



# CS65K Robotics

Modelling, Planning and Control

Welcome to CS 65K Course

WELCOME

DR. ERIC CHOU

IEEE SENIOR MEMBER

# Instructor

SECTION 1

Eric Chou, Ph.D.



IEEE Senior Member  
CSTA Member  
USAT/AAU Coach



IEEE

USC



National  
Taiwan  
University

# Eric Chou, Ph.D.

A researcher. An inventor. An Engineer.

- IEEE Senior Member
- Founder of eC Academy ([Udemy](#), [Teachable](#), and [YouTube](#))
- CEO & President, Charisma Comm. Inc.

## Ph.D. Dissertation:

- [VLSI Array Sensory Information Processing](#)
- University of Southern California, Dept. of Electrical Engineering and Computer Science
- Category:** VLSI design, Artificial Intelligence, Neural Networks for Machine Learning, Array Processors, Communication Channel Equalization, Parallel Processing.

## My Patents (Part):

- [Amorphous Silicon Sensor](#)
- [Ethernet and WIFI Channel Equalization Scheme](#)
- [Multilingual Input System for Mobile Device](#)
- [Active Pixel Readout Channel](#)
- [Analog Sensor](#)
- [Adjustable Sensor](#)
- [Multimedia accessible universal input device](#)
- [Auslesungskanal für aktiven Pixelsensor](#)
- [Image sensor](#)
- [輸入國際語文文字的系统及方法](#)
- [十鍵國際語文輸入法](#)

## National Taiwan University

B.S. in Computer Science and Information Engineering

## University of Southern California

M.S./Ph.D. in EECS

Hewlett Packard Labs, Micrel Semiconductore, Glenayre Communication

[Inventor: Eric Y. Chou](#)

[Inventor: Eric Ying-Chin Chou](#)

[PhD PDF](#)

[PhD Dissertation: VLSI Array Sensory Information Processing](#)

# Textbook

## SECTION 2

# Robotics

## Modelling, Planning and Control

Publisher:

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ISBN: 978-1-84628-641-4

[Robotics: Modelling, Planning and Control \[LINK\]](#)

Bruno Siciliano



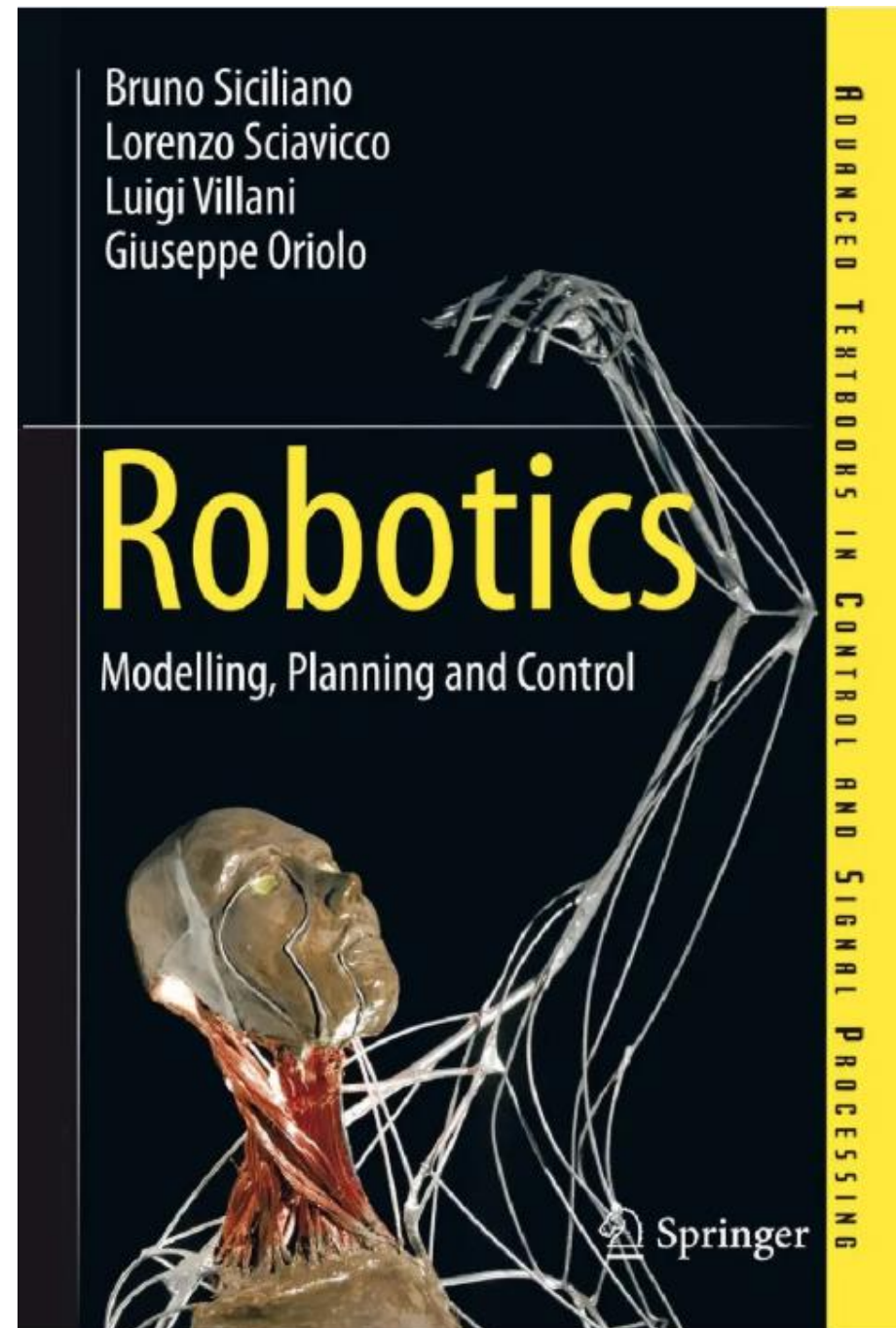
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# Syllabus

