# MATH 376 Advanced Linear Algebra

## Projects

## Introduction

This project is the culmination of your Advanced Linear Algebra experience. It will draw on everything we have studied this semester and require you to demonstrate a mastery of that content sufficient to explain your topic to the rest of the class. It is the largest single item making up your grade for the course and serves in lieu of a final exam.

The outline below is approximate. I will fill in further details as I see what is needed. Within the outline, there are notes about the **target** and what information is used by later presentations.

- The **target** is meant to be the end goal of the presentation. Be sure to work out your timing so you can reach it.
- (**LG**) means the material is needed for the Lie Group section, (**ST**) for the Spectral Theorem section, and (**IP**) for the Inner Product section.

## Expectations

You are responsible for

- creating a coherent presentation that covers the topic;
- presenting understandable proofs that cite earlier theorems as needed;
- creating clarifying examples to illustrate new ideas as needed;
- timing your presentation to fit within your 30 minutes.

I expect that you will need your full 30 minutes to cover your content; if you are much below that, it means you have room to prove more of the results in your material (and you should do so). You will more likely need to be selective about which results you actually prove, however.

## Broad Outline and Schedule

1. Background info (cstarr) Rest of semester
2. (**IP**) Inner Product Spaces (Beck) 5/10 8-8:30
3. (**ST**) Spectral Theorem (Chris) 5/10 8:40-9:40
4. (**LG**) Lie Groups (Tyler and Zach) 5/10 9:50-10:50

(Times approximate!)

## Detailed Outline

1. Background info (cstarr) (Rest of semester)
   (a) (Brief!) introduction to topology (definition, open sets, metric spaces, manifolds, homeomorphisms, ...) (**ST**) (**IP**) (**LG**)
   (b) A bit of Abstract Algebra (groups, FTA) (**ST**) (**LG**)
   (c) More Linear Algebra:
      i. Jordan Canonical Form (**ST**)
      ii. Bilinear forms (orthogonal subspace, Lemma 6.3.11) (**IP**) (**ST**)
      iii. Normal linear transformations (**ST**)
      iv. Intro to inner product spaces (**IP**) (**ST**)
   (d) Isometries (**LG**)
2. Inner Product Spaces (Beck)

(a) Section 7.2 through Lemma 7.2.13.

(b) Theorem 7.2.1 (prove their $x_i$ actually work)

(c) Orthogonality (subspaces, direct sums, projections, some covered by cstarr previously))

i. Definitions 7.2.4, 7.2.5 (cstarr covered in Chapter 6)

ii. Theorem 7.2.6 (prove)

iii. Lemma 7.2.7 (prove if time)

iv. Corollary 7.2.8 (free! ish)

v. Definition 7.2.10 (**ST**)

vi. Lemma 7.2.11

vii. Corollary 7.2.12 ("prove")

viii. **Target**: Lemma 7.2.13 (example)

3. Spectral Theorem (Leo and Chris)

(a) Section 7.3

(b) Lemma 7.3.16

(c) Lemma 7.3.19

(d) Target: Corollary 7.3.20

(e) Target: Corollary 7.3.21

(f) Target: Corollary 7.3.22

4. Lie groups (Tyler and Zach)

(a) Definition 7.2.17

(b) Lemma 7.2.19

(c) Theorem 7.2.20

(d) Section 8.1

(e) Section 8.2