NEW YORK UNIVERSITY TANDON SCHOOL OF ENGINEERING
Department of Mechanical and Aerospace Engineering

Foundations of Robotics (ROB-GY 6003)

Fall 2023 — **Section B** — 3.0 credits

William Z. Peng, Ph.D
Thursdays 6:00 PM – 8:30 PM
6 MetroTech Center
Jacobs Building, Room 474

Office Hours
Weekly Schedule TBD
6 MetroTech Center
Rogers Hall, Room 501A

Contact
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Course Webpage
NYU Brightspace

Textbook Craig, J.J., *Introduction to Robotics: Mechanics and Control*, **4th Edition**, Pearson, 2018.

- *All homework assignments and lectures will closely follow the 4th edition of the textbook.*

Prerequisites Undergraduate math: trigonometry, linear algebra, multivariable calculus, ODEs, etc. Basic computer programming. Graduate standing. Advisor's approval. Consent of instructor.

Course Objectives To present fundamental concepts and principles for the analysis, design, and control of robot manipulators and mechanisms. The field of robotics brings together theories from fields such as kinematics, dynamics, design, control, and computer science. Applications of robotics to different fields will be illustrated through lectures and assignments.

Topics Robot components, types, and their mathematical models; Spatial description of position and orientation; Types and modeling of robotic joints; Differential rotations and translations; Forward and inverse kinematics; Homogeneous transformation; Denavit-Hartenberg (DH) kinematic convention; Jacobian and mapping; Manipulator statics and dynamics; Trajectory planning; Robot mechanism; Feedback control.

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. Randomly selected problems will be graded from each assignment and solutions will be uploaded to NYU Brightspace one week after the due date. Late assignments will receive a 15% grade penalty for every day late.

Grading Policy **Homework** 10 pts + **Term Project** 15 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.

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Course Schedule

Week	Date	Content	
1	**Sep 7**	**Textbook Chapters 1–5**	Introduction Spatial Descriptions and Transformations Manipulator Kinematics Inverse Manipulator Kinematics Jacobians: Velocities and Static Forces
2	**Sep 14**		
3	**Sep 21**		
4	**Sep 28**		
5	**Oct 5**		
6	**Oct 12**		
7	**Oct 19**		
8	**Oct 26**	**Midterm Exam***	
9	**Nov 2**	**Textbook Chapters 6–9**	Manipulator Dynamics Trajectory Generation Manipulator-Mechanism Design Linear Control of Manipulators
10	**Nov 9**		
11	**Nov 16**		
12	**Nov 23**		
13	**Nov 30**	**Thanksgiving (No class)**	
14	**Dec 7**	Final Exam Review & Project Help	
15	**Dec 14**	**Final Exam & Term Project Due***	

**Exam dates and project deadlines 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 Student Code of Conduct (also uploaded to NYU Brightspace).

Other Resources

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.

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.

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

- Spong, M.W., Hutchinson, S., and Vidyasagar, M., *Robot Modeling and Control*, Wiley, 2006.
- Sciavicco, L. and Siciliano, B., *Modeling and Control of Robot Manipulators*, McGraw Hill, 1996.
- Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw-Hill, 1987.
- Murray, R.M., Li, Z., and Sastry, S.S., *A Mathematical Introduction to Robotic Manipulation*, CRC Press, 1994.
- Nakamura, Y., *Advanced Robotics: Redundancy and Optimization*, Addison-Wesley, 1991.
- Strogatz, S.H., *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*, Perseus Books, 1994.
- Siciliano, B. and Khatib, O. (Eds.), *Springer Handbook of Robotics*, Springer, 2008.
- Wilson, C.E. and Sadler, J.P., *Kinematics and Dynamics of Machinery*, Second Edition, Prentice Hall, 1997.
- Tsai, L.-W., *Robot Analysis: The Mechanics of Serial and Parallel Manipulators*, John Wiley & Sons, Inc., 1999.