Millersville University, Fall 2012
UNIV 103: From pi to e through i
A Freshmen Seminar for Mathematics Majors, 3 credits

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MWF: 1:00-1:50PM; 2:00-2:50PM

Course Description:
The intent of the course is to examine, study, and analyze mathematics through a variety of mathematical lenses (applied and pure math, statistics, and education). The seminar format will allow students to discuss, investigate, and take ownership in the learning process along with their classmates and professors. Students will examine mathematics that may or may not have been part of their secondary school curriculums, explore the use of appropriate technologies, and utilize a variety of problem solving strategies to solve mathematical exercises and situations. Students will be expected to read mathematical journal articles, reflect on the problem solving sessions, and participate in student research and class discussion. Students will **actively participate in work-sessions, and will present their hypotheses and/or solutions to problems encountered in class on a regular basis**. The course will further introduce the process of **critical inquiry in mathematics**, rather than a "memorize an algorithm and solve" approach. Applications will be generated, particularly based on faculty specialties including (but not limited to): social, medical, cultural, scientific, technological, business, and educational problems. This seminar will introduce **multiple perspectives** related to the understanding and resolution of mathematical problems. As a community of mathematics majors, working collaboratively with several mathematics faculty members, the course will also function to support students' transitions into the college experience as mathematics majors academically, socially, and personally.

The students will be part of a major-based learning community in mathematics. These communities have existed prior to this course, but without the UNIV 103 connection. It is believed that partnering the learning community with a major-based seminar will promote a richer experience that extends the learning and relationships beyond the classroom. The course will be team-taught by at least two, and as many as six individual professors of mathematics. Each will lend his/her own passion/discipline within mathematics to create a **broader scope of what mathematics means** to the freshmen in the course. The course will serve to further **connect the mathematics and habits** of mind previously developed in secondary school with the mathematics and learning strategies of college.

Broad Course Objectives: Students should be able to

- Utilize mathematical software and graphing calculators appropriately
- Critically analyze and reflect upon their work, and that of their classmates
- Explain a broad range of mathematical topics and/or disciplines
- Discuss what is currently taught in 7-16 mathematics classrooms globally and in the US
- Investigate alternative strategies in pure and applied mathematics to solve interesting problems
- Create, modify and/or apply new strategies to solve classical and new problems
- Critically discuss the ideas from the class readings, discussions and activities.

Required Materials:

- Computer with internet access
- Some access to the following: graphing calculator, computer software

- Text: None required. Faculty will utilize online and print resource material in the form of up-to-date journal articles, research essays, and current issues. Faculty will also pull from a wide-variety of sources to create an investigative environment.

Attendance: Regular class participation is required. Daily discussions and activities are the heart and soul of this course. Students will regularly participate in problem-solving discussions and regularly reflect (in writing and orally) on the material that is being learned. Given the interactive nature of the course, daily coursework will not be able to be made up and will only be excused if it is a documented university-accepted excused absence.

Email Contact:
Given the nature of the course, you will have 5 different professors. Email is the most common form of communication and generally the easiest form for reaching any of your professors (unless they indicate otherwise). Certain "protocol" should be adopted by all students.
Questions like, "Could you explain the assumptions for regression and ANOVA?", "Can you explain to me why Galois is an important mathematician?" and "What are the benefits of utilizing proof by contradiction over induction?" are not appropriate. None of us cannot even begin to adequately answer those types of questions via e-mail. A more appropriate e-mail would be something like, "I have some questions regarding the proof we did on Monday, could we meet tomorrow afternoon?"
One last thing about e-mail, always use proper greetings, punctuation, grammar, and closings. Often times we receive e-mails with no salutations and no closings and the only identifier is the e-mail address which is often something like, sugarbaby@yadayada.com . How are we supposed to know who sugarbaby is? And more importantly, do we really want to know who sugarbaby is? (No.)

Assignments: Regular assignments (research, readings, exploration problems, and projects) will be given in order to supplement class work and extend student learning. Effective class discussion will rely on all students' fulfillment of these assignments. You will have some reaction/reflection papers to write and turn in as announced.

