Course Description

Prof. Gerardo Flores

January 2025

Robotics and Automation (CSCE 3345 - SENG 3340)

TAMIU

Robotics and Automation (CSCE 3345 - SENG 3340)

Times and Location

MWF 12pm-12:55pm in Academic Innovation Center 204

Study of the use, design, and deployment of industrial automation and robotics technologies in high-precision, multi-product manufacturing environments. Robot manipulators, kinematics and dynamics, robot automation and control, integrated robotic systems for manufacturing, automation in manufacturing, programmable logic controllers, applications to industrial systems. Interchangeable with CSCE 3345.

Prerequisite: ENGR 2305, ENGR 2105, and MATH 3310

Additional Course Information:

- **Course Overview**
  - Comprehensive introduction to robotics and automation principles.
  - Focus on designing, analyzing, controlling, and implementing robotic systems.

- **Key Topics**
  - **Robotic Manipulators**: Forward and inverse kinematics, Jacobians, dynamics, and motion planning.
  - **Automation and Control**: Applying control theories for precise robotic operations.
  - **Mobile Robotics**: Fundamentals of mobile and autonomous systems.

- **Practical Integration**
  - Combines theory with hands-on experience using **Robotics Toolbox**, **Python**, and **ROS**.
  - Simulation and control of robotic systems in virtual environments.

- **Outcomes**
  - Develop problem-solving skills for academic and industrial challenges.
  - Gain expertise in simulation and implementation of robotic systems.

Prerequisites:

- Basic knowledge of linear algebra, differential equations, and control systems.
- Familiarity with programming languages such as Python or C++ is recommended.

Target Audience

- Ideal for undergraduate and graduate students in engineering, computer science, and related fields.
- Focused on those interested in robotics, automation, and intelligent systems.

AI Tools

- Encouraged as supplementary resources for learning and problem-solving.
- Not permitted during exams; students will be evaluated on their own knowledge and skills.

Program Learning Outcomes

- **Mathematical Modeling and Analysis**
  - Proficiency in deriving and analyzing kinematic and dynamic models for manipulators and mobile robots.

- **Control System Design**
  - Design and implement simple controllers to ensure stability, accuracy, and efficiency.

- **Simulation and Implementation**
  - Utilize tools like Robotics Toolbox, Python libraries, and ROS to simulate, control, and analyze robotic systems.

- **Problem-Solving and Critical Thinking**
  - Solve complex engineering problems in robotics with innovative, systematic approaches.

- **Programming and Software Development**
  - Develop software for robotics applications, including sensor integration and real-time control in Python or C++.

- **Collaborative Project Management**
  - Work in multidisciplinary teams, demonstrating project management and communication skills.

- **Innovation and Lifelong Learning**
  - Stay updated on robotics and automation, fostering creativity and continuous learning.

Student Learning Outcomes

1. Develop a deep understanding of robotics's mathematical models and control algorithms.

2. Gain proficiency in using Python and simulating and controlling robotic systems.

3. Design and analyze robotic systems for various applications, including industrial automation and autonomous navigation.

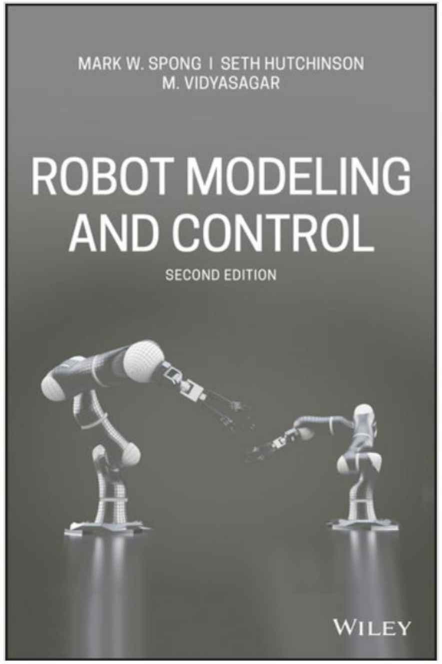
4. Understand and address ethical issues and societal impacts of deploying robotics and automation technologies.

