Math 70 – Calculus with Applications to Social Science

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Description: Math 70 is a survey of calculus for students with a good understanding of high school mathematics and an interest in economics or other social science. No background in calculus or any social science is required. The course covers standard introductory topics (differentiation, integration, convex/concave functions, optimization, fundamental theorem, approximation) and touches on others (Taylor series, differential equations, partial derivatives, Lagrange multipliers, continuous probability). To accommodate them there is less emphasis on the theory of limits and on trigonometry. Applications are usually drawn from economics (marginal analysis, elasticity, consumer/producer surplus), finance (present value, amortization) and sociology (wealth inequality), as well as demography (population growth) and physics (velocity, acceleration).

Rationale: As noted above, Math 70 will serve students who only want a survey of calculus and its applications. For those who need a follow-up course, such as economics and BEO concentrators, Math 70 satisfies the prerequisite requirement for Econ 170, Econ 1110 and Econ 1210, among others, but may not suffice for Math 100.

Sources: (optional) *Schaum's Outline of Calculus*; *Calculus* by G. Strang; the Internet

Goals: The main objectives are understanding (1) how differential calculus provides tools for finding rates of change between related quantities (2) how integral calculus provides tools for finding relations between quantities from their rates of change (3) how the problems treated in (1) and (2) arise in economics and other social sciences. A secondary aim is appreciating various historical and cultural aspects of calculus.

Evaluation: will be based on regular homework assignments (20%), two hour exams (20% each) and a final exam (40%). The only grade option is S/NC.

Attendance & Participation: are essential to get the most out of this course. Questions, comments, boardwork, etc. are always encouraged.

Tentative Syllabus

- the main problems of calculus, classical theorems (Thales, Apollonius, Archimedes)
- variables, functions, graphs, slopes, secant/tangent lines, even/odd functions, inverse functions
- average rates of change, simple/natural growth/inflation rates, supply/demand, revenue, elasticity, equilibrium
- instantaneous rates of change, limit/continuity, notations: Newton, Leibniz, Lagrange; power rule, scale/sum rules
- product/quotient/chain rules, average/marginal cost, elastic/inelastic supply/demand, growth rate = logarithmic derivative
- compound interest, future/present value, elasticity & revenue, average vs. marginal
- higher derivatives, best approximations, factorials & Stirling's formula
- binomial & Taylor series, multiplier & propensity to consume, nominal & effective rates
- critical points, maxima/minima, convex/concave, inflection points, curve sketching, optimization with/out constraint
- implicit differentiation, partial derivatives, level curves, marginal rate of substitution, regression, Lagrange multipliers, equal-bang-for-the-buck
- antiderivatives, in/definite integrals, length/area/volume, the fundamental theorem of calculus, improper integrals
- Lorenz functions, Gini index, consumer/producer surplus, continuous probability (mean, variance), differential equations (separation, integrating factor), amortization
- integration techniques (substitution, by parts), numerical techniques (Riemann sums, trapezoidal/Simpson's rules)