Major Evaluation Components: details below

- **Written Reflections:** (40%): All students will be required to write extensively about the content, and discussion of the course regularly (in many cases, daily). These reflections will be graded on quality, style, and content.
- **Oral Presentations**: (10%) At least once during the semester, every student must present a solution to a problem in front of the class. The presentation grade will be based on clarity of thought, detail of description, and overall content. The grade will not be based on the students' correctness to the problem; indeed the problem may be left as "unsolved" for the rest of the class to work on.
- **Problem Journal**: (40%) Although the course is built around many sub-themes of mathematics, students are to maintain an organized problem journal. They need to be able to access prior work and reference it throughout the course. These journals will be graded on completeness and thoroughness of solutions presented.
- **Seminar Assignments**: (10%) All students will be expected to complete additional seminar assignments (some may be optional) as given. These will include completing or participation in: 4-year Plan, Study Skills, Advisement/Course Scheduling, Day of Caring Service Project (or alternate approved project), Math Colloquiums, Math Club Activities, Math Department Picnic, Tutoring, University Community Activities and Cultural Events, Personal Dispositions Reflection, Preparing for Finals. (Professors will pre-determine the opportunities available each semester, and the syllabus will clearly indicate those that are required, vs. suggested.) These assignments will be graded as complete/incomplete.

Course Content/Topics

Note: Content will not necessarily occur in the order prescribed. This is a sample table to illustrate the 6 modules upon which the course is built.

August 27: Intro: Getting off on the right foot – planning for 4 successful years!	29: The Art of Problem Solving	31: The Art of Problem Solving
September 3 (Labor Day) No Class	5: The Art of Problem Solving	7: The Art of Problem Solving
10: The Art of Problem Solving	12: The Art of Problem Solving	14: The Art of Problem Solving
17: Study Skills The Day of Caring: Service Project Advising – being part of the math community as a whole	19: Discrete Mathematics: An Introduction to Graph Theory	21: Discrete Mathematics: An Introduction to Graph Theory
24: Discrete Mathematics: An Introduction to Graph Theory	26: Discrete Mathematics: An Introduction to Graph Theory	28: Discrete Mathematics: An Introduction to Graph Theory
October 1: Discrete Mathematics: An Introduction to Graph Theory	3: Discrete Mathematics: An Introduction to Graph Theory	5: Scheduling courses
8 (Fall break) No Class	10: Service Projects in Tutoring – working with Math Club – leading a math team at a middle school?	12: The "Big Picture" of Statistics
15: The "Big Picture" of Statistics	17: The "Big Picture" of Statistics	19: The "Big Picture" of Statistics
22: The "Big Picture" of Statistics	24: The "Big Picture" of Statistics	26: The "Big Picture" of Statistics
29: Activity for Community-building	31: The University Community & the Student; Attending University Events	**November 2:** Geometry
5: Geometry	7: Geometry	9: Geometry
12: Geometry	14: Geometry	16: Geometry
19: BSEs and the Dispositional Review and the Content Portfolio The Final Push – What to Expect from Finals & How to Prepare	21 (Thanksgiving break) No Class	23 – (Thanksgiving break) No Class
26: Applications of Mathematics (Connecting Mathematical Ideas)	28: Applications of Mathematics (Connecting Mathematical Ideas)	30: Applications of Mathematics (Connecting Mathematical Ideas)
December 3: Applications of Mathematics (Connecting Mathematical Ideas)	5: Applications of Mathematics (Connecting Mathematical Ideas)	7: Applications of Mathematics (Connecting Mathematical Ideas)
10 (Last class) : Applications of Mathematics (Connecting Mathematical Ideas)	Final Exam Meeting Time Wed. Dec. 12, 10:15am-12:15pm	Final Exam Meeting Time Thurs. Dec. 13, 10:15am-12:15pm

Content

In general, the UNIV 103 for Math Majors will utilize a framework that seeks to introduce students to a wide variety of new (and sometimes familiar) mathematical topics that will be approached in new and unique ways. Students will often work in small groups, will be challenged to discover their own results, and then will share with the class about their findings. Hints and guidance will be provided by the instructor(s) as necessary. The goals are to build the community of mathematicians that strengthens how they think about mathematics (their chosen major) in such a way that they will become more competent and confident in their approaches to collegiate mathematics.

Module I: The Art of Problem Solving

Problem-solving is critical to successfully studying mathematics. Developing a state of mind in which a student is investigative is necessary in accepting the fact that not all problems can be solved in a few minutes, and that looking for the solution is sometimes the most interesting part of the process. Students will be guided through some initial and typical techniques for addressing new mathematical problems, and will also study some classic problems to fine-tune their skills.

In general, three major themes will form the module:

An introduction to mathematical problem solving,
Modular arithmetic and its application to cryptography,
and Games and strategies.

