Calculus 3, Fall 2025
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Matlab Project 1

Due on Friday October 24, 2025

Instructions. Use Matlab to solve the problems below. In the problems below, a is the last nonzero digit of the phone number you listed on your student record and b is the second to last nonzero digit of your phone number. For example, if your phone number is 256-0307 then $a = 7$ and $b = 3$.

You should copy all the Matlab commands as well as the answers and figures which you obtained when executing the commands, into a text file (you can use Microsoft Word or any other text editor). You can add your comments and any sketches you may want to enclose (by hand or in an electronic format). In particular, for problems 3 and 5 and, possibly, parts of 4 **you should turn in all your (non-Matlab) work**. For problem 5, you need to demonstrate how you obtained the bounds of integration and the function you integrated. Presenting only the final Matlab command that evaluates certain integral is not full credit even if the command is correct.

To insert a figure into a text file, you can choose the format in which you want to save the figure file (go to the "File" menu of the figure, choose "Save as", and then select the location, file name and file type, for example png). You can import the figure into the word file using "Insert Image".

When your file contains all the answers and figures, print the file and bring the printout and the by-hand work to our class on the due date listed above.

1. Using dot and cross products, determine whether the given planes are parallel, perpendicular or neither.
   (a) $5x + ay - 5z = 3$ and $bx + 4y - 6z = 7$
   (b) $x + 4y - 3az = 2$ and $-3x - 12y + 9az = 11$
   (c) $ax + 4ay - 7az = -13$ and $-x + 2y + z = 5$
2. Let $z = ay^3 e^{bxy^2 + x^3 y}$. Find the following partial derivatives: z_x, z_y, z_{yyx}, z_{xxy}, and z_{yyxyx}.
3. Let $f(x, y, z) = xy + 2xz + 2yz$.
   (a) Write down a set of equations for computing the values of x, y and z that minimize $f(x, y, z)$ subject to the constraint $xyz = 4000a^3$.
   (b) Find the values of x, y and z that minimize $f(x, y, z)$ subject to the given constraint. You can use Matlab to find the critical point. Then demonstrate (with or without Matlab) that the critical point you obtain is really a minimum, not a maximum of the objective. Make your final conclusion about the x, y and z values.
4. Graph the following objects.
   (a) The paraboloid $z = a^2 - b^2x^2 - b^2y^2$ for $-\frac{a}{b} \leq x \leq \frac{a}{b}$ and $-\frac{a}{b} \leq y \leq \frac{a}{b}$.
   (b) The cylinder $x^2 + y^2 = \frac{a}{2b}$ for $0 \leq z \leq a^2$. You need to represent this cylinder using parametric equations before you can graph it.
   (c) The intersection of the paraboloid from part (a) and the cylinder from part (b). You need to represent this intersection using parametric equations before you can graph it. For the choice of the command to use, consider whether this intersection is a curve or a surface.
5. Consider the region below the cone $z = 2a - \sqrt{x^2 + y^2}$, above the xy-plane, and inside the cylinder $x^2 + y^2 = a^2$.
   (a) Set up a double integral computing the volume of this region. Use polar coordinates if necessary. Then evaluate the integral using Matlab.
   (b) Using **hold on** and **hold off** commands and *parametric equations* of the two given surfaces, graph the *boundary* of the region whose volume you computed in part (a).