## SECTION 3



# All Types of Robots by Locomotion

## STATIONARY ROBOTS

Cartesian Robots



Cylindrical



Spherical



SCARA



Articulated



Parallel

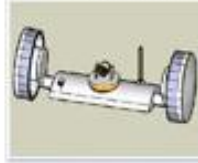


## WHEELED ROBOTS

Single Wheel



2 Wheeled



3 Wheeled



4 Wheeled



6 Wheeled



Tracked Robots



## LEGGED ROBOTS

One Leg



Bipedal



Tripedal



Quadrupedal



Hexapod



Many Legs



SWIMMING ROBOTS



FLYING ROBOTS



Robotic Balls



SWARM ROBOTS



MODULAR ROBOTS



MICRO Robots



NANO Robots



SOFT ROBOTS



SNAKE Robots



CRAWLER Robots



HYBRID Robots



# Robotics: Modelling, Planning and Control

## Chapter 1: Introduction

### Planning (Optimization, AI)

Chapter 4: Trajectory Planning (Static)

Chapter 11: Mobile Robots

Chapter 12: Motion Planning (Dynamic)

Appendix E: Graph Search Algorithms

### Modelling (Kinematics, Transformation)

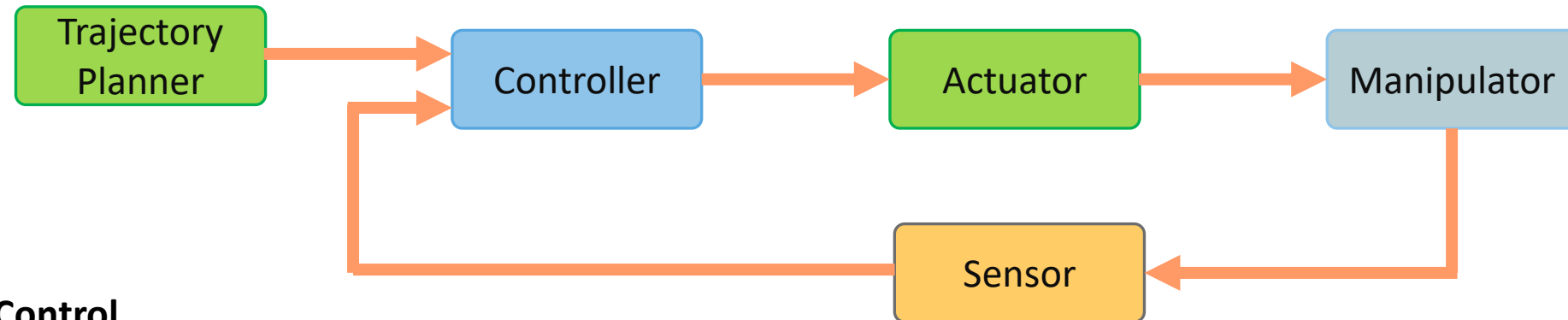
Chapter 2: Kinematics (Static)

