experiment with variations of the given commands. For example, in the third section, you should be able to discover how the constants A and B affect the graph of the polar function r = A - B*Sin[t], and of how C being odd or even affects the graph of r = Cos[C*t]. And in the second section, you should be able to discover what the velocity vector tells you about the motion of the particle.

Another objective of these labs is to learn to express your own ideas in your own words. The WriteNow word processor, with its on-line Webster dictionary and thesaurus will help you to do this. Review the Lab 5 handout on these facilities.

Most of your attention should be devoted to these goals: discovering mathematics, and expressing yourself clearly in your report. Remember, you should write in a style that could be understood by an intelligent person who has not enjoyed the benefits of this course.

Step 5

Launch Mail and send your lab report to **math235**. Review the Lab 2 handout for more information on the NeXTmail faciility.[1]

Include a comment telling how much time you spent on this lab.

Appendix: *Mathematica* Commands

Here are some of the *Mathematica* commands that you might use in this lab:

`Clear["@*"]`	Deletes all definitions of variables that begin with a lower-case letter
`g[f_][a_,b_] = ParametricPlot[ f[t], {t,a,b} ]`	Defines **`g[f][a,b]`** to be the graph of the vector-valued function **`f`** over the interval **`[a,b]`**.
`PlotPoints -> 64`	Option to plot 64 points, instead of the default 15.
`Axes -> {0,0}`	Option to force the axes to be drawn in their standard positions through the origin (0,0).
`p[f_][t_] := Graphics[ Point[f[t]] ]`	Defines **`p[f][t]`** to be the point at **`f[t]`**.
`PointSize[.02]`	Sets the point size to be 0.02 as large as the picture.
`Text["x",f[t]+{0.1,0.2}]`	Prints the text "**`x`**" at the location **`f[t]+{0.1,0.2}`**.
`FontForm["x", "Plain", 10 ]`	Uses Plain font 10-point size[2] to print "x".
`TextForm[t]`	Converts the *value* of the variable **`t`** to text for printing.
`t[f_][a_,b_] := { g[f][a,b], Table[ p[f][t], {t,a,b} ]}`	Defines the trajectory of **`f`** on the interval **`[a,b]`** to be the graph of **`f`** together with a list of points.
`Table[ p[f][t], {t,a,b} ]`	Defines a list of points. For example, if **`a=0`** and **`b=2Pi`**, then this would be the list **`{p[f][0], p[f][1], p[f][2], p[f][3], p[f][4], p[f][5], p[f][6]}`**.
`f[t_] := { 1+t, 3+2t }`	Defines the function **`f`** to be the vector **`(1+t)i + (3+2t)j`**.
`Show[ t[f][-1,3] ]`	Displays the trajectory of **`f`** over the interval **`[-1,3].`**
`AspectRatio -> Automatic`	Option to force the scales on the axes to be the same.
`v[f_][t_] := Graphics[ Line[{f[t],f[t]+f'[t]}] ]`	Defines the velocity vector for the function **`f`** at time **`t`**.
`Line[{f[t],f[t]+f'[t]}]`	The line segment from **`f[t]`** to **`f[t]+f'[t].`**
`f[t_] := { r[t]Cos[t], r[t]Sin[t] }`	Defines **`f`** so that it has the same graph as the polar function **`r[t].`**

[1] Remember: your file will *not* be received unless its icon is in the Send window when you press the Deliver button.

[2] The default size is 12-point.