In this module, students will

Learn to outline and apply the steps of problem solving from a mathematical perspective.
Develop (as appropriate) a closed form (algebraic process) to solving the problem.
Create public and private keys for encryption
Develop and justify strategies for games and determine winning strategies

Module II: Applications of Mathematics (Connecting Mathematical Ideas)

Students beginning their college careers as mathematics majors often do not have the "big picture" of what mathematics can do. The goal of this module is to bridge the mathematics students have seen in secondary mathematics with some applications that are readily available to them. This module will also connect the secondary mathematics with collegiate mathematics in the investigation of complex numbers and mathematical models.

In general, four major themes/applications will form the module:

Examining Olympic competitions mathematically,
Estimating length, area and volume of familiar objects (baseball, Washington Monument, Golden Gate Bridge, Gateway Arch, Hershey's Kiss)
Optimization and rainbows
Financial mathematics

In this module, students will

Develop rational ways to compare performance of nations
Plot data and hypothesize relationships in a scatterplot.
Develop, use, and justify methods for estimating physical quantities
Find the index of refraction of water to model a raindrop
Participate in a mock auction to bid on unknown payoffs
Justify the existence of a "true and correct" price for options and the relationship between price of call and put options

Module III: The "Big Picture" of Statistics

The probability and statistics section will encourage students to look for the "big picture." Statistics is a subject where students can lose the ability to think about why they are learning a new area of mathematics because the details become overwhelming. If they can see the big picture then the details make sense. This strategy of learning mathematics will help the students with many of their undergraduate mathematics courses.

In this module, students will

- Learn to solve the same probability problems using several different techniques.
- Learn about some probability paradoxes
- Think like a statistician when dealing with discrete and continuous probability distributions.
- Learn that they can explain and model randomness.
- Use simulations to model behavior
- Recognize the meaning of and the need for measures of variability in statistics.
- Estimate the value of parameters and use computer simulation to compare several estimators for the same parameter.
- Learn how hypothesis testing works.
- Connect Statistics to real world problems.

Module IV: Geometry

The geometry section will introduce students to various interesting topics in geometry. They will be challenged to discover their own results and share them with the class.
In general, four major themes/applications will form the module:

- The history and various proofs of the Pythagorean Theorem
- Comparisons of Euclidean and Spherical geometries
- Euler's formular
- Mobius bands and Klein bottles
- Billiards and puzzles
- Intuitive topology and knot theory

In this module, students will

- Learn that this course is not about the same geometry they had in high school geometry
- Explore a variety of proofs to verify the same theorem
- Examine alternate geometries and connect them to prior mathematical understandings such as trignonometry
- Discover surprising relationships that occur in simple polyhedron
- Examine the one-sidedness of introductory topology
- Apply the basics of transformational geometry
- Explore alternate geometries and their applications

Module V: Educational Issues; including Information Literacy; & Technology

This module is intended to get students to think about their role as a student of mathematics. Active learning vs. passive learning will be explored, discussed, and modeled. For some students, who may be BSE majors, this will serve as an introduction to the field of mathematics education. For others, this module is intended to help them to make the transition from secondary school to collegiate mathematics a smoother one. Resources will be formally discussed as relevant to information literacy and pertinent technologies.

In this module, students will

Formally present a problem from a prior module
Critique their peers' presentations
Utilize appropriate information literacy tools to create a summary of practical mathematics education, locally and abroad
Use appropriate technology to solve, model, or present a mathematical solution
Discuss their roles as active learners of mathematics

Module VI: Discrete Math: An Introduction to Graph Theory

In the spirit of inquiry, the graph theory portion of the freshman seminar will be presented as an exercise in guided discovery of introductory graph theory concepts. To do such, students will be given the basic definitions of a (simple) graph, vertex set and order, edge set and size, the relations of adjacency and incidence and degree of a vertex. At this point, the investigation and discovery begins.

In this module, students will

Create their own examples of graphs
Use their examples and others provided by the professor to discover relationships between

- Size and order
- Degree and order
- Degree and size

Recognize regular graphs
Discover special families of graphs (complete, cycles, wheels, paths, complete bipartite, stars, etc.)
Define connected graphs
Recognize trees and their properties
Define distance in a connected graph and discover relationships involving distance
Distinguish between planar and nonplanar graphs and recognize their properties
Distinguish between Eulerian and Hamiltonian graphs and their applications
Investigate vertex coloring and its applications
Create graphs according to given specifications or explain why no such graph exists
Determine if two graphs are isomorphic or nonisomorphic
Investigate an unsolved problem utilizing heuristic techniques