Chapter 3: Differential Kinematics and Statics

Appendix A: Linear Algebra

Chapter 7: Dynamics

Appendix B: Rigid-body Mechanics



### Control

Chapter 8: Motion Control

Chapter 9: Force Control

Chapter 10: Visual Servoing

Appendix C: Feedback Control

Appendix D: Differential Geometry

### Robot Architecture

Chapter 5: Actuators and Sensors

Chapter 6: Control Architecture

# Grading: Accumulated Point System

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- We use an Accumulated Points System for grading.
- For example, quiz 1 is worth of 100 pts with 10 bonus pts. Quiz 2-1 is worth of 50 pts with 5 bonus pts. Term project is worth of 500 pts with 100 bonus pts, and something like that for all assignments.
- At the end of the semester, we sum up all your total points, including bonus points. We divide your total pts with the maximum base pts and get a percentage score. Use the percentage score to decide your course grade. Your total pts may be higher than the maximum base pts due to the bonus pts.

	Name ▾	Grading Period	Category ▾	Due Date ▾	Date Created ▾	Points Possible ▾
⛶	<input type="checkbox"/> Weighted Total	Not in a Grading Period	Calculated Grade		None	0 (may vary by student)
⛶	<input type="checkbox"/> Total (External Grade)	Not in a Grading Period	Calculated Grade		None	2255 (may vary by student)
⛶	<input type="checkbox"/> WK1 DB1: Introductions	Not in a Grading Period	Discussion	None	Jan 26, 2017	20
⛶	<input type="checkbox"/> WK1 DB2: Language	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK2 DB1: NFA	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK3 DB1: Dynamic Binding	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK4 DB1: IEEE 754	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK5 DB1: Data Types	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK6 DB1: Calling Sequence	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK7 DB1: Object-oriented Programming	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> WK8 DB1: Synchronization Schemes	Not in a Grading Period	Discussion	None	Jan 28, 2017	20
⛶	<input type="checkbox"/> Quiz 1	Not in a Grading Period	Test	None	Feb 6, 2017	100
⛶	<input type="checkbox"/> Quiz 2-1	Not in a Grading Period	Test	None	Feb 6, 2017	50
⛶	<input type="checkbox"/> Domain Name Checking Project	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Term Project Assignment Submission	Not in a Grading Period	Assignment	None	None	500
⛶	<input type="checkbox"/> Quiz 2-2	Not in a Grading Period	Test	None	Feb 22, 2017	150
⛶	<input type="checkbox"/> Term Project Proposal	Not in a Grading Period	Assignment	None	None	100
⛶	<input type="checkbox"/> Quiz 3	Not in a Grading Period	Test	None	Feb 23, 2017	75
⛶	<input type="checkbox"/> Quiz 4	Not in a Grading Period	Test	None	Feb 23, 2017	75
⛶	<input type="checkbox"/> Quiz 5	Not in a Grading Period	Test	None	Feb 23, 2017	75
⛶	<input type="checkbox"/> Quiz 6	Not in a Grading Period	Test	None	Feb 23, 2017	75
⛶	<input type="checkbox"/> Quiz 7	Not in a Grading Period	Test	None	Feb 23, 2017	75
⛶	<input type="checkbox"/> Quiz 8	Not in a Grading Period	Test	None	Feb 23, 2017	75
⛶	<input type="checkbox"/> Quiz 9	Not in a Grading Period	Test	None	Feb 23, 2017	100
⛶	<input type="checkbox"/> Quiz 10	Not in a Grading Period	Test	None	Feb 23, 2017	100
⛶	<input type="checkbox"/> Quiz 13	Not in a Grading Period	Test	None	Feb 23, 2017	100
⛶	<input type="checkbox"/> Week 1 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Week 2 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Week 3 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Week 4 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Week 5 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Week 6 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Week 7 Homework Due	Not in a Grading Period	Assignment	None	None	50
⛶	<input type="checkbox"/> Exit Reviews	Not in a Grading Period	Test	None	Mar 8, 2017	25

