

Freshman Seminar for Mathematics Majors
Fall 2009

MATH 171.01F (1 credit), W, 10:00AM-10:50AM, Wickersham 219

Corequisites: Freshman standing as a mathematics major and MATH 161 *Calculus I*.

Instructor: Dr. Buchanan

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Office Hours: 2:00PM–3:00PM (MTWTF), or by appointment

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Course URL: <http://banach.millersville.edu/~bob/math171/>

Textbook: There is no traditional textbook for this course. Assigned readings of printed handouts and web material outside of class will substitute for a textbook.

Objectives: The semester activities may include exposure to and exploration of the following topics and activities. The topics may not be covered in precisely the order in which they are described below. Related topics from the list below will be covered together. Whenever possible, topics from the list below will be synchronized with the topics in the *Calculus I* syllabus.

Course Contents: Topics covered this semester may include the following (in no particular order):

- Components of the mathematics major — required and elective courses, scheduling.
- *Mathematica* Basics — kernel and front-end, syntax, commonly used facilities.
- Fibonacci sequence and some of its properties.
- Game theory — students will examine the possible moves in a simple game and determine if there exist strategies for guaranteeing a player a victory.
- Cryptanalysis — students will be introduced to the elementary number theory, abstract algebra, and statistics which play a role in enciphering and deciphering messages.
- Identification numbers — students will be introduced to check digit schemes used to transmit, retrieve, and store data.
- Bertrand's paradox — students will explore the probability that a randomly selected chord of a circle is longer than a side of an inscribed equilateral triangle.
- Complex numbers — students will explore representations of complex numbers, complex number arithmetic, roots of unity, *etc.*
- Divisibility/indivisibility of natural numbers by 2, 3, 7, or 11 and why the familiar tests for divisibility work.

- Taylor polynomial approximations to functions — students will extend the concept of linear approximations of a function to higher order polynomial approximations.
- Elementary matrix algebra — affine transformations of the Cartesian plane, iterated function systems.
- Buffon needle problem — students will understand how a probability experiment can lead to an approximation to the transcendental number π .
- Quadratic forms — students will explore some of the properties of the level curves of expressions of the form $\mathbf{x}^\top A \mathbf{x}$ where $\mathbf{x} \in \mathbb{R}^2$ and A is a 2×2 hermitian matrix.
- Conic sections — the circle, parabola, ellipse, and hyperbola and their geometric properties.
- Navigation — an activity in which students will apply some of what they have learned so far to understanding the principles of operation of the Long Range Navigation (LORAN) system commonly used for coastal navigation.
- Envelopes of tangent lines — students will determine the curves formed by envelopes of tangent lines of the forms $x \cos \alpha + y \sin \alpha = 1$ and $\frac{x}{\cos \alpha} + \frac{y}{\sin \alpha} = 1$ where $\alpha \in [0, 2\pi]$.
- Computer arithmetic — fixed and floating point representations, round off errors, numerical precision, numerical approximation, and numerical errors.
- Root finding methods — Newton's method and the secant method.
- Optimization — an activity in which students will optimize a function whose critical points can only be numerically approximated.
- Binomial series — students will explore through the notion of area under a curve the infinite series expansion of $(a + b)^k$ where $k \in \mathbb{Q}$.
- Mean Value Theorem for Definite Integrals — students will explore the relationship between the mean of a set of numbers and the mean value of a function on an interval.
- Probability distributions — binomial distribution and its approximation by the normal distribution.

If time permits other topics may be covered as well.

Attendance: Students are expected to attend all class meetings. Since an objective of the seminar is to demonstrate that mathematical inquiry is often a collaborative activity, students must be present to participate and benefit from the seminar. Every absence in excess of two will result in the lowering of a student's course grade by a letter grade. There is no final written examination for this course and therefore, as per University policy, during the week of final examinations, we will meet as a regular class (day and time to be determined). If you must be absent from class on the day an assignment is due, you must complete and hand in the assignment prior to the absence.

Homework: Since this is a single credit course, the workload will be proportional to the credit earned. The assignments of the course will be designed so that they can be completed in the hour of class meeting and an estimated single hour of homework per week. Depending on the student and the assignment, some homework assignments may require longer than one hour to complete. Student work will be assessed for correctness, generality, and evidence of insight into mathematical ideas.

Grades: Course grades will be based on the student's participation in the seminar and their graded written homework. I keep a record of students' homework scores and of their class participation. Students should also keep an individual record of graded assignments. The course letter grades will be calculated as follows.

90-100	A
80-89	B
70-79	C
60-69	D
0-59	F

Course Repeat Policy An undergraduate student may not take an undergraduate course of record more than three times. A course of record is defined as a course in which a student receives a grade of A, B, C, D, (including + and -) F, U, Z or W. The academic department offering a course may drop a student from a course if the student attempts to take a course more than three times.¹

The last day to withdraw from a course (and receive the W grade) is November 6, 2009.

Inclement Weather Policy: If we should miss a class day due to a school closing because of weather, any activities planned for that missed day will take place the next time the class meets. For example, if a test is scheduled for a day that class is canceled on account of snow, the test will be given the next time the class meets.

¹Memorandum to mathematics faculty from Dr. Charles G. Denlinger, Assistant Chair, Department of Mathematics, August 30, 2004.