A List of Topics for the Final

Here's what you should be able to do for the final exam.
Really Old Stuff

1. Riemann sums

   (a) Compute L_n, R_n, and M_n estimates for areas under curves.

   (b) Write the (exact) area under a curve as a limit of Riemann sums and (for certain curves) evaluate that limit.

   (c) Recognize such a limit, convert it to an integral, and compute it.

2. Integration

   (a) Find antiderivatives of certain elementary functions including polynomials, exponential functions, and certain trigonometric functions.

   (b) Use u-substitution to evaluate more challenging integrals.

   (c) Compute indefinite integrals and definite integrals.

   (d) Evaluate integrals of odd or even functions on intervals of the form $[-a, a]$.

   (e) Use the fundamental theorem of calculus to differentiate functions that are defined in terms of integrals.

3. Applications

   (a) Given velocity or acceleration, compute the net displacement of an object over a time interval *or* compute its total distance traveled.

   (b) Find the area bounded by two or more curves in the plane.

   (c) Compute the volumes of solids by integrating their cross-sectional areas.

   (d) In particular, use the washer method for finding volumes of solids of revolution by integrating along the axis of rotation.

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4. More applications

   (a) Find volumes of solids of revolution using the shell method.

   (b) Compute the work required to perform certain tasks.

   (c) Find the average value of a function over an interval.

5. More integration techniques

   (a) Understand how to use trigonometric identities to compute integrals of the forms $\int \sin^m(x) \cos^n(x)\, dx$ or $\int \tan^m(x) \sec^n(x)\, dx$.

   (b) Know how and when to use the following techniques:
   - Integration by parts
   - Trigonometric substitution
   - Integration with partial fractions

6. Integral approximation

   (a) Approximate integrals with the trapezoid rule or Simpson's rule.
   (b) Know when L_n, R_n, M_n, or T_n are underestimates or overestimates.

7. Improper integrals

   (a) Evaluate type-1 and type-2 improper integrals.
   (b) Use integral comparison to tell whether certain integrals converge or diverge, even when their integrands are hard to antidifferentiate explicitly.

New Stuff

8. Arc length

   (a) Set up an integral to compute the arc length of a curve on some interval.
   (b) Approximate that integral if it's too hard to compute explicitly.

9. Center of mass

   (a) Compute moments around the x- and y-axes for shapes of uniform density.
   (b) Find the center of mass of such a shape.
   (c) Compute the centroid of a region.

10. Differential equations

   (a) Solve separable differential equations given initial conditions.
   (b) Set up differential equations for word problems, such as those involving mixing.