WPR II Topics

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1. Functions of Several Variables & Estimations

   - What are the three rules for finding the domains of these functions?
   - Understand how to work with these functions whether given as $f(x, y)$, in a table of values, or in a contour plot (i.e. level curves).
   - Understand how to estimate net volumes using functions of two variables, given in all of the 3 types above. (How: find volumes of "bricks". The heights of the bricks are given by the function value at some sample point in your sub-rectangle.) Refine your estimates in Mathematica.
   - Understand how to over/under-estimate the net volume.

2. Double Integration (**Big** topic!!)

   - Understand how we defined the double integral symbol (Lesson 23) (i.e. as the limit of the estimation process in the previous section).
   - What does the symbol $\int\int_R f(x, y)\, dA$ mean geometrically?
   - Know how to compute iterated integrals *by hand* by moving from the "inside-out." (This goes for all types of regions.)
   - Fubini's Theorem (i.e. how to switch the order of integration when integrating over a rectangle).
   - Integration over general regions, including how to switch the order of integration. (**Always** draw a picture of the base region!)
   - Know how to use double integrals to compute the mass and center of mass of a thin plate (lamina). Remember, it takes three double integrals to compute the center of mass.
   - Integration over polar regions. Recognize when you may need to use this and how to execute the switch from rectangular to polar integrals.
   - Physical quantities and double integration: remember that if you double integrate any type of density function (any mass per area) over a region, you are computing the total amount of mass in that region. (e.g. total population for population density, total charge for charge density, total mass for mass density...)

3. Parametric Equations, Vector Functions, Arc Length, and Motion in Space

   - Be comfortable with parametric equations and vector functions given in 3 different forms: $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$ notation, bracket notation, or as $x =$, $y =$, $z =$.
   - Understand what a parametric curve is and how to sketch one (by hand and with Mathematica). Know how to find where it starts, stops, what direction it travels, etc.
   - Know how to differentiate and integrate vector functions. This includes solving for constants C in indefinite integrals.
   - Know how to compute the length of a parametric curve, or the total distance traveled by a particle. (i.e. arc length)

- Know the relationships between all of the following: position, velocity, speed, and acceleration. Also, know how to find one given any of the others.
- Understand the derivation for the equations of projectile motion in 2 dimensions.
- Be able to solve projectile motion problems like the ones we did in class and in the do problems. You may have to find any of the following: angle, initial position, initial speed, time, where it lands, ... (and more!)

4. Mathematica: Things we discussed

- Double integrals in Mathematica (including `NIntegrate` if necessary)
- Plotting:
  - Functions of two variables
  - Parametric curves in $2D$
  - Parametric curves in $3D$ (space curves)
- Vector functions in Mathematica (and how to integrate them)
- Arc length
- Solve command (primarily for projectile problems)