

Abstract Algebra 1

Project Description

1 Expectations and Logistics

The project is to be completed by groups of 3 or 4 students. Groups will be assigned based on expressed interest in the topic options.

The project consists of three tasks: a written report, a presentation, and a “deliverable”:

- the report should be a well-written and readable document, including:
 - background on the non-mathematical aspects of the topic,
 - a general description of the role of abstract algebra in the topic,
 - a precise description of at least one problem/situation in the topic in which abstract algebra is used,
 - a clear and precise mathematical statement of the relevant theorems, along with proofs,
 - a brief discussion of the current status of the topic,
 - a list of resources for further study and relevant citations.
- the presentation should:
 - be approximately 20 minutes long,
 - give a brief introduction to the non-mathematical aspect of your topic,
 - give a description of the precise problem/situation you considered, and the way in which abstract algebra was used to address the problem/situation
- the “deliverable” is a concrete task to complete and should be delivered in the 10 minutes after your presentation has ended.

Some basic research materials can be provided to initiate a research direction, if desired. However, this project is intentionally open-ended and minimal guidance will be provided. One of the core task of this project is to *find and define the problem*.

2 Topics

- **Crystallography:** Describe how abstract algebra is used in chemistry to classify crystal structures. Deliverable: describe a crystal of your choice using abstract algebra, and present a physical model of the crystal.
- **Coding:** Describe how abstract algebra is used to send messages that can be read despite transmission errors. Deliverable: send a noisy message to the class and help us read it.
- **Cryptography:** Describe how abstract algebra is used in public-key cryptography. Deliverable: send an encrypted message to the class and help us decrypt it.
- **Optimization:** Describe how abstract algebra is used in integer programming. Deliverable: use the methods you studied to solve an explicit integer optimization problem.

- **Experiment design:** Describe how abstract algebra is used to design statistically sound experiments. Deliverable: use the methods you studied to design an experiment.
- **Pattern Design:** Describe how abstract algebra has appeared in pattern design in art-work. Deliverable: lead the class in creating a work of art using abstract algebra.