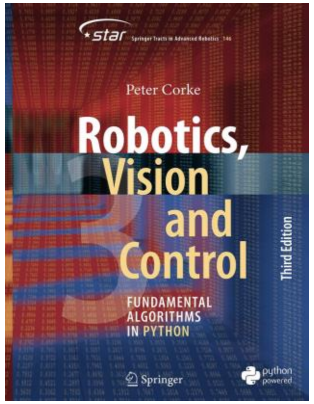
Important Dates

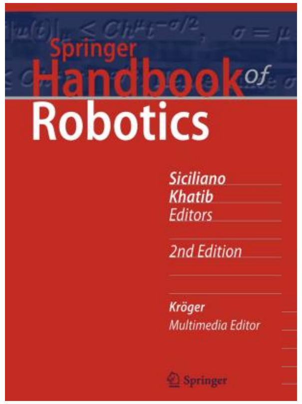
Visit the Academic Calendar (tamiu.edu) (https://www.tamiu.edu/academiccalendar/) page to view the term's important dates.

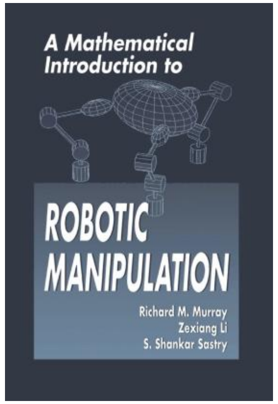
Textbooks

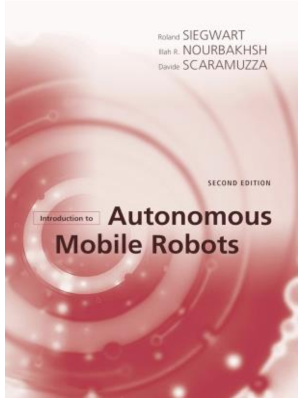
Group	Title	Author	ISBN
Optional	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, M. Vidyasagar	978-1-119-52404-5
Optional	Robotics, Vision and Control: Fundamental Algorithms In MATLAB	Peter Corke	978-3319544120
Optional	Springer Handbook of Robotics	Bruno Siciliano, Oussama Khatib	978-3-540-30301-5
Optional	A Mathematical Introduction to Robotic Manipulation	Richard M. Murray, Zexiang Li, S. Shankar Sastry	978-0849379819
Optional	Introduction to Autonomous Mobile Robots	Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza	9780262015356
Optional	Control of Robot Manipulators in Joint Space	Rafael Kelly , Victor Santibáñez Davila , Antonio Loría	978-1-85233-999-9
Optional	Introduction to Modeling and Simulation: A Systems Approach	Mark W. Spong	978-1-119-98288-3
Optional	Linear System Theory and Design	Chi-Tsong Chen	9780199964543
Optional	Applied Nonlinear Control	Jean-Jacques Slotine, Weiping Li	978-0130408907

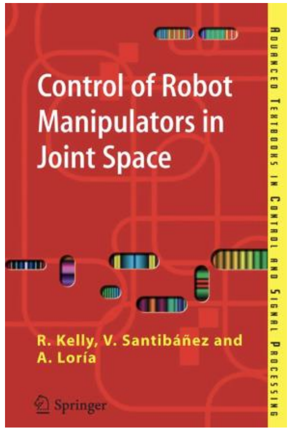


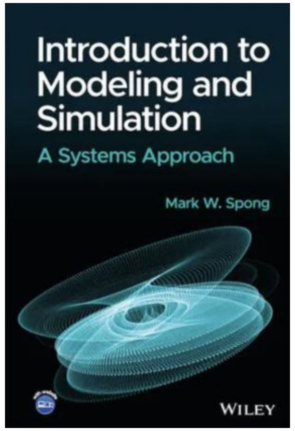


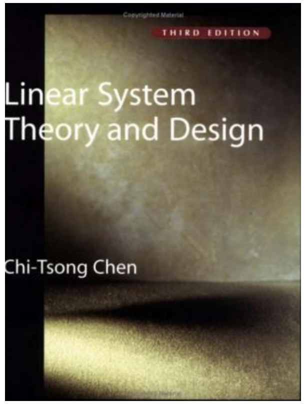


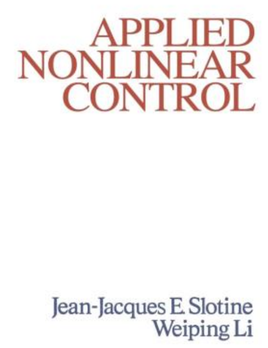












Other Course Materials

1. ROS tutorials (https://wiki.ros.org/ROS/Tutorials/).
2. Visual Studio Code (https://code.visualstudio.com/)
3. Robotics Toolbox (https://github.com/petercorke/robotics-toolbox-python/) for Python

Grading Criteria

- Final Exam – 25%: A comprehensive final exam that assesses the overall knowledge of the course.