(Subject to changes)

# Grades are calculated based on the percentage score, as follows:

<i>Score</i>	<i>Grade</i>
90% and above	A
80% up to 89%	B
70% up to 79%	C
60% up to 69%	D
59% and below	F

Week	Lecture	Assignments	
One	Chapter 1: Introduction Appendix A: Review of Linear Algebra and Python	Discussion, Quiz	
Two	Chapter 2: Kinematics, Rotational Matrix and Displacement Vector	Discussion, Quiz	
Three	Chapter2/3: Inverse Kinematics/Differential Kinematics	Discussion, Quiz, Term Project Proposal	
Four	Chapter3/4: Differential Kinematics/Trajectory Planning	Discussion, Quiz	
Five	Chapter 5: Actuators and Sensors	Discussion, Quiz	
Six	Chapter 10: Vision and Image Processing	Discussion, Quiz	
Seven	Chapter 6/7/9: Control, Dynamics and Force Control	Discussion, Quiz	
Eight	Chapter 8/11/12: Motion Control, Mobile Robots, and Motion Planning	Discussion, Quiz, Term Project	

# Background

SECTION 4



**High School:**

Physics (AP 1/2/C), Chemistry, Biology, Calculus (BC), Trigonometry, Geometry, Number Theory and Statistics

**College:**

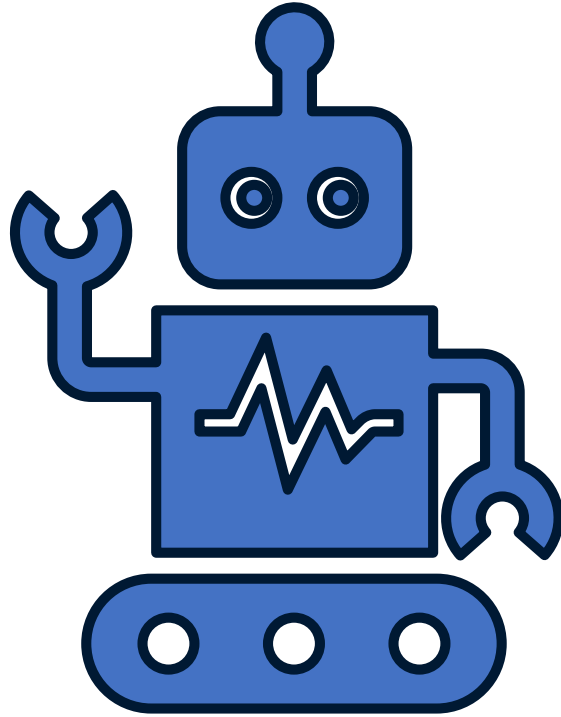
Computer Science:      Programming Skills (Java I/II/III, C++ I/II/III, Python I/II/III), Data Structures/Algorithms, Assembly and Computer Organization, Embedded OS, Logic Design, Digital Electronics, Computer Architecture, Networks, Neural Network, Graph Algorithms

Mathematics:      Linear Algebra, Discrete Math, Calculus I/II/III, Multivariable Calculus, Differential Equation, College Probability and Statistics, Transform Theory, Optimization Theory

Engineering:      College Physics I/II/III (Mechanism, Electricity and Electromagnetism, Wave and Optics), Basic Electrical Engineering, Circuit and System, Signal and System, Control System (Feedback control), Adaptive Filtering, Micro-processor