Calculus III - Math 2210
Mathematica Commands

1. The Mathematics computer lab is located in Bldg 4, Rm 505. All computers in this lab have Mathematica 5 installed. Other computer labs should have access to this software. Edit your document (remove extras and errors, ensure the rest works correctly) and turn in your print-out as your 2nd computer homework.

2. We will use the package for vector calculus. Input the following. **Input the statements in `True Type` font exactly as is**!

   `` <<Calculus`VectorAnalysis` `` There are no blank spaces. The first two symbols are less than signs and the symbol ` is on the same key with ∼ and is usually on the far left side next to the key for the number 1.

   You may input the mathematics as below or in a more standard form using palettes. A basic palette is usually present on the top right hand side of the screen. (If it is not, you can get it by clicking consecutively on the buttons Files, Palettes, and BasicInput.

3. Braces, { }, signal a "list" to Mathematica. A list can be used to represent a set, an interval, a table of data, the parameters in a command, a vector, etc. Now try the following.

   (a) `u={1,-3,5}` This is the vector $\vec{u} = \langle 1,\, -3,\, 5 \rangle$.

   (b) `v={-2,4,-1}` This is the vector $\vec{v} = \langle -2,\, 4,\, -1 \rangle$.

   (c) `DotProduct[u,v]` This is $\vec{u} \cdot \vec{v}$.

   (d) `CrossProduct[u,v]` This is $\vec{u} \times \vec{v}$.

4. Mathematica can be used to perform change of coordinates. Input the following.

   (a) `CoordinatesToCartesian[{1, Pi/2, Pi/4},Spherical]` This convert the point $(1,\, \pi/2,\, \pi/4)$ given in spherical coordinates to cartesian coordinates.

   (b) `CoordinatesToCartesian[{1, Pi/6, 5},Cylindrical]` This convert the point $(1,\, \pi/6,\, 5)$ given in cylindrical coordinates to cartesian coordinates.

   (c) `CoordinatesFromCartesian[{-2, 3, 5}, Spherical]` This convert the point $(-2,\, 3,\, 5)$ given in cartesian coordinates to spherical coordinates.

5. Plots in space, contour plots and vector fields. Input the following.

   (a) `f[x_,y_]:=Sin[x y]` This is the function $f(x, y) = \sin(x\,y)$.

   (b) `Plot3D[f[x,y],{x,-2,2},{y,-2,2}]` This gives the plot of $z = f(x, y)$ on the domain $[-2, 2] \times [-2, 2]$.

   (c) `ContourPlot[f[x,y],{x,-2,2},{y,-2,2},ContourShading->False]` This is the contour plot of $z = f(x, y)$ on the domain $[-2, 2] \times [-2, 2]$.

   (d) `g[t_]:={Sin[t],2 Cos[t],0.5 t}` This is the space curve $f(t) = \sin t\,\vec{i} + 2\cos t\,\vec{j} + 0.5t\,\vec{k}$.

   (e) `ParametricPlot3D[g[t],{t,0,4Pi}]` This gives the graph of our curve which is a Helix.

   (f) `h[u_,v_]:={u Sin[v],2 u Cos[v],Sqrt[1-u^2]}` This is the parametric surface $h(u, v) = u\sin v\,\vec{i} + 2u\sin v\,\vec{j} + \sqrt{1-u^2}\,\vec{k}$.

   (g) `ParametricPlot3D[h[u,v],{u,0,1},{v,0,2Pi}]` This gives the graph of our surface which is the top half of an ellipsoid.

   (h) `<<Graphics`PlotField`` This enables the package for plotting vector fields.
   ```
   k[x_,y_]:={-y/(x^2+y^2+1),x/(x^2+y^2+1)}
   PlotVectorField[k[x,y],{x, -2, 2}, {y, -2, 2}]
   ```

   (i) `<<Graphics`PlotField3D`` This enables the package for plotting vector fields.
   ```
   l[x_,y_,z_]:={y,-x,z^2}
   PlotVectorField3D[l[x,y,z],{x, -2, 2}, {y, -2, 2},{z,-1,2},
                                          VectorHeads->True]
   ```

6. Partial derivatives, Gradient, Curl and Divergence. Input the following.

   (a) `f[x_,y_,z_]:=x E^(y)z^2 - Cos[x+z^3]` This is the function $f(x, y, z) = xe^y z^2 - \cos(x + z^3)$.

   (b) `D[f[x,y,z],{x,1},{z,2}]` This is $\frac{\partial^3 f}{\partial x \partial z^2}$.

   (c) `Grad[f[x,y,z],Cartesian[x, y, z]]` This finds the gradient of f which was given in the cartesian coordinate system.

   (d) `g[x_,y_,z_]:={x y z, y z, x z}` This is the vector field $g(x, y, z) = xyz\vec{i} + yz\vec{j} + xz\vec{k}$.

   (e) `Curl[g[x,y,z],Cartesian[x,y,z]]` This gives the curl of g which was given in the cartesian coordinate system.

   (f) `Div[g[x,y,z],Cartesian[x,y,z]]` This gives the divergence of g which was given in the cartesian coordinate system.

7. Integration. Input the following.

   (a) `Integrate[ x^2 + y^2, {x, 0, 1}, {y, 0, x} ]` This is the double iterated integral $\int_0^1 \int_0^x (x^2 + y^2) dy\, dx$.

   (b) `f[x_,y_,z_]:=x^2+y^2-z`

   (c) `Integrate[ f[r Cos[t],r Sin[t],z] r, {r, 0, 1}, {t, 0, Pi/2},{z,0,2} ]` This finds the triple integral $\iiint_E f\, dV$ where the solid E is the part of the cylinder $x^2 + y^2 = 1$ in the first octant between $z = 0$ and $z = 2$ done in cylindrical coordinates.

   (d) `Integrate[ x^2 + y^2 z, {x, 0, 1}, {y, 0, x},{z,0,1-x y} ]` This is the triple iterated integral $\int_0^1 \int_0^x \int_0^{1-xy} (x^2 + y^2 z) dy\, dx\, dz$.

8. It is essential, both as a courtesy to future users, and to continued problem-free usage, to leave the computers as you find them. When you are done, close the software being used and/or log off properly.