MATH 1951 Concept List for Midterm 2 (Sections 3.4-3.6, 3.8-3.10, 4.1, 4.3, 4.5)

Here is a rough list of concepts which we've covered in class since Midterm 1, and which could appear on Midterm 2. I do not promise that this list is absolutely exhaustive; there may be subconcepts which I am not specifically listing. (ALSO: there are topics from the first midterm which can still show up; for instance you need to know how to find limits to find horizontal asymptotes!) But this contains all of the most relevant topics, and should be useful as a study aid.

- You should know all of the differentiation rules, including the Product, Quotient, and Chain rules.

- Implicit Differentiation (Section 3.5): know how to find y' (or $\frac{dy}{dx}$; they're the same) for an implicitly defined relation between x and y, and be able to use this to answer standard questions related to the derivative (i.e. where is there a horizontal tangent line, give the equation of a tangent line at a particular point. etc.)

- Logarithmic Differentiation (Section 3.6): know how to use logarithmic differentiation to take the derivative of a function f for which $\ln f$ is easier to work with than f (the common examples are functions made up of products and quotients of expressions using exponents and/or roots (like $\frac{x^2(x+2)^{10}}{e^x\sqrt{x^2+1}}$), and functions made of a function to the power of a function (like $(\sin x)^{x^2}$)

- Exponential Decay and Growth (Section 3.8): know how to use the general exponential growth/decay formula $P(t) = Ce^{kt}$ to solve various word problems involving exponentially growing ($k > 0$) or decaying ($k < 0$) quantities. The usual examples are population and radioactive decay.

- Related Rates (Section 3.9): know how to use the techniques we talked about in class to solve related rates problems. REMEMBER that this includes knowing some geometric/trigonometric formulas, such as the Pythagorean Theorem, similar triangles, definitions of trig functions (e.g. $\sin\theta = \frac{\text{opposite side}}{\text{hypotenuse}}$), and formulas for areas and volumes of various shapes (e.g. areas of triangles, circles, and rectangles, and volumes of cones, spheres, cylinders)

• Linear Approximations (Section 3.10): know how to use the technique of linear approximation to approximate a function $f(x)$ at an x-value which is close to an x-value for which $f(x)$ can be found exactly (for instance, be able to approximate $\sqrt{82}$ by using the fact that 82 is close to 81, and $\sqrt{81} = 9$)

• Absolute Extrema (Section 4.1): know how to find absolute extrema of a function $f(x)$ over a closed interval. (find critical numbers, then plug critical numbers and endpoints of the interval into f to see which is biggest and which is smallest)

• Local Extrema (Section 4.3): know how to check whether critical numbers yield a local extreme of a function $f(x)$ over any interval by using EITHER the First or Second Derivative Tests.

• Concavity and Inflection Points (Section 4.3): know how to check where the graph of a function $y = f(x)$ is concave up or concave down by making a sign chart for f''. Know how to use information about concavity to find inflection points.

• Graphing (Section 4.5): know how to find intercepts and asymptotes of a function $y = f(x)$, how to find out where f is increasing, decreasing, concave up, and concave down (thereby also finding local extrema and inflection points of f), and how to put all of this information together to sketch an accurate graph of $y = f(x)$.