Outline for Exam 1

The exam will cover sections 10.4, 10.5 and 12.1-12.8. The topics by section are

**10.4** Cross products and determinants. Algebraic and geometric aspects of the cross product. 2 × 2 determinants, the cross product and the area of a parallelogram. 3 × 3 determinants, the box product and the volume of a parallelepiped.

**10.5** Planes in space. The plane through three points. The plane through a point with normal vector \( \vec{n} \).

**12.1** Functions of several variables. Graphs of functions of two variables. Level curves and level surfaces.

**12.2** Limits and continuity for functions of several variables. Functions taking different values as \((x, y) \to (x_0, y_0)\) along different paths.


**12.4** The chain rule. Computing first and second-order derivatives of functions of the form \( z(t) = f(x(t), y(t)) \), \( z(s, t) = f(x(s, t), y(s, t)) \) etc. Implicit differentiation and the chain rule.

**12.5** The gradient. Directional derivatives and the gradient. The direction and rate of steepest ascent. The gradient as a normal vector to a level surface or level curve.

**12.6** Tangent planes, differentials and the Principle of Linear Approximation (PLA). Using the differential to estimate the change in the value of a function.

**12.7** Local extrema and saddle points. Critical points. The second derivative test for functions of two variables.

**12.8** Constrained optimization. The method of Lagrange multipliers.