You will complete an individual project on a topic or problem in mathematics, present the project to an audience of your mathematical peers (this class and possibly other math majors/math interested students who attend the presentations), and write a paper about the topic/problem, incorporating any feedback you receive. You may select one of these options for your individual project:

1. Choose a problem from a completed Putnam Competition exam (if you google Putnam Competition, you'll find a lot of things!). Either solve the problem yourself or find a solution for the problem online and rewrite the solution filling in all the missing details as well as any necessary background information. Propose at least two of your own extensions to the problem and solve at least one of the extensions. Your grade will be based on the quality of your explication, extensions, and solutions.
2. Choose a paper from a peer-reviewed mathematical journal on a topic that interests you. Write an explication of the paper, including your own original examples of concepts in the paper. Propose at least two further directions for research based on the paper topic and pursue one of them yourself as far as possible in the time frame.

Process and Timeline

1. **Initial exploration**

   Spend a few hours in January and early February looking at options for a project topic. On **Thursday, February 20**, you'll tell the class about the choices you're considering.

   If you are going to do the Putnam problem option, bring at least 3 problem choices with you to class for which you have worked to understand the problem, but you are *not* expected to start on a solution. Consider the following questions as you explore:

   - What terms need to be defined in order to understand the problem?
   - Is there a good example that would illustrate the nature of the problem?
   - Why is the problem interesting or important? Or, what makes it a *problem*?

   On Feburary 20, you will present your choices to the class (2–3 minutes per problem). The goal of the presentation is to help everyone in the class understand and appreciate the problem. You are not required to give suggestions for solving the problem.

   If you are going to do the peer-reviewed paper option, bring at least 2 papers with you to class for which you have worked to understand the main idea of the paper. On February 20, tell us about the topic and area(s) of mathematics for each paper, why the paper is interesting to you, and give an idea of the main result(s) of the paper.

   In either case, turn in a summary of the choices you're considering. If you're doing option 2, also email me links to the papers you're considering.

2. **Choose a problem** (deadline: Friday, February 28)

   Email me your choice.

3. **Solve the problem/Find and understand a solution/Carefully read and understand the paper** (timeline: by April 3)

   Finish this part of the process by April 3 at the latest so that you will have time to work out any bugs, extend the problem/research, solve an extension/create your own examples, and write your paper.

4. **Extend the problem/research**

   Once you have solved the problem/understood the original paper, find some ways to extend it. Extensions come in many forms, but some ideas are to generalize the problem to a different situation, pose new questions related to the problem, and relate this problem to others. You should come up with several (at least two) extensions, and solve/pursue at least one of them.

5. **Write a draft of your paper** (deadline: Tuesday, April 15)

   A complete draft of your paper (in LaTeX) is due Tuesday, April 15. Please bring three copies of your draft to class on April 15 (one for each of your peer reviewers and me).

6. **Review your classmates' papers** (deadline: Thursday, April 24)

   You will be assigned two classmates' drafts on Tuesday, April 15 and provide feedback for them, based on the peer review guidelines, by Thursday, April 24. You should both write on their draft and write a summary review.

7. **Present your project** (May 1 and May 6)

   Your presentation should be professional and use LaTeX slides with supplemental writing as appropriate.

8. **Submit your final paper** (deadline: Tuesday, May 6)

   Turn in your completed paper with your original reviewed drafts (all three of them) at our final period.

Assessment

The following criteria will be given approximately equal weight when determining a grade.

1. Problem/Research: To earn a B, your explication of the problem/research should show consistent effort (i.e. make sure that you are keeping me up-to-date on your progress throughout the semester!), and your mathematics to explain the problem/research must be complete and correct. A solution/explication will earn an A if it does the above and demonstrates notable independence (e.g., you came up with your own solution to the Putnam problem for that option), creativity, resourcefulness, or elegance.

2. Extension: To earn a B, you must ask two or more questions that vary or extend the problem/research and solve/explore in depth at least one of them. If the extensions are relatively simple to solve then you should plan to solve at least two. To earn an A, you must demonstrate some of the following in your extensions: creativity, work beyond the standard given above, or articulation of connections that place the problem/research in a larger framework.

3. Presentation: To earn a B, you should present your project on time, showing effort and solid presentation skills (such as appropriately aiming your presentation at an audience of peers, speaking clearly, and answering relevant questions from the audience). To earn an A, you must demonstrate all or some of the following: creativity, elegance, and capturing the interest and and imagination of the audience.

4. Paper: To earn a B, your write-up should be clear, complete, and have proper mathematical formatting. Keep in mind that precise and careful wording is vitally important in mathematics, and that the strategic use of figures and diagrams can greatly enhance your ability to communicate mathematics in written form. To earn an A, you must demonstrate elegance, excellence in formatting and/or presentation, and/or extra effort to make the project accessible to the reader. More details about the format of the paper are given below.

5. Peer Reviews: To earn a B, your peer reviews should be thorough and helpful. To earn an A, your peer reviews should go above and beyond to make suggestions that will substantially improve the papers you review.

Paper details

1. Papers must be typed using LaTeX with proper mathematical formatting.
2. A list of references (if needed) should include all sources, including those for definitions or ideas in solving the problem or extending it.
3. In addition to a title, an abstract, and list of references, the finished paper should have at least these (labeled) parts
   - an introduction, in which you state and explain the problem/research and place it in context. Terms in the problem should be defined, examples may be used to clarify what is being asked, and you should explain which area(s) of math the problem/research draws on. Anything else of interest (why is the problem/research important? what seemingly unrelated ideas are brought together? why is the result surprising?) may be included to pique the reader's interest.
   - the solution to the problem/explication of the original paper. All mathematics should be accessible to an audience of your (mathematical) peers.
   - an extension section.
   - a conclusion