

Assignment Instruction
Daemen College
Mathematics Capstone - MTH 460
Fall 2013

Assignment Description

You are expected to demonstrate research, analytical, and writing skills in Mathematics by writing an (original) document (minimum 12 pages) based on sources appropriate to the topic and approved by the instructor.

This assignment will enable you to integrate coursework, knowledge, and skills to demonstrate a broad mastery of the theories and background in a specific topic within the mathematics discipline and apply the topic to an entirely different discipline. The paper will draw on theories from mathematics and another discipline such as physics, biology, chemistry, system information management, computer science, business and others.

This assignment is worth 70% of the total course grade. Items identified in Stages I, II, and III will be worth 10% of the grade and 60% is on the final paper (Stage IV).

You will need to complete the assignment in four stages:

Stage I: Research Proposal (due at the end of first two weeks)

Stage II: First Draft of Paper (due at the end of the seventh week)

Stage III: Second Draft of Paper (due at the end of the tenth week)

Stage IV: Final Paper (due at the end of the semester)

Meeting Times

You will need to schedule individual one-hour meetings with the instructor twice a week throughout the semester while working on your paper.

The Research Paper

The capstone paper will explore in depth a topic in mathematics and illustrate how the mathematical theories can be applied to a problem from a different topic in another discipline. It must identify various references on the topic in different media. The paper will synthesis the information in the references and go beyond the syntheses to include additional contribution to illustrate a deep understanding of the topic and its application to another discipline.

Topic Selection

Within the first two weeks of class, you must pick a project topic (i.e., Algebra, Analysis, Number Theory, and Calculus) and an application topic in another discipline (i.e., Physics, Biology, Chemistry, System Information Management, Computer Science, Business). The project topic needs to be approved by the instructor.

Research Proposal

You must submit a research proposal by the end of the first two weeks into the semester. The research proposal is a short description (2-3 pages) of the topic typically used to clarify thoughts on a topic. The research proposal will consist of the following elements:

- a) **Title.** The title should indicate clearly the topic of the paper and its application component;
- b) **Key questions.** State the key questions and inquiries that you hope the paper will answer or address;
- c) **Abstract.** State the content of your paper concisely in no more than two or three sentences;
- d) **Outline.** Prepare a brief outline of your proposed paper;
- e) **Sources.** Briefly list and discuss the sources that you intend to use or have used;
- f) **Plan.** Provide a week by week schedule for completing the paper.

Paper Format

The format of the paper must follow and contain all elements provided in the sample posted on blackboard and must contain minimally: Abstract, Introduction, Historical Background of the topic selected, main theorems and results, an application section that link the topic to another discipline, conclusions, and references.

The research paper must be typed using a word processor that is capable of handling an equation editor and mathematical styles typing, PCTex, Latex, or Scientific Word is preferred over other processors. You may use other word processors; however, be advised that they have limited capabilities of handling mathematics styles typing, (e.g., Word, WordPerfect, etc.). The paper should be at least 12 pages in length (not including graphics or references). The paper should demonstrate appropriate mathematical conventions and writing tasks including organization, content, presentation, formatting, and stylistic choices. You are required to communicate your finding and ideas through another writing medium such as graphs, software solutions, spreadsheets, charts, computer program outputs, and others.

Additional Requirement

1. Paper must either be an extension of concepts you have learned or be on a topic that you have never studied. You may not take a topic entirely from a previous course.
2. Your paper must illustrate your ability to solve a substantial problem in mathematics. Your paper must also contain a quantitative analysis that presents a solution to a mathematical problem.

3. The paper must illustrate your ability to use technology in the process of solving a significant mathematical problem graphically or numerically, (i.e., advanced graphing calculator features, computer software's such as C++, GEO-GEBRA, EXCEL, MINITAB, MATHEMATICA or MAPLE).
4. Your paper must incorporate and properly cite multiple information resources in different media. Use [MathSciNet](http://www.mathscinet.org) format, visit www.ams.org.

The Research Paper Topic

The capstone topic may involve original research, or it may involve the summarization and consolidation of reports from the research literature, or designing and implementing a mathematical model or algorithms for the performance of some task. Individual conferences with the instructor during the first two weeks of the semester will help you generate topic ideas.

Selecting a topic is often the most difficult step for this assignment. You will need to identify the mathematics topic that can be applied to another topic in a different discipline. To identify a topic, first identify your favorite mathematics course that you took and write reasons as to why you liked it. Then, identify your favorite non-mathematics course that you took and write reasons as to why you liked it. Now, think about connecting the content of the two courses together. Finally, narrow your topic by considering your career goals and any of your other interests.

Examples of Possible Topics

The topic and outline for the paper must be negotiated between the student and the instructor. Below is a list of possible topics that can be used as a guide to select your own topic.

1. ***Calculus of Variations.*** Maximizing or minimizing a function using multi variables for example finding the shape of a suspension bridge cable or industrial optimal shapes.
2. ***Quaternions.*** A generalization of complex numbers. Quaternions can be used to represent rotations in 3D and animation.
3. ***Mathematics of Elections.*** Why is it that no election method is perfect, and what are the paradoxes that can arise? How do paradoxes apply to various governmental elections?
4. ***The 4-Color Map Problem.*** The study of Graph Theory. How many colors do you need to color a map so no adjacent countries have the same color?
5. ***Fourier Transforms.*** Decomposing functions into sines and cosine. How is it applied to the study of heat wave equation, vibration analysis, and acoustics?
6. ***Laplace Transformation.*** Solving differential equation using the Laplace Transform method. Use the method to find the current in electric circuits.

7. ***Riemann and Lebesgue Integral.*** Generalization of the notion of Integration. How is it used in the physical and engineering sciences?
8. ***The Study of Group Theory.*** Galois Theory and its application to symmetric formation of molecular compounds or coding theory.
9. ***Differential Equation.*** The Lotka-Volterra Equations and its application to Ecology System in various biological species.

Grading

Your instructor, along with the mathematics faculty and invited faculty from other departments, will be responsible for reading and grading the final research paper.

Your paper should address and will be graded on the following, as outlined in posted rubric.

- I. Identifies a creative, focused, and manageable topic that addresses potentially significant yet previously less-explored aspects of the topic.
- II. Independently combine examples, facts, or theories from the mathematical topic selected and from a field other than mathematics.
- III. Communicates, organizes, and synthesizes information from sources to fully construct the research paper, with clarity and depth.
- IV. Fulfills a paper by choosing a format, language, or graph (or other visual representation) **to explicitly connect content and form**, demonstrating awareness of purpose and audience.
- V. Expressing quantitative evidence in support of the mathematical theories presented in the work (in terms of what evidence is used and how it is formatted, presented, and contextualized).
- VI. Demonstrates detailed attention to and successful execution of a wide range of conventions particular to a specific discipline and/or writing task (s) including organization, content, presentation, formatting, and stylistic choices,
- VII. States a conclusion that is a logical extrapolation from the topic inquiry findings. Critical elements of theoretical framework are appropriately developed.