Course Syllabus

MEC 529: Introduction to Robotics (Theory and Applications)

Spring 2022

Instructor	Amin Fakhari, Ph.D., Department of Mechanical Engineering
Office	165 Light Engineering, Stony Brook University
Office Hours	TuWe 4:15 – 5:45 PM (and, any other time by appointment*)
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* I will respond to your emails as soon as possible, however, please allow 24-48 hours for a response. Please use your SBU email for all your communications.

Course Detail

Title	MEC 529: Introduction to Robotics – Theory and Applications
Credit	3
Lecture	Tu 1:15 - 4:05 PM, Humanities 1023
Prerequisites	A knowledge of undergraduate-level dynamics and control, a foundation in linear algebra and calculus, and an ability to program in MATLAB or Python.

References

- Kevin M. Lynch and Frank C. Park, *Modern Robotics: Mechanics, Planning, and Control*, Cambridge University Press, 2017 [Publisher, Amazon, PDF (freely available)].
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2009 [Publisher, Amazon].
- Richard M. Murray, Zexiang Li, and S. Shankara Sastry, *A Mathematical Introduction to Robotic Manipulation*, CRC Press, 1994 [Publisher, Amazon].
- John Craig, *Introduction to Robotics: Mechanics and Control*, 4th Edition, Pearson, 2018 [Publisher, Amazon].

Course Description

This course provides an overview of fundamental concepts in Robotics including kinematics, dynamics, and control. The aim is to provide the fundamental knowledge and tools needed for modeling, design, planning, and control of robotic systems. The main focus of the course will be on forward and inverse position kinematics and differential kinematics, dynamics, trajectory generation, motion planning, and feedback control within the context of serial robotic manipulators. This course is intended for graduate students with an interest in Robotics. Advanced undergraduates with a demonstrated interest in Robotics are also welcome. Prerequisites include a knowledge of undergraduate-level dynamics and control, a foundation in linear algebra and calculus, and the ability to program in MATLAB or Python.

Course Learning Objectives

Upon completion of this course students will be able to

- Convert description of points and vectors among different reference frames.
- Know about different representations of the configuration of a rigid body.
- Solve forward and inverse position and velocity kinematics problem of a serial manipulator.
- Form Jacobian of serial manipulators and use it in singularity analysis and control.
- Know trajectory planning techniques for serial manipulators.
- Know how to derive the equations of motion of serial manipulators.
- Understand basic feedback control schemes for controlling a manipulator.
- Implement kinematic analysis, dynamic analysis, and control algorithms for manipulators in computer programs/simulations.

Course Main Topics

1. Configuration Space,
2. Rigid-Body Motions,
3. Forward Kinematics,
4. Velocity Kinematics and Statics,
5. Inverse Kinematics,
6. Dynamics,
7. Trajectory Generation,
8. Motion Planning,
9. Robot Control,
10. Grasping and Manipulation.

Tools

Blackboard: It is required that you use the Blackboard for this course. Blackboard is used for facilitation of communications between faculty and students, submission of assignments, posting of the course materials, important announcements, and grades.

MATLAB: It is a programming and numeric/symbolic computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamical systems and embedded systems. You can Download and Install MATLAB Software using your SBU email address. Make sure to install Robotics System Toolbox while installing MATLAB.

Examinations

Midterm Exam Tuesday, Mar. 8, 2022 (in class)
Final Exam Monday, May. 16, 2022, 11:15-1:45 PM (in class)

(a) There will be no make-up exams unless provided me an official proof of the reason within three days following the exam.
(b) The exam dates are subject to change. Students will be notified in a timely manner of any changes in the exam dates.

Homework Assignments, Paper Review, and Final Project

- Homework assignments will be assigned in the class or posted on Blackboard.
- You are allowed and encouraged to discuss and work with your classmates, however, you have to submit your own homework. Any discussion or help that you have taken from your classmates should be acknowledged explicitly by writing their names and the kind of help you have received. Note that your homework should not be a copy of your classmate's homework.
- You have up to 15 late days for use on any homework assignment throughout the semester, but no homework may be more than 5 days late. Once you used your budget of 15 late days for the semester, each late day will be assessed a 25% penalty on your grade for that assignment(s).
- Each student will select an academic paper to review, present, and discuss with the class. Each presentation should follow the following format:
  (a) Title Slide: Including authors names and institutions, the presenter's name, and date,
  (b) Summary Slide: Summary of the main contributions of the paper,
  (c) Background Slide(s): Summary of the relevant background of the problem to be solved,
  (d) Method Slide(s): Summary of the methods used,
  (e) Results Slide(s): Details of the paper's main results including supporting figures,
  (f) Strengths Slide(s): Discussion of at least one major strength of the paper,
  (g) Weakness Slide(s): Discussion of at least one major weakness and how it might be improved.
- There will be one final project that will be done in groups of at most 2 students. You have to submit a final project report and present it in the class (More information will be provided during the semester).
- No late submission is allowed for the final project report.
- All students are expected to attend all paper review and final project presentations.

Grading Policy

Homework	30%
Paper Review & Presentation	10%
Final Project & Presentation	30%
Midterm Exam	15%
Final Exam	15%

Grading Scale

A	[100, 90]%	**A**$^-$	(90, 85]%		
B$^+$	(85, 80]%	**B**	(80, 75]%	**B**$^-$	(75, 70]%
C$^+$	(70, 65]%	**C**	(65, 60]%	**C**$^-$	(60, 55]%
F	(55, 0]%				

- Grading will not probably be on a curve.

Syllabus Disclaimer

The instructor views the course syllabus as an educational understanding between the instructor and students. Every effort will be made to avoid changing the course schedule, materials, assignments, and deadlines, but the possibility exists that unforeseen events will make syllabus changes necessary. The instructor reserves the

right to make changes to the syllabus as deemed necessary. Students will be notified in a timely manner of any syllabus changes via email or in the Blackboard Announcements. Please remember to check your SBU email or Blackboard Announcements regularly.

University Policies and Statements

Academic Integrity Statement

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html.

Student Accessibility Support Center (SASC) Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center (SASC). For procedures and information go to Evacuation Guide for People with Physical Disabilities and search Fire Safety and Evacuation and Disabilities.

Critical Incident Management Statement

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Until/unless the latest COVID guidance is explicitly amended by SBU, during Spring 2022 "disruptive behavior" will include refusal to wear a mask during classes. (For the latest COVID guidance, please refer to: https://www.stonybrook.edu/commcms/strongertogether/latest.php)

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