Fall 2012 - Math 241

MATLAB Assignment #1 - Due Oct. 4th

This project is very simple. Its goal is to introduce you to Matlab. For an introduction to Matlab, you can read the first two chapters of the recommended textbook *A guide to Matlab for beginners and experienced users.* You may also consult the brief introduction to Matlab posted on the class website.

Whenever you use a new Matlab command, you can learn about it by using the `help` command; *e.g.*, type `help cross` to learn about the `cross` command.

For informations about Matlab tutoring and computers location, go to the Math. Dept. undergraduate resources web page:
`http://www-math.umd.edu/undergraduate/resources.html`

You should hand in your printed output. One way to do that is to use the **diary** command to save your work: Type

```
>> diary project1
```

and Matlab will save all following outputs to a file called project1. Whenever you wish to stop saving, you may type

```
>> diary off
```

You should then edit the file project1 (with your favorite text editor) to include your name, the problem numbers, and the answers to any questions asked in the problems. Then print your file.

Basic operations with vectors. We can define the vectors $\vec{a} = (2, 4, -7)$ and $\vec{b} = (1, -1, 7)$ as follows:

```
>> a=[2 4 -7]
>> b=[1 -1 7]
```

The components of the vector $\vec{a}$ can be extracted as `a(1)`, `a(2)`, `a(3)`. You can now do all basic operations with Matlab. For instance `2*a-b` will return the vector $2\vec{a} - \vec{b}$. The dot product, cross product and norm can be computed as follows:

```
>> dot(a,b)
>> c=cross(a,b)
>> norm(c)
```

Problem 1. *Use appropriate Matlab commands to do the following:*

(a) Find a unit vector in the direction of $(1,\ -3,\ 5)$.

(b) Let $P_0 = (1, 0, 2)$, $P_1 = (2, 1, 2)$ *and* $P_2 = (1, 3, 0)$, *and denote by* $\mathcal{P}$ *the plane through the points* P_0, P_1 *and* P_2. *Find a vector* $\vec{N}$ *normal to* $\mathcal{P}$.

(c) Find the distance from the point $P = (1,\ 2,\ 3)$ *to the line* ℓ *passing through the points* $P_1 = (1,\ 4,\ 7)$ *and* $P_2 = (-1,\ 3,\ 6)$.

(d) Find an equation of the plane which contains the line

$$\frac{x-2}{4} = \frac{y-3}{5} = \frac{z+2}{3}$$

and the point $(0, -2, -1)$.

(e) Find the area of the triangle with vertices $(3, 1, 0)$, $(1, 2, 3)$ *and* $(0, -1, -2)$.

Formal computations. It is also possible to do formal computations with Matlab. For instance we can check that $\vec{a} \cdot (\vec{a} \times \vec{b}) = 0$ for any vectors easily. First we need to define $\vec{a}$ and $\vec{b}$ with symbolic real components:

```
>> syms a1 a2 a3 b1 b2 b3 real
>> a=[a1 a2 a3]
>> b=[b1 b2 b3]
```

(the use of `real` in the first line is important. Otherwise, Matlab assume that these are complex numbers). Now, try computing $\vec{a} \cdot (\vec{a} \times \vec{b})$ with Matlab. The result should be 0. However, sometimes, Matlab does not simplify the result. If the result is not zero, try the following:

```
>> dot(a,cross(a,b))
>> simplify (ans)
```

and you should find zero (the command `ans` recalls the most recent answer).

Problem 2. *Proceed as above to check Jacobi's identity for the cross product:*

$$\vec{a} \times (\vec{b} \times \vec{c}) + \vec{b} \times (\vec{c} \times \vec{a}) + \vec{c} \times (\vec{a} \times \vec{b}) = \vec{0}$$

for all vectors $\vec{a}$, $\vec{b}$, $\vec{c}$.

Plotting curves in 3 dimension. The command `ezplot3` can be used to plot parametric curve. For instance, the curve parametrized by

$$\vec{r}(t) = t \sin t \vec{i} + \cos(2t)\vec{j} + 3t\vec{k}, \quad 0 \leq t \leq 2\pi$$

can be plotted with the command

```
>> ezplot3('t*sin(t)','cos(2*t)','3*t',[0,2*pi])
```

Note that Matlab produces the figure in a different window. For any problem requiring a graph, go to the window to save/print your picture file separately. You can use the `title` command to title your graphs (or you can select **Axis properties...** in the **Edit** menu of the figure window).

If $P = (1, 2, -1)$ and $\vec{L} = (2, 1, 4)$, then we can get the vector equation for the line through P with direction $\vec{L}$ as follows:

```
>> P=[1 2 -1];
>> L=[2,1,4];
>> syms t
>> line = P + t*L
```

(note the use of the **semicolon** to suppress the output. Use it whenever possible to reduce the length of your printout). We can then plot the line as

```
>> ezplot3(line(1), line(2), line(3),[-2,2])
```

(`[-2,2]` is optional. It indicates that you want to plot the line for $-2 \leq t \leq 2$). Now, try

```
>> ezplot3(line(1), line(2), line(3),[-2,2])
>> hold on
>> plot3(1,2,-1,'o')
>> quiver3(1,2,-1,2,1,4)
>> hold off
```

The command `hold on` retains the current graph so we can add subsequent graphs to it (by default Matlab clears the current graph when you make subsequent calls to plotting functions). The `plot3` command plots the point $(1, 2, -1)$. The `quiver3` command plots the vector $(2, 1, 4)$ anchored at (1,2,-1).

Problem 3

(a) Use `ezplot3` *to draw the curve parametrized by*

$$\vec{r}(t) = \left(\left(2 + \cos\left(\frac{3t}{2}\right)\right)\cos(t), \left(2 + \cos\left(\frac{3t}{2}\right)\right)\sin(t), \sin\left(\frac{3t}{2}\right)\right)$$

for t in $[0, 4\pi]$. Once you've created the picture, you can go to the window that has the figure and use the tools to rotate the graph to view it from different angles. Find a view you like to print out.

(b) Find the vector equation of the line passing through the points $P = (2, 0, 3)$ and $Q = (3, -2, 1)$ (use Matlab as much as possible). On the same graph, plot this line and the points P and Q.