Fall 2016 Math 138 Topics for the exam

Preliminaries about functions. Know:

- ➢ Formal definition of a function.
- ➢ Formal definitions of injection, surjection and bijection; important examples of bijections and definitions of the important inverse functions (relevant material posted on September 26 and September 27)
- ➢ The definition of the composition of functions and have understanding of the website post on September 29 related to this definition

Limits, continuity Know:

- ➢ The formal definition of limit at $+\infty$ posted on October 2 and how to apply this definition in simple examples (posts of October 2 and October 3)
- ➢ The ϵ-δ definition of limit at a point a and how to apply this definition in simple examples (post of October 4)
- ➢ Proofs posted on the website on October 5. (This is closely related to the Lipschitz condition for the existence of limit posted on October 11)
- ➢ ϵ-δ definition of continuity of a function at a point and how to apply it in simple examples (posts on October 7, October 10 and October 11)
- ➢ The Intermediate Value Theorem and the Extreme Values Theorem and how to apply them in simple situations

Derivatives. Know:

- ➢ The formal definition of differentiability and derivative of a function and and how to apply these definitions in simple examples (post of October 14)
- ➢ the concept of the tangent line to a graph and its connection to the definition of derivative and how to calculate tangent lines to simple graphs
- ➢ The geometric relationship between the derivative of a bijection and its inverse and how to use it to calculate derivatives of the inverse.
- ➢ How to use the concept of a tangent line and a normal line to solve geometric problems related to graphs of functions; see post of October 24.
- ➢ The definition of Lambert's W functions and how to use them to solve simple problems, posts of October 25 and October 26.

Differentiation. Know:

- ➢ The statement and the geometric interpretation of the mean value theorem and its consequences and how to apply them to do related problems, post of October 25
- ➢ How to find higher order approximations and the osculating circle for a function at a point, posts of October 28 and November 2
- ➢ How to solve optimization problems using properties of differentiable functions, lecture of November 4
- ➢ How to do implicit differentiation and how to use it to analyze simple implicit equations, post of November 7
- ➢ How to construct parametric equations of simple planar curves and their tangent lines, post of November 10

Integration. Know:

- ➢ The definition of a Riemann sum of a function, definitions of special Riemann sums: Left, Right, Middle, Lower, Upper, post of November 14

- ➢ The formal definition of a Riemann integrable function and the definite integral of a function on an interval $[a, b]$, post of November 15
- ➢ How to use the formal definition to prove that $f(x) = x$ is Riemann integrable on $[a, b]$, post of November 15
- ➢ How to use the Left, Right, Middle, Lower, Upper Riemann sums and the Trapezoidal rule and the Simpson's rule to find approximations for definite integrals
- ➢ How to use known areas to find definite integrals
- ➢ The concept of the average value of a function
- ➢ The formal statements of the Fundamental Theorem of Calculus and how to use it solve related problems, post of November 16
- ➢ How to use substitution and integration by parts to find basic anti-derivatives
- ➢ How to use definite integral to calculate volumes with known cross-sections, post of November 22 and November 21
- ➢ How to use definite integrals to calculate lengths of graphs and curves given by their parametric equations, post of November 28
- ➢ How to use definite integrals to find areas enclosed by graphs or curves given by their parametric equations, post of November 29
- ➢ How to use definite integrals to calculate the surface area of surfaces of revolution of graphs and curves given by their parametric equations, post of November 30
- ➢ How to use the method of cylindrical shells to calculate volumes of solids of revolution, post of December 1
- ➢ How to use symmetry to calculate the definite integrals involving inverse functions