The first exam will be Friday, April 29. It will cover Chapter 13 as well as sections 14.4, 14.6, and 16.1. Most of the exam questions will be very similar to exercises from the homework. Some good review exercises (from the chapter review exercises) are listed below.

p. 898-899 # 1, 2, 5, 8, 10, 11 (yes, it gets messy…), 13, 16, 17, 18
p. 992-993 # 25, 31, 33, 43, 45, 47, 49

I’d also suggest looking at some of the graph matching problems from p. 870 and p. 1085-1086. Make sure that you can do these without needing to use a computer.

In addition, at least one of the following questions will be on the exam:

1. Show that if \( \mathbf{r}(t) \) is a vector function and \( |\mathbf{r}(t)| = c \) (where \( c \) is a constant) for all \( t \), then \( \mathbf{r}'(t) \) is orthogonal to \( \mathbf{r}(t) \) for all \( t \).

2. Suppose \( f \) is a function of two variables with continuous partial derivatives. Explain in as much detail as possible why an equation for the tangent plane to the surface \( z = f(x, y) \) at the point \( (x_0, y_0, z_o) \) is given by \( z - z_0 = f_x(x_0, y_0)(x-x_0) + f_y(x_0, y_0)(y-y_0) \).

3. State the definition of the directional derivative of a function \( f(x, y) \) at a point \( (x_0, y_0) \) in the direction of a unit vector \( \mathbf{u} \). What does the directional derivative mean geometrically? The formula given in the definition is extremely difficult to use in practice. Give a simpler formula (a theorem) that is typically used in practice to actually compute a directional derivative.

4. a. State the definition of the gradient of a function \( f(x, y) \) at a point \( (x_0, y_0) \).

b. Let \( f \) be a function of 2 variables that is differentiable at \( (x_0, y_0) \). Prove that
   a. the largest value of \( D_u f(x_0, y_0) \) for any unit vector \( \mathbf{u} \) is \( |\nabla f(x_0, y_0)| \)
   b. if \( \nabla f(x_0, y_0) \neq 0 \), then direction in which \( f \) increases most rapidly at the point \( (x_0, y_0) \) is given by \( \nabla f(x_0, y_0) \).