

MATH 120: Honors Differential Calculus

Winter term, 2016

Instructor: Joshua Zahl.

Where and when: MTWF 10-11, in MATH 102.

My office: MATH 238.

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Office hours: M 16:00-17:00, T 14:30-15:30, W 11:00-12:00

Text: We will loosely follow *Calculus Single Variable 8th edition* by Adams and Essex. Previous editions should be fine as well.

Course Description

This is an Honours course. Emphasis will be on both computation and theory. Course material will mostly be taken from Chapters 1-4 of the text: Limits, Differentiation, Elementary functions, Applications and Approximation.

Grading policy

The course mark will be based on weekly homework assignments (20%), two midterms (40%), and a final exam (40%).

There will be weekly homework assignments, which are due Friday at the beginning of class. Graded homework will be returned the following Wednesday at the end of class. The lowest homework score will be dropped.

There will be two in-class midterms. These will be held on **Wednesday, October 5th** and **Wednesday, November 9th**. Please make sure you do not make travel plans, work plans, etc., without regard to the examination schedule in this class. There will be no make-up or alternate exams. If you miss a midterm, your score will be recorded as 0, unless you have a serious documented reason (an illness, a death in the family, etc.), in which case you should discuss your circumstances with the instructor as soon as possible, and in advance of the test.

(Approximate) Course Outline

Sept 7: Sets and set notation, the natural numbers, integers, rationals, real numbers. Properties of the real numbers.

Sept 9: The real numbers; Least upper bound property, number line, open intervals.

Sept 12: Closed intervals, functions: domain, co-domain, graphs of functions, range, one-to-one

Sept 13: arithmetic of functions, composition of functions, into to limits

Sept 14: examples of limits, arithmetic of limits

Sept 16: Limits are a local property, squeeze theorem
Sept 19: One-sided limits, limits at infinity
Sept 20: Limits at infinity of rational functions
Sept 21: Limits at infinity of rational functions cont'd
Sept 23: Infinite limits, continuity
Sept 26: The intermediate value theorem
Sept 27: The extreme value theorem, types of discontinuities, arithmetic of continuous functions
Sept 28: differentiability
Sept 30: differentiability

Oct 3: differentiability implies continuity, one-sided derivatives differentiability rules, proof by induction

Oct 4: Reciprocal rule, quotient rule, f^* theorem

Oct 5: Midterm 1

Oct 7: chain rule

Oct 10: Thanksgiving

Oct 11: Positive derivative \rightarrow increasing function, local max/min

Oct 12: local max/min, Newton's method

Oct 14: Rolle's theorem, mean value theorem

Oct 17: mean value theorem cont'd, higher derivatives, alternate notation for derivatives

Oct 18: Taylor's theorem, summation notation, telescoping sums, Landau's big-O notation

Oct 19: Big-O and Taylor's theorem, cont'd

Oct 21: Taylor's theorem cont'd, proof of Newton's method

Oct 24: Functional equation for $\log(x)$

Oct 25: Properties of $\log(x)$

Oct 26: inverse functions

Oct 28: Properties of e^x

Oct 31: Derivatives of trigonometric functions

Nov 1: Derivatives of trigonometric functions cont'd

Nov 2: hyperbolic trig functions, inverse trig functions

Nov 4: Inverse trig functions cont'd, implicit differentiation

Nov 7: Implicit differentiation cont'd, logarithmic differentiation

Nov 8: L'Hopital's rule

Nov 9: Midterm 2

Nov 11: Remembrance day

Nov 14: L'Hopital's rule cont'd

Nov 15: Applications of L'Hopital's rule, anti-derivatives

Nov 16: First order differential equations, $y' = ky$

Nov 18: Homogeneous first order differential equations and initial value problems

Nov 21: Non-homogeneous first order differential equations

Nov 22: Non-linear first order differential equations, existence and uniqueness, second order equations

Nov 23: Linear second order homogeneous differential equations

Nov 25: Linear second order homogeneous differential equations cont'd, complex numbers

Nov 28: Logistic growth, harmonic motion

Nov 29: Review

Nov 30: Review

Dec 2: Review