Mathematica Project 6: due May, 6th by 10 am!
Multivariate Calculus, MTH 212, Spring 2019

Note: late projects will not be accepted.

Use the text input mode to start your Mathematica notebook with your name and project number. Your project should be well-organized and clear to read; make sure all the exercises are clearly labeled and all questions answered. (Failure to follow these directions will result in lost points.) Make sure that you get all your Mathematica input (functions, formulas, commands you use to answer questions) and the required output (evaluate all the necessary cells to produce/display your results, plots, etc.). Bring your project printout to class on 5/1/19. (Please staple it!)

1. Working with the solid E bounded by $z = 0$, $z = 5y$ and $x^2 = 36 - y$, use Mathematica to:

   (a) graph the solid E (you can use both *ContourPlot3D* and *RegionPlot3D*);

   (b) set up and evaluate at least three triple integrals in Cartesian coordinates using different order of integration each time to find the volume of E. (Make sure you get the same value every time!)

2. Find the centroid of the solid bounded below by the xy-plane, on the sides by the sphere $\rho = 2$, and above by the cone $\phi = \pi/3$ (you can find the picture of the solid in Exercise 38 on page 805 in your text). Use Mathematica to do all the computations (you need integrals for the first moments and the mass (do not forget to use the symmetry), and graph the surfaces bounding the region using *SphericalPlot3D* and/or *ParametricPlot3D*, together with the centroid (make it big enough to be seen - you can graph it as a small ball). Use "Opacity" option to make the surfaces transparent enough so that the centroid can be seen.

3. Consider two fields $\mathbf{F}_1 = x\mathbf{i} + y\mathbf{j}$ and $\mathbf{F}_2 = -y\mathbf{i} + x\mathbf{j}$ and two curves: the circle $\mathbf{r}_1(t) = (\cos t)\mathbf{i} + (\sin t)\mathbf{j}$ and the ellipse $\mathbf{r}_2(t) = (\cos t)\mathbf{i} + (4\sin t)\mathbf{j}$ $(0 \le t \le 2\pi)$.

Use Mathematica to draw four pictures showing all possible combinations of a vector field with a curve, and for each picture use Mathematica to compute the circulation and the flux. Label your pictures and show your work clearly.

4. For the portion of the cone $z = \dfrac{\sqrt{x^2 + y^2}}{3}$ between the planes $z = 1$ and $z = 4/3$, use Mathematica to:

   (a) graph the described surface using *ContourPlot3D*;

   (b) graph the described surface using *ParametricPlot3D* (for this, you need to choose a parameterization of the surface first);

   (c) BONUS! - evaluate the integral for the area of the surface.