**UT Math 1730 Submission for OTM Business Calculus – TMM 013**

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|   | Learning Outcome Description | Describe how the Courses or Programs address each outcome |
| 1.01  | \* Determine limits analytically, numerically and graphically including one-sided limits and limits at infinity. | Students examine tables of sequential values and graphs of functions to analyze limiting behavior of functional values, including infinite limits and limits at infinity. Students determine whether limits exist and evaluate those limits by manipulating the algebraic expressions of functions. |
| 1.02  | \* Analyze the limit behavior of a function at a point in its domain to determine if the function is continuous at that point. Determine intervals in which a function is continuous. Analyze and classify the discontinuities of a function. | Students identify removable and jump discontinuities and asymptotes from graphs and evaluate left- and right-hand limits from piecewise algebraic definitions. |
| 2.01  | \* Use the limit definition of the derivative to determine the existence and to find the derivative of a given function. | Students apply the limit concept to the secants through a given point on the graph of a function to define the tangent line and interpret the derivative as its slope.  |
| 2.02  | \* Find the derivative of a function by identifying and applying the appropriate derivative formula. | Students apply Linearity, Power Rule (including fractional and negative powers), Chain Rule, Product and Quotient Rules to differentiate functions and expressions, expressed in a variety of variables. These include polynomial, rational, and radical expressions. |
| 2.03  | \* Find higher order derivatives. | Students will be presented with problems, common in macroeconomic trends, where the rate of change of a rate of change is called for, and apply the differentiation rules iteratively to compute and interpret second and higher order derivatives. |
| 3.01  | \* Interpret the derivative as a rate of change. | Students will be presented with problems from economics and finance whose solution requires the interpretation of the rate of change as the derivative of the quantity referred to in the problem. |
| 3.02  | \* Find the slope of the tangent line to the graph of a function at agiven point. | Students will derive the equation for a tangent line at a point and interpret this in terms of the rate of change extrapolated over short intervals, relating it to both absolute and marginal rates of change. |
| 3.03  | \* Use the first derivative to determine intervals on which the graph of a function is increasing or decreasing and to determine criticalpoints of the function. | Students will apply the understanding (described above) of derivative as rate of change to determine intervals of monotonocity. They will be presented with such questions both graphically and analytically. |

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| 3.04 | \*Use the second derivative to determine intervals on which the graph of a function is concave upwards or concave downwards and to determine points of inflection. | Students will further explore the consequences of the interpretation of derivative as rate of change and as slope to study graphs and interpret concavity as the trend in the instantaneous slopes. They will be led to identify those points where such trends change and to intpret these in terms of the values of the second derivative. Finally they will be presented with analytic expressions and asked to determine these inflection points by computing and finding the roots of the second derivative.  |
| 3.05 | \*Find and classify relative extrema and, on a closed interval absolute extrema of a function. | Students will apply both the first and second derivative knowledge described above to locate and described relative extrema from data given either verbally, graphically, or algebraically. They will complete their analysis by forming tables of this behavior and seeking the absolute extrema. |
| 3.06 | \*Solve applied problems including marginal analysisapplications. | Students will apply all of these techniques to problems presented with real-world economic data as well as hypothetical microeconomic situations. This is integrated throughout the course. Students will be derive marginal rates from demand functions, implicit and explicit.  |
| 3.07 | \*Explain the relationship between marginal cost and averagecost. | Students will compare values of these quantities for a variety of curves. This will be a focus of computer labs where students will be asked to interpret these values from data supplied in Maple workbooks. |
| 3.08 | Determine and discuss the elasticity of demand for a product. | From the demand equations they will derive expressions for elasticity and interpret their results in the context of microeconomic problems. |
| 4.01 | \*Construct antiderivates analytically. | Students will be introduced to antiderivatives as the answer to questions about quantities given information about rates of change. |
| 4.02 | \*Find indefinite integrals using integration formulas and the method of substitution. | Once students are grounded in the relationship between derivative and antiderivative they will be asked to apply the rules of differentiation in reverse. Particular attention will be paid to the Chain Rule and its consequences for antidifferentition. |
| 4.03 | Find indefinite integrals using integration by parts. | This is an optional topic but many instructors will include the Product Rule in a continuation of the development poutlined above.  |
| 4.04 | \*Identify definite integrals of functions as the areas of regions between the graph of the function and the x-axis. | Students will be presented with problems that lead naturally to the consideration of areas under and between curves. The notation and concept of definite integral will defined in these terms.  |
| 4.05 | Estimate the numerical value of a definite integral using a Riemann sum. | Students will first develop estimate for areas under or between curves using “typical”, maximum, and minimum values, and then refine this analysis towards approximation of the area using Riemann sums. Much of this will be done in the computer labs where sophisticated illustrations and accurate approximations will lead the students to see the relationship between marginal rates of change of accumulated values and antiderivatives. |
| 4.06 | \*Understand and use the Fundamental Theorem of Calculus to evaluate definite integrals. | The hands-on experience with the relationship between definite integrals and antiderivatives (see above) will lead naturally to the Fundamental Theorem. Students will apply this theorem to the computation of definite integrals, in problems given verbally or algebraically. |

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| 4.07 | \*Use definite integrals to calculate the area of the region under a curve and the area of the region between two curves. | This is described above. |
| 4.08 | \*Determine present value and future value for an investment with interest compounded continuously. | Students will apply the process outlined above to the situation where interest rates and inflation must be taken into account to determine future value, present value, sinking funds, amortization, etc. |
| 4.09 | Determine the average value of a function on an interval. | These topics are addressed at the discretion of the instructor. |
| 4.10 | \*For given supply and demand functions find and interpret the consumer’s surplus and the producer’s surplus. | Students will find and interpret the consumer’s surplus and the producer’s surplus given demand equations. |
| 5.01 | Find the domain of a function of two variables. | These topics are addressed at the discretion of the instructor. |
| 5.02 | Interpret contour diagrams for functions of two variables. | These topics are addressed at the discretion of the instructor. |
| 5.03 | Compute partial derivatives of functions of two variablesalgebraically. | These topics are addressed at the discretion of the instructor. |
| 5.04 | Determine critical points for functions of two variables. | These topics are addressed at the discretion of the instructor. |
| 5.05 | Use the second derivative test to determine the nature of critical pointsof a function of two variables. | These topics are addressed at the discretion of the instructor. |
| 5.06 | Use the method of Lagrange multipliers to determine extreme valuesof functions of two variables subject to constraints. | These topics are addressed at the discretion of the instructor. |

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| 5.07 | Solve applied problems involving the Cobb-Douglas productionfunctions. | These topics are not addressed. |