

## **Syllabus for Math 20A**

### **Using Rogawski's *Calculus: Early Transcendentals***

(revised September 2007<sup>1</sup>)

Math 20A is the first quarter calculus course for students majoring in Mathematics, Engineering and the sciences. The vast majority of students taking Math 20A have had a year of high school calculus, but did not score well enough on the Advanced Placement examination to start with Math 20B or Math 20C. They may be familiar with the mechanics of solving calculus problems, but weak on conceptual understanding, which should be emphasized in Math 20A.

Students should be encouraged to use a graphing calculator (the TI-86 is standard) to facilitate computation and graphing, and build – not substitute for – understanding. Calculators with the capability to perform symbolic manipulation, such as the TI-89 or TI-92, are generally disallowed on exams; in fact, many instructors prefer not to allow calculators of any type on exams. Students should be clearly informed which calculators are permissible and, in particular, which of their capabilities (if any) may be used on exams.

Solid intuitive understanding of the concepts should be preferred to “rigorous” proof in this course. At this level, deeper understanding may result from a graphical argument emphasizing the conceptual issues than from a proof based on unfamiliar technical manipulation or unstated axioms about the real number system.

The following generic syllabus takes 27 lectures (out of the 28 to 30 available in a typical quarter). It is intended to be an approximation: in practice, some topics may take less time than allotted, while other topics may take more time. Supplementary or review lectures may be added if time permits.

**Review.** Students should read and should be assigned exercises from Sec. 1.1, Sec. 1.2 and Sec. 1.3. Students should already be familiar with this material, but may benefit from being reminded about it with some assigned exercises. Consider asking your TAs to discuss exercises from these sections during the first discussion meeting.

**Lec. 1.** Sec. 1.4: Trigonometric functions, and Sec. 1.5: Inverse functions. Quickly review trigonometric functions, emphasizing their definition on the unit circle. The addition (and double-angle) identities should be discussed, since they will be important later on. The inverse trigonometric functions provide an example of restricting the domain of a function to obtain an invertible function.

**Lec. 2.** Sec. 1.6: Exponential and logarithmic functions. Introduce the natural exponential and logarithmic functions as well as the hyperbolic functions. Since a full development of the natural exponential requires calculus, a brief introduction suffices here.

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<sup>1</sup> Revised 9/17/07 – John Eggers

Students should read Sec. 1.7 on their own. The realization that calculator-generated graphs can be unreliable in various ways can motivate calculus as a way to investigate and justify the correctness of such graphs.

**Lec. 3.** Sec. 2.1: Limits, rates of change and tangent lines, and Sec. 2.2: Limits: a numerical and graphical approach (The epsilon-delta definition, Sec. 2.8, is *not* covered.)

**Lec. 4.** Sec. 2.3: Basic limit laws, and Sec. 2.4: Limits and continuity.

**Lec. 5-6.** Sec. 2.5: Evaluating limits algebraically, Sec. 2.6: Trigonometric limits, and Sec. 2.7: Intermediate value theorem. The trigonometric limits should be done carefully, since they will be used later to obtain the trigonometric differentiation formulas.

**Lec. 7.** Sec. 3.1: Definition of the derivative.

**Lec. 8.** Sec. 3.2: The derivative as a function. This includes a discussion of the derivative formulas for polynomials and exponential functions. Most students will be familiar with the differentiation rules from high school, but may not understand that these are *consequences* of the definition, not the definition itself.

**Lec. 9-10.** Sec. 3.3: The product and quotient rules, Sec. 3.4: Rates of change, and Sec. 3.5: Higher derivatives. Present one or two simple examples/applications of rates of change: ultimately, students should be able to recognize rates of change in many contexts.

**Lec. 11.** Sec. 3.6: Trigonometric functions. Emphasize how the formula for the derivatives of the sine and cosine follow naturally from the definition of the derivative.

**Lec. 12.** Sec. 3.7: The chain rule. Emphasize that the chain rule applies to composite functions. A brief reminder about composition may be in order.

**Lec. 13.** Sec. 3.8: Implicit differentiation, and Sec. 3.9: Derivatives of inverse functions. Be sure to emphasize how the formula derivative of an inverse function is related to implicit differentiation.

**Lec. 14.** Sec. 3.10: Derivatives of general exponential and logarithmic functions. Passing familiarity with the hyperbolic and inverse hyperbolic functions is sufficient.

**Lec. 15.** Sec. 3.11: Related rates. This is hard for students since it combines many of the non-formulaic aspects of calculus: the meaning of the derivative and of the chain rule, functions which are not explicitly given by formulas and the use of a symbol such as  $x$  to represent both a function and its value at a point.

**Lec. 16.** Sec. 4.1: Linear approximation and applications. Mention in passing that linear approximation can be expressed using the language of differentials; however, this should not be emphasized (it is not emphasized by the textbook).

**Lec. 17.** Sec. 4.2: Extreme values.

**Lec. 18.** Sec. 4.3: The mean value theorem and monotonicity. Emphasize the geometric connection between the derivative and the monotonicity (increasing/decreasing) of a function and how this leads to the first derivative test. The mean value theorem should be mentioned only in passing, since it is hard for students to appreciate its role at this level because it seems less obvious than many of the results it is used to prove.

**Lec. 19.** Sec. 4.4: The shape of graph. Emphasize the geometric basis of the tests for concavity and inflection points of graphs and the second derivative test for extreme values.

**Lec. 20.** Sec. 4.5: Graph sketching and asymptotes. This is where the students use all the tools they've learned previously to characterize the behavior of graphs.

**Lec. 21.** Sec. 4.6: Applied optimization. Students often find it difficult to translate an optimization problem into mathematical language: it is this process that should be carefully exhibited to them.

**Lec. 22.** Sec. 4.7: L'Hôpital's rule, and Sec. 4.8: Newton's method. Apply L'Hôpital's rule to indeterminate quotients only, skipping products and powers.

**Lec. 23.** Sec. 4.9: Antiderivatives.

**Lec. 24.** Sec. 5.1: Approximating and computing area. Sigma (summation) notation should be introduced.

**Lec. 25.** Sec. 5.2: The definite integral.

**Lec. 26-27.** Sec. 5.3: The Fundamental Theorem of Calculus, part I; Sec. 5.4: The Fundamental Theorem of Calculus, part II; and Sec. 5.5: Net or total change as the integral of a rate.