Mathematics for Robotics (ROB-GY 6013 Section A)

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Mental Map (How to think about the last 5 weeks)

- **Think and write like a mathematician**
  - Mathematical Notation, Logic, Proof Techniques
- **Core Mathematical Objects/Concepts**
  - Fields, Vector Spaces, Subspaces
- **Taking Linear Combinations of Vectors**
  - Linear (In)dependence, Span, Dimension, Basis
- **Representations**
  - Change of Basis, Matrix Representation of Linear Operators
- **Review of Eigenvalues/vectors and Diagonalization**

Exam Philosophy

- The exam will contain questions from each of the **bolded categories** in the mental map.
- The exam will be closed-book and closed notes. A formula sheet will be provided to you (shared on NYU Brightspace).
- There will be both short answer and long answer questions.
  - Short answers can be true/false, multiple choice, or fill-in-the-blank.
  - For long answer questions, you must show all your work to obtain full credit.

Guaranteed Exam Questions

- **You will be asked to write an inductive proof.**
- Recommendation: clearly indicate which proof technique (ordinary or strong induction), what is the base case, induction step, and induction hypothesis. Clarity is key.
    - There are good inductive proof examples included in the Midterm Exam Preparation Materials > PreliminariesProofs
- **You will be asked to be asked to find a change of basis matrix.**
- **You will be asked to diagonalize a matrix.**

Possible Exam Questions

- There can be other proofs on the exam. In those cases, it will be clearly indicated which proof technique should be chosen.
- Checking whether something is or is not a field, vector space, or subspace.
- Checking whether a set of things are linearly (in)dependent

General Tips

Negating Statements

- When in confusion, break down everything into all possible cases.
  - The truth table is an example: find all possible combinations of T/F

Common/Interesting Examples

- **Real numbers are a field**
- **3-D space is a vector space**
  - You can often rely on your intuition about 3-D space to remember properties of span, basis, and dimension.
- **Things that do not look like vectors can be vectors:**
  - n-degree polynomials
- **Things that do not look like matrices can be linear operators:**
  - For the vector space of n-degree polynomials over the field of the real numbers, “taking the derivative” is a linear operator.

Linear Combination

- Many problems related to dimension, basis, representation, linear (in)dependence, etc. simply involve writing a linear combination and setting it equal to 0 or x or something else:

$$\alpha_1 v^1 + \alpha_2 v^2 + \ldots + \alpha_n v^n$$

- So when in confusion, just write the above. It will never hurt.

Extra Study Material

- Homework solutions to select problems have been posted for review
- Sample Midterm Solutions have been posted.