This Final Exam Overview and Review serves three purposes:

- To provide an overview of the format of the final exam.
- To provide a detailed list[1] of topics you are expected to know on the material covered after Midterm 2.
- To provide some practice problems to aid your studying.

Exam Format

(I) The final exam is designed to be taken in no more than 2 hours. However, as the scheduled time slot is three hours, you may take as long as you need (within that three hours).

(II) Calculators are **not permitted** for use during the exam.

(III) The exam is **closed book**: notes, textbooks, computers, mobile devices, listening devices are **not permitted** for use during the exam.

(IV) There will be five to six problems on the final exam. Approximately 80% of the exam will be on new material covered after Midterm 2. Approximately 20% of the exam will be on material prior to Midterm 2.

(V) There will be one problem consisting of several True/False subproblems.

(VI) There will be one short-answer problem consisting of several short, computational subproblems.

(VII) There will be three long-answer problems. Each long-answer problem may have multiple parts.

Outline of Topics to Know (together with those for Midterms 1 and 2)

Theory

Definitions/Concepts/Results

You should know all definitions/concepts/results from lecture (and used in homework) precisely, including of the theorems, propositions and corollaries we've covered. If I've given a proof of something in class, you should know it (or have a thorough understanding of the details). Here is a list of concepts/definitions/results we've seen since the previous midterm:

1. For a suitably differentiable function f, the quadratic approximation $Q(x,y)$ about a point (x_0, y_0) (this includes knowing the local linearization $L(x,y)$).
2. Higher order partial derivatives and Clairaut's Theorem on the equality of mixed partial derivatives
3. The first derivative test which says that local extrema happen at stationary points.
4. The second derivative test to classify stationary points
5. You should understand the concept of the double integral of a function of two variables as the limit of Riemann sums.
6. Fubini's theorem on changing the order of integration for rectangular regions
7. Conceptually, you should understand the definition of the double integral over non-rectangular regions
8. You should understand the concept of the triple integral of a function of three variables as the limit of Riemann sums over a three-dimensional region.
9. You should understand the approach to computing multiple integrals using iterated integration, and the underlying geometry.
10. Polar coordinates and integration in polar coordinates.

[1] You should include this list together with the analogous lists provided for the midterms as you study for the final exam.

Computation

In general, you should know how to work problems connected to each key concept discussed in the previous section. As I said before, if you understand all of the lecture material and all of the homework (both the "turn in" and "do not turn in" problems), are able to work quickly and efficiently, you should perform well on the exam. Here is an incomplete list of things we have done since Midterm 2:

1. Given a sufficiently differentiable function $f(x, y)$, you should know how to find the quadratic approximation $Q(x, y)$ (and the local linearization $L(x, y)$) about a point (x_0, y_0)
2. You should know how to use the quadratic approximation and local linearization to approximate the values of a sufficiently differentiable function near the basepoint (x_0, y_0).
3. For relatively simple functions, including polynomial, rational, transcendental, trigonometric and compositions thereof, you should know how to compute first and higher-order partial derivatives.
4. You should know how to find and classify (as local min/local max or saddle points) stationary points of a twice (continuously) differentiable function f.
5. You should know how to compute double integrals over rectangles using Fubini's theorem.
6. You should know how to compute double integrals over non-rectangular regions (and be able to reverse the order of integration).
7. You should know how to compute triple integrals for certain regions S in $\mathbb{R}^3$.
8. You should know how to compute double integrals in polar coordinates.

Practice Problems (over new material)

1. Exercises 3, 5, 7, 9 11 and 23 in Section 13.6
2. Exercises 9, 15, 17, 43, 67 and 77 in the review exercises for Chapter 13
3. Exercises 1, 11, 27 and 29 in Section 14.1
4. Exercises 1-29 odd in Section 14.2
5. Exercises 9, 11, 17, 21, 29, 31, 33, 37, 39 and 41 in Section 14.3
6. Exercises 9, 11, 13, 25 and 38 in Section 14.4 (For 38, notice that this can be written as the volume between two graphs, $z = f_1(x, y) = -\sqrt{R^2 - x^2 - y^2}$ and $z = f_2(x, y) = \sqrt{R^2 - x^2 - y^2}$.)
7. Exercises 1, 3, 7, in Section 14.5
8. Exercises 1, 3, 13, 20, 23, 28, 31, 37, 47 in the review exercises for Chapter 14