Outline for the Final Exam

***10.1** Points in $\mathbf{R}^3$. The distance formula in $\mathbf{R}^3$. Sets in $\mathbf{R}^3$ defined by systems of equations or inequalities. The equation of a sphere with given radius and center.

***10.2** Scalars and vectors. Initial and terminal points, magnitudes of vectors, Vectors in component form. Vector addition, scalar multiplication and magnitudes of vectors in component form. The zero vector. The negative of a vector. Graphical vector algebra. Drawing resultant vectors and scalar multiples of vectors. Unit vectors. The standard unit vectors $\vec{\imath}$, $\vec{\jmath}$ and $\vec{k}$. Finding the unit vector with a given direction. Writing vectors in the form (magnitude) $\times$ (direction).

***10.3** The dot product. The algebraic and geometric definitions of the dot product. Using the dot product to compute the angle between vectors. Orthogonal vectors. Projections and components.

***10.4** The cross product. The geometric definition of the cross product. Determinants. Using the determinant to compute the cross product. Applications of cross prodcuts: Finding orthogonal vectors orthogonal to a plane, computing areas of parallelograms and volumes of parallelpipeds.

10.5 Planes in $\mathbf{R}^3$. Finding the equation of the plane through a given point normal to a given vector. Finding the equation of a plane through three points. Finding the equation of the plane through a given vector, parallel to a given plane.

11.1-11.3 Vector-valued functions. Motion in space and on the plane. Position, velocity, speed and acceleration. Projectile motion. The arc length integral.

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

12.3 Partial derviatives. Calculation of first and higher-order partial derivatives. Computing first partial derivatives of implicitly defined functions. Equality of certain mixed partials, e.g. $f_{xy} = f_{yx}$, $f_{zzx} = f_{zxz} = f_{xzz}$, etc.

12.4 The multivariable chain rule. Tree diagrams, applications of the chain rule. Computing higher derivatives with the chain rule.

12.5 The gradient. Properties of the gradient. Directional derivatives, the direction of most rapid increase, the normal vector to a surface.

12.6 Linear approximation. The tangent plane. The linear approximation to a function at a given point. The total differential of a function.

12.7 Local extrema, critical points, the second derivative test.

12.8 Constrained optimization. The method of Lagrange multipliers.

13.1-13.3 The double integral over a rectangular and nonrectangular regions. Iterated integrals over rectangles and regions bounded by curves. Fubini's theorem. Changing the order of integration. Finding area and volume by double integration.

13.4 Double integrals in polar coordinates.

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* Knowledge of this material will be assumed, but you won't be tested *explicitly* over it.

13.5, 13.6 Triple integrals. Triple integrals over boxes and more general regions. Iterated integrals over boxes. Iterated integrals over regions bounded by surfaces. Fubini's theorem. Changing the order of integration. Applications of the triple integral: Volume and mass.

13.7 Triple integrals in cylindrical and spherical coordinates.

14.2 Vector fields. Line integrals of vector fields. Work and circulation. Gradient vector fields.

14.3 The component test for gradient vector fields. Finding the potential of a gradient vector field. The fundamental theorem of line integration. Line integrals of gradient fields over closed curves. Path-independence and conservative vector fields. Exact differential forms. The equivalence of gradient and conservative fields, path-independent integrals and exact differential forms.

14.4 Green's theorem. Using Green's theorem to convert line integrals to double integrals and vice-versa.

14.5, 14.6 Surface area. Surface integrals and the the flux of a vector field.

14.7 Stokes' theorem.

14.8 The divergence theorem.