# Introduction to Robotics

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| Instructor | Dr. Petras Swissler<br>Office: ME326<br>Email: Petras.swissler@njit.edu<br>Lecture: Thursday 6pm – 9pm, KUPF 202<br>Office Hours: Friday 9am – 11am, ME326<br>(notice will be given for any deviations from these office hours) |
| Website | Canvas, Discord |
| Course Text | Lecture slides will generally be uploaded to Canvas after the lecture |
| Recommended Reading | No textbooks are mandated for this course, however there are several books that you may find useful to have access to:<br>• Modern Robotics by Lynch and Park, 1st Edition. ISBN: 1107156300<br>• Probabilistic Robotics by Thrun, Burgard, and Fox, 1st Edition. ISBN: 0262201623<br>• Artificial Intelligence by Russel and Norvig, 4th Edition. ISBN: 9356063575 |
| Purchases | For the final project, it may be necessary to purchase equipment |
| Prerequisites | Matrix analysis, Dynamics, Matlab programming |
| Learning Objectives | By the end of this course, students should be able to:<br>1) Demonstrate the principles and concepts in robotics, encompassing robot manipulation, swarm behaviors, robot navigation, and robot control through applied projects.<br>2) Communicate effectively about the principles, challenges, and applications of robotics.<br>3) Analyze and evaluate the performance of robotic systems using appropriate metrics and assessment methods.<br>4) Assess and select appropriate robotic platforms, sensors, and actuators for specific robotic applications or tasks.<br>5) Evaluate ethical, societal, and legal implications associated with the development and deployment of robotics technologies. |

## Grading

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| Weekly In-Class Quizzes: | 5% |
| Individual Projects: | 45% (6%, 13%, 13%, 13%) |
| Final Collaborative Project: | 20% |
| Unit Exams: | 30% ($3 \times 10\%$) |

Final grades will be based on a weighted average of the above.
See https://www5.njit.edu/registrar/policies/grading.php
Scores will not be rounded for the final grade

- `[90, 100]` A
- `[85, 90)` B+
- `[80, 85)` B
- `[75, 80)` C+
- `[70, 75)` C
- `[60, 70)` D
- `[0, 60)` F

## Assignment Turn-In Policy

Assignments will be due at 11:59 PM the day before class. Late assignments will be accepted without penalty until the beginning of class, at which point no further assignments will be accepted without explicit exemption. Exemptions will not be granted for technical issues / computer crashes since such issues should be addressed during the grace period. You should perform work in a folder that is automatically synchronized to the cloud, such as within a Google drive folder.

Assignments must be submitted as two files: a .docx report using the supplied template and a .zip file containing other files pertinent to the work your work (do not use .rar or .7z compression). Any assignment instructions supersede these policies. If the incorrect file formats are submitted, a zero may be issued. It is the responsibility of the student to ensure that the submitted files conform to the assignment turn-in policy and are functional (i.e., not blank, not corrupted).

## Projects

The projects in this course provide students an opportunity to apply classroom learnings in scenarios like those that might be encountered in their research or future work. These projects will be somewhat open-ended in how students can approach them, and students will generally be given several weeks to complete these projects. Project assignments will outline the requisite deliverables. If you choose not to carefully read the instructions you should be prepared for the consequences of that decision; literacy is an unlisted prerequisite for this class.

All work performed towards these projects shall be entirely your own work and should be unique to this class and section. i.e., if you are retaking the class, you are not permitted to re-use work from last year.

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| Readings | The course will involve several assigned readings of academic papers related to the topics discussed in class. Students are expected to perform these readings prior to class. |
| Exams | For most projects there will be an associated exam of duration approximately 1 hour. Exams are planned to be administered the week of the due date of the project and are expected to cover all aspects of the course, including but not limited to: questions regarding concepts introduced in the lectures, questions pertaining to the project, and questions pertaining to the assigned readings.<br>Usage of technology during exams other than those allowed via accommodations or specified by the instructor is not allowed and will be treated as prima facie evidence of academic misconduct. |
| Final Project | The final project will be a group-based project where students will propose an extension of the material covered in class or other robot-related subject and deliver a presentation and final report detailing their work. |
| Exceptions and Exemptions | To maintain fairness to all students, any exceptions or exemptions to course policy must either go through the Dean of Students Office (or similar), or must be approved as far in advance as possible. |
| Academic Integrity | It is your responsibility to be familiar with NJIT expectations regarding what constitutes academic integrity within NJIT, which is available here: https://www5.njit.edu/policies/sites/policies/files/NJIT-University-Policy-on-Academic-Integrity.pdf<br><br>Process: Professors at NJIT are required to submit any suspicion of academic integrity violations to the Dean of Students office. After submission of evidence, the Dean of Students will execute all assessments and judgements regarding responsibility; the professor is not involved in the process after this point unless an academic board hearing is requested.<br><br>Any student that is assessed to have violated academic integrity policy during this course forfeits any and all extra credit opportunities during the semester, including extra credit previously earned.<br><br>Use of fake sources in bibliographies will result in a zero on any assignment in which they appear.<br><br>Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT |

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| | community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf. Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu. |
| Active Learning | This course incorporates active learning activities throughout the semester. These activities have been designed to promote holistic thinking about the material. |
| Policy Regarding Use of Generative AI | By default: the following policy applies regarding the use of AI tools:<br><br>*This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this content area. As such, AI usage is not permitted throughout this course under any circumstance.*<br><br>Deviation from this course policy is only permissible following written approval by the course instructor and only in circumstances outlined in the written approval. In such circumstances, the following policy takes effect:<br><br>*If and when students use AI in this course, the AI must be cited as is shown within the NJIT Library AI citation page for AI. If you have any questions or concerns about AI technology use in this class, please reach out to your instructor prior to submitting any assignments.*<br><br>Failure to comply with the above policy will be considered an academic integrity violation since it constitutes misrepresentation of the work performed. |

Tentative Course Outline:

| WEEK | DATE | DUE | TOPICS |
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| 1 | Sep 4 | | • Course Introduction<br>• Matlab refresher<br>• Degrees of freedom |
| 2 | Sep 11 | Project 0 | • Rotation and transformation matrices<br>• Forward kinematics |
| 3 | Sep 18 | Project 1.a | • Forward kinematics pt 2<br>• Joint torques |
| 4 | Sep 25 | Project 1.b | • Inverse kinematics |
| 5 | Oct 2 | | • Special topics 1 |
| 6 | Oct 9 | Project 1.c | • Exam: Kinematics<br>• Introducing Swarm robotics |
| 7 | Oct 16 | | • Swarm algorithms and hardware |
| 8 | Oct 23 | | • Special topics 2 |
| 9 | Oct 30 | Project 2<br>Project Selection | • Exam: Swarm robotics<br>• Path planning algorithms |
| 10 | Nov 6 | Project Proposal | • Sensor measurement<br>• Information filtering |
| 11 | Nov 13 | | • Mechatronics 1: Basics of Arduino |
| 12 | Nov 18 | Project 3 | • Exam: Planning and Perception<br>• Mechatronics 2: Sensor processing |
| 13 | Nov 25 | | • Mechatronics 3: Control |
| 14 | Dec 4 | | • Final project presentations |
| 15 | Dec 11 | Final report | • Reading day: no class |