Dr. Noble's Checklist
for MA104 Term End Exam
Spring, 2006

Block I: Numerical and Graphical Approximations of solutions of Differential Equations

- ☐ Know that Euler's Method is a numerical approximation to a solution to a differential equation
- ☐ Use Euler's Method by hand and in Excel
- ☐ Plot slope fields (simple ones) in Mathematica
- ☐ Use a slope fields to find a graphical solution to a differential equations
- ☐ Given a slope field know how to find equilibrium solutions; know how changing the initial condition change the solution; know what happens to the solution over time, etc.
- ☐ Given a differential equation know how to find equilibrium solutions
- ☐ Write a differential equation from an English description (e.g., the rumor problem from PS 1, the population problem from WPR I)
- ☐ Know what it means for two quantities to be *proportional*

Block II: Continuity and Derivatives of Single Variable Functions

- ☐ Have conceptual understanding of the idea of limit ("lim"), including right hand limits and left hand limits
- ☐ Know what it means for a function to be continuous at a point;
  know how that relates to the limit of the function at that point
- ☐ Understand derivative
  1. graphically (limit of the slope of secant lines; slope of the tangent line)
  2. algebraically (limit of the difference quotient)
  3. physically (limit of average rates of change; instantaneous rate of change)
- ☐ Be able to estimate derivatives given discrete data (i.e., data from a table instead of a function or graph)
- ☐ Understand the relationship between the graph of a function and the first derivative. (What does the first derivative tell you about the function?)
- ☐ Understand the relationship between the graph of a function and the second derivative. (What does the second derivative tell you about the function?)
- ☐ Given a graph of a function, sketch its derivative.
  Given the graph of a derivative, sketch a possible function.
  (Given the graph of a function, sketch its second derivative.)

- ☐ Know the derivatives of the basic functions and how to calculate them in Mathematica
- ☐ Know the Product, Quotient, and Chain Rules
- ☐ Given a function and a point on its graph, find the equation of the line tangent to the graph at that point
- ☐ Intermediate Value Theorem (Section 2.4)
- ☐ Word Problems
    1. Related Rates
    2. Max/Min and Optimization (Sections 4.2 and 4.6)
        - Critical Values,
        - Local Max/Min; Absolute Max/Min
        - Extreme Value Theorem
        - First Derivative Test; Second Derivative Test

Block III: Vectors, Lines, and Planes in 3-dimensions

- ☐ Know the difference between a vector function and a parametric equation
- ☐ Plot parametric functions and vector functions in Mathematica
- ☐ Determine whether objects with paths described by parametric or vector equations will collide or intersect
    - Be able to solve systems of equations by hand and in Mathematica
- ☐ Calculate distances between objects in 3-D
- ☐ Calculate the length of a vector
- ☐ Given a vector, calculate its unit vector
- ☐ Know the definition of dot product; calculate it by hand and in Mathematica
- ☐ Know the definition of cross product and how to calculate it in Mathematica
- ☐ Know how to tell if two vectors are parallel, orthogonal, or neither
- ☐ Know how to find an equation of a line in 3-D
- ☐ Know how to find an equation of a plane in 3-D
- ☐ Know how to figure out where a line intersects a plane
- ☐ Projections
    - project one vector onto another
    - project a point onto a plane

- ☐ Know how to find derivatives of vector functions
- ☐ Find $\mathbf{r}(t)$ (position vector) given $\mathbf{a}(t)$ (acceleration vector) and $\mathbf{v}(0)$ and $\mathbf{r}(0)$ (i.e., understand how to find an antiderivative)
- ☐ Word Problems
  - Projectile motion
  - Force problems (like Sec 9.2 # 28)

Block IV: Multivariable Functions: Directional Derivatives, Partial Derivatives, Optimization

- ☐ Know how to find the domain of a multivariable function
- ☐ Understand partial derivatives
  1. graphically (limit of the slope of secant lines drawn perpendicular to one axis; slope of the line tangent to the graph and perpendicular to one axis)
  2. algebraically (definition of partial derivative)
  3. physically (limit of average rates of change with one variable held constant; instantaneous rate of change with one variable held constant)
- ☐ Be able to estimate partial derivatives given discrete data (i.e., data from a table instead of a function or graph)
- ☐ Directional derivatives
- ☐ Know the relationship between directional derivatives and partial derivatives
- ☐ Gradients
  - are the direction of the greatest rate of change (direction of max slope)
  - are normal (perpendicular/orthogonal) to contour lines (aka level curves); are normal to level surfaces
  - length of gradient is the maximum slope
- ☐ Know the geometric interpretation of Lagrange Multipliers
- ☐ Word Problems
  - Use the second derivative test to find all critical points, relative max/min, and saddle points for functions of two variables
  - Optimization by using the constraint to reduce the problem to a one or two variable optimization problem
  - Optimization using the method of Lagrange Multipliers
- ☐ Multivariable Chain Rule is NOT on the test. (Know the Chain Rule for single variable functions only.)