- Midterm (2 Key Assignments or Exam) – 30%: Two key assignments or a midterm exam that together account for 30% of the total grade, with each
- component (assignment or exam) representing 15% of the overall grade.

- Project – 45%: The major project is a cornerstone of the course, accounting for nearly half of the total grade. Students will collaborate in teams of 5 to n members to develop a comprehensive project that spans the entire semester.

This project is an opportunity to apply the knowledge and skills gained throughout the course in a meaningful and practical way.

Teams have the flexibility to choose from a range of project types, including:

- **Research Work**
  - Conduct research on a cutting-edge robotics or automation topic, analyzing a relevant research paper and presenting findings.
  - Include implications, potential improvements, and future research directions.

- **Presentation**
  - Deliver a professional-grade presentation on a specialized robotics topic, supported by thorough research and simulations if needed.
  - Topics can include chapters from the *Springer Handbook of Robotics*.

- **Robot Design in ROS/Python**
  - Design, simulate, and test a robotic system using ROS or Python with the Robotics Toolbox.
  - Showcase proficiency in both theoretical and practical robotics concepts.

- **Real Robot Construction**
  - Build and program a physical robot, demonstrating creativity, engineering skills, and teamwork.

Grading Criteria

GRADE	PERCENTAGE
A	91-100
B	80-90.9
C	70-79.9
D	60-69.9
F	Below 60

Assignments

- Tasks include readings, research, exercises, and coding challenges aligned with lecture topics.
- Designed to reinforce understanding and provide hands-on experience with theoretical concepts.
- Some assignments may offer **extra credit**, evaluated on complexity and effort, to boost final grades.

Schedule of Topics and Assignments

Week of	Agenda/Topic	Reading(s)	Due
1/22	Introduction to the Course	Course overview and objectives.	
1/27	Introduction to robotics and preliminaries	Chapter 1 of Spong's book Chapter 1 of Siegwart's book	
2/3	Rigid motions and homogenous transformations	Chapter 2 of Spong's book Chapter 2 of Murray's book Chapter 2 of Corke's book	
2/10	Rigid motions and homogenous transformations	Chapter 2 of Spong's book Chapter 2 of Murray's book Chapter 2 of Corke's book	
2/17	Forward kinematics	Chapter 3 of Spong's book Chapter 1.6 of Handbook of Robotics Chapter 3.2 of Murray's book Chapter 7.1 of Corke's book	
2/24	Forward kinematics	Chapter 3 of Spong's book Chapter 1.6 of Handbook of Robotics Chapter 3.2 of Murray's book Chapter 7.1 of Corke's book	
3/3	Midterm		
3/10	Spring Break.	No classes.	

3/17	Inverse kinematics	Chapter 5 of Spong's book Chapter 1.7 of Handbook Chapter 3.3 of Murray's book Chapters 7.2 and 8.6 of Corke's book
3/24	Velocity kinematics and jacobians	Chapter 4 of Spong's book Chapter 3.4 of Murray's book Chapter 8 of Corke's book Chapters 1.8 - 1.9 of Handbook
3/31	Velocity kinematics and jacobians	Chapter 4 of Spong's book Chapter 3.4 of Murray's book Chapter 8 of Corke's book Chapters 1.8 - 1.9 of Handbook
4/7	Dynamics	Chapter 6 of Spong's book Chapter 4 of Murray's book Chapter 9 of Corke's book
4/14	Dynamics	Chapter 6 of Spong's book Chapter 4 of Murray's book Chapter 9 of Corke's book
4/21	Robot control Vision-based control	Chapter 8 of Spong's book Chapter 4 of Murray's book Chen and Slotine books Chapter 9 of Corke's book Chapter 11 of Spong's book Chapter 15 of Corke's book
4/28	Final projects week	Final projects and exercises for preparation of final exams
5/5	Reading Day.	No classes. Final Examination period.
5/12	Final Examination period.	