

Mathematics for Robotics (ROB-GY 6013)

Fall 2023 — Section A — 3.0 credits

William Z. Peng, Ph.D

Tuesdays 6:00 PM – 8:30 PM

6 MetroTech Center

Jacobs Building, Room 475

Office Hours

Weekly Schedule TBD

6 MetroTech Center

Rogers Hall, Room 501A

Contact

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Course Webpage

NYU Brightspace

Textbook

Grizzle, J., *ROB 501 Mathematics for Robotics*, University of Michigan, 2022.

- Textbook posted on NYU Brightspace and github.com/michiganrobotics/rob501/tree/main

Prerequisites

Graduate standing. Advisor's approval. Consent of instructor.

Course Objectives

Students will gain familiarity with linear algebra, optimization, differential equations, and probability. They will be able to use mathematical tools and numerical methods for formulating and solving the modeling, estimation, planning, optimization, and control problems related to robotic systems.

Topics

Review of vectors and matrices (linear independence, rank, basis, subspaces, etc.); Matrix operations and types (determinant, inverse, eigenvalues, matrix exponential, etc.); Matrix decompositions (SVD, Eigenvalues, Cholesky, LU, QR, etc.); Newton-Raphson method; Least-squares/pseudo-inverse; Linear, quadratic and nonlinear programming; ODEs with numerical methods; Probability.

Homework

Homework assignments will be posted by the instructor and submitted by the students through NYU Brightspace. Clearly indicate answers by **underlining** or **boxing** them. Late assignments will receive a 15% grade penalty for every day late.

Grading Policy

Homework 25 pts + Midterm 30 pts + Final Exam 45 pts ± Extra Credits[†] 10 pts = Final Grade

Final to Letter Grade

Letter	A	A-	B+	B	B-	C+	C	F
Final Grade	≥95	≥90	≥87	≥83	≥80	≥75	≥70	<70

[†] **Extra credits** of up to +10 pts will be awarded for active and professional class participation (e.g., discussion and interactions during lecture), and **up to -10 pts will be deducted for negative participation** (e.g., disrupting instruction through excessive chatter). Note that there is no deduction of points for absences.

Course Schedule

Week	Date	Content
1	Sep 5	Lecture 1
2	Sep 12	Lecture 2
3	Sep 19	Lecture 3
4	Sep 26	Lecture 4
5	Oct 3	Lecture 5
6	Oct 10	Legislative Monday (No Class)
7	Oct 17	Midterm Exam*
8	Oct 24	Lecture 6
9	Oct 31	Lecture 7
10	Nov 7	Lecture 8
11	Nov 14	Lecture 9
12	Nov 21	Lecture 10
13	Nov 28	Lecture 11
14	Dec 5	Lecture 12
15	Dec 12	Lecture 13
16	Dec 19	Final Exam*

**Exam dates are final.*

Exam Policy	Exams are closed-book and closed-notes. Bring your own scientific calculator. Unexcused absences from an exam will result in a zero grade.
Academic Integrity	Refer to NYU Tandon Policies and Procedures on Academic Misconduct for the Student Code of Conduct (also uploaded to NYU Brightspace).
Other Resources	<p>NYU's Moses Center for Students with Disabilities 726 Broadway, 2nd floor www.nyu.edu/csd 212-998-4980 mosescsd@nyu.edu Students with disabilities must register with CSD to receive accommodations.</p> <p>NYU's Wellness Exchange Available via 24-hour hotline 212-443-9999, chat through the Wellness Exchange app, or appointment for mental health resources. Confidential and free of charge.</p>
Inclusion Statement	NYU values an inclusive and equitable environment for all our students. The instructor of this course hopes to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is this instructor's intent that all students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit.

Additional Readings

- Dingyü Xue and Yang Chen, *System Simulation Techniques with MATLAB and Simulink*, Wiley, (**any edition**).
Companion Website: <https://mechatronics.ucmerced.edu/simubook2013wiley>
- Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Springer, (**any edition**).
Companion Website: Robot Academy <https://robotacademy.net.au/>