Welcome to Math 1b Calculus, Series, and Differential Equations

Thomas W. Judson (Course Head)
Spring 2006

About Math 1b

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* We will learn how to represent interesting functions using series and find qualitative, numerical, and analytic ways of studying differential equations
* We will develop both conceptual understanding and the ability to apply it.

Learning Objectives

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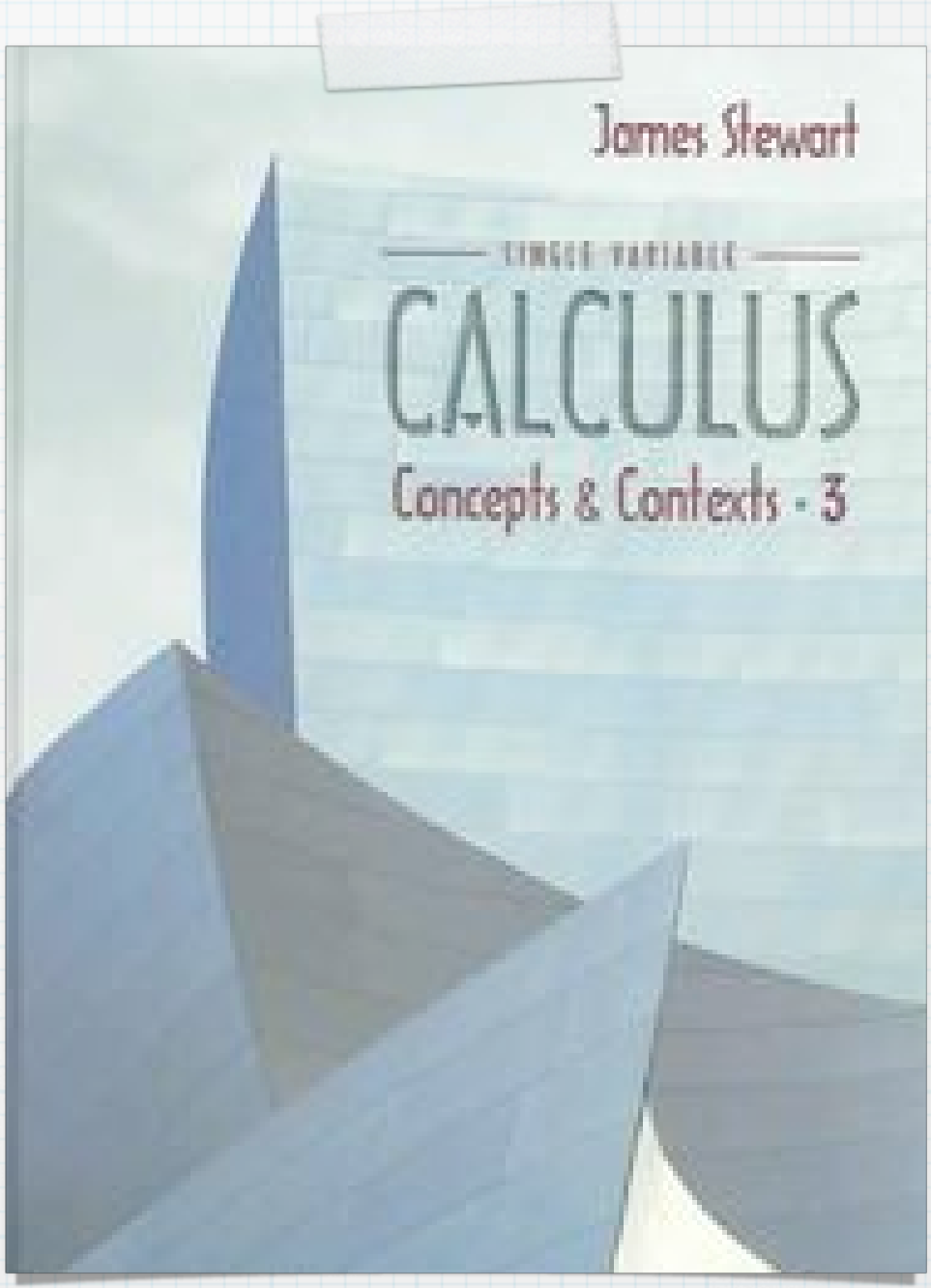
* Infinite Sequences and Series—Sequences, series, testing for convergence, power series, and Taylor series.
* Differential Equations—Modeling, differential equations from a numerical, an analytical, and a geometrical approach, systems of differential equations

The Textbook

James Stewart. Single Variable Calculus: Concepts & Context, third edition. Brooks/Cole, Belmont CA, 2005.
ISBN 0-534-41022-7.



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* Calculators are allowed on homework but not on exams

Techniques of Integration

- $\int u\,dv = uv - \int v\,du$
- $\int \sin^2\theta\,d\theta$
- $\int \dfrac{1}{x\sqrt{4x^2-9}}\,dx$
- $\int \dfrac{5}{(2x+1)(x-2)}\,dx$

Applications of Integration

* How much work is done when pumping out all of the full contained in cylindrical tank?

Sequences and Series

Computing π

$$\frac{\pi^2}{6} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \cdots$$

Representing Functions with Power Series

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$

Differential Equations

Predator-Prey Systems

$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = -\gamma y + \delta xy$$

Prerequisites for Math 1b

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To Get a Second Opinion

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* The Online Placement Exam

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Grading

Component	Percentage
Homework	20%
Techniques of Integration Exam	10%
Midterm I	20%
Midterm II	20%
Final Exam	30%

Exam Dates

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* Techniques of Integration Exam—Wednesday, February 22 at 6-7 PM in Science B

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* Midterm II—Tuesday, April 18 at 7-9 PM in Science B

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* Final Exam—Tuesday, May 23

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* There are two homework schedules—one for MWF and one for TuTh classes
* Homework is due at the beginning of class
* We drop your three lowest scores

Pre-Reading Questions and Pre-Class Surveys

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* Pre-Class Surveys are assigned for each class period (Q&A Tool 2.0)
* Pre-Class Surveys are 5% of your homework grade

Take Advantage of the System

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* New location for the MQC

Which of the following are equal to

$$\int_1^5 \frac{\ln x}{x}\,dx?$$

Please circle all of the correct answers. You do not need to justify your solution.

(a) $\displaystyle\sum_{i=1}^{5} \frac{\ln x_i}{x_i}\Delta x$, where $\Delta x = 4/n$ and $x_i = 1 + i\Delta x_i$.

(b) $\displaystyle\lim_{n\to\infty} \sum_{i=1}^{5} \frac{\ln x_i}{x_i}\Delta x$, where $\Delta x = 4/n$ and $x_i = 1 + i\Delta x_i$.

(c) $\displaystyle\lim_{n\to\infty} \sum_{i=1}^{n} \frac{\ln x_i}{x_i}\Delta x$, where $\Delta x = 4/n$ and $x_i = 1 + i\Delta x_i$.

(d) $(\ln 5)^2/2$

(e) $\displaystyle\frac{1}{2}\left(\frac{\ln 5}{5}\right)^2 - \frac{1}{2}(\ln 1)^2$

(f) $\displaystyle\frac{1}{5^2} - \frac{1}{1^2}$

(g) $\ln(\ln(5)) - \ln(\ln 1))$

(h) $\displaystyle\frac{\ln 1}{1} + \frac{\ln 2}{2} + \frac{\ln 3}{3} + \frac{\ln 4}{4}$

Put the following in *ascending* order (with "=" or "<" signs between each expression. You do not need to justify your solution. [*Hint*: Think about which expressions are positive, which are negative, and which are zero. A picture may be helpful.]

(a) $\displaystyle\int_2^6 \ln t \, dt$

(b) $\ln 2 + \ln 3 + \ln 4 + \ln 5$

(c) $\ln 3 + \ln 4 + \ln 5 + \ln 6$

(d) zero

(e) $\ln(2/6)$

(f) $\displaystyle\lim_{h \to 0} \frac{\ln(2+h) - \ln 2}{h}$

Important Addresses

* Thomas W. Judson (Course Head) judson@math.harvard.edu
* Course Web Site http://www.courses.fas.harvard.edu/~math1b/
* Sectioning Directions http://abel.math.harvard.edu/sectioning/index.html