

16-741: Mechanics of Manipulation

Fall 2023

Class Sessions:

Monday & Wednesday 11:00 AM - 12:20 PM

Location: WEH 2302

Website:

<https://zackory.com/16741-23/>

Professor:

Zackory Erickson (zackory@cmu.edu)

Office Hours:

Upon request

Course Description

Mechanics of Manipulation is a graduate level course that dives into the fundamentals of robotic manipulation. Through this course you will learn the kinematics, statics, and dynamics of robotic manipulators as they interact with the world to accomplish tasks. You will gain experience with the intelligent use of kinematic constraint, gravity, and frictional forces. Additional topics include rigid body mechanics, automatic planning based on mechanics, deformable manipulation, and simulation of dynamic manipulation. Applications of robotic manipulation are drawn from physical human-robot interaction, manufacturing, and other domains.

Pre- &/or Co-Requisites

Kinematics of manipulators, elementary Newtonian mechanics, some python experience.

Course Goals and Learning Objectives

The primary goal of this course is to provide you with both a foundational and practical understanding of robotic manipulation. By the end of this course, you should:

- i) Have an appreciation of the state of the art in robotic manipulation.
- ii) Be able to model the mechanical interactions involved in manipulation.
- iii) Know the foundations of statics, static manipulation, and quasistatic manipulation.
- iv) Be able to model rigid-body dynamics and dynamic manipulation.
- v) Have experience with various applications of robotic manipulation.

Course Textbook

The textbook for the course is “Mechanics of Robotic Manipulation”, by Matthew T. Mason. MIT Press, 2001.

An online version of the textbook can be found here:

<http://cognet.mit.edu/book/mechanics-of-robotic-manipulation>

Grading

Component	Percentage
Assignment	60%
Term Project	40%

Take care of yourself

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is almost always helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

Diversity and Inclusive Learning

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. **Each of us is responsible for creating a safer, more inclusive environment.** I strive to create a class environment that is respectful of diversity where all students feel supported and encouraged to ask questions and engage in discussion. I welcome suggestions and feedback about this.

My research involves creating robotic technology for accessibility, and I feel strongly that diversity in the classroom includes accommodating diverse abilities. If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

Food Insecurity

If you are worried about affording food or feeling insecure about food, there are resources on campus who can help. Email the CMU Food Pantry Coordinator to schedule an appointment:

Pantry Coordinator

cmu-pantry@andrew.cmu.edu

412-268-8704 (SLICE office)

Academic Integrity

Academic Integrity is a core CMU value, and as a member of the CMU community, it is important that the work you turn in for this class is wholly your own.

Collaboration is integral to learning, and you are encouraged to discuss course material outside of class. However, any assistance you get on graded material, including assistance from classmates and CMU academic resources, **should be acknowledged**. Include an acknowledgments section for assignments noting who helped and in what way.

All content produced for this class must be **original to the submitter(s)**, unless noted. Any sources of information should be cited correctly. Plagiarism is a very serious offense and will be treated according to university policy. If you have any questions about whether something is allowable, please contact me. For more details, see CMU's academic integrity policy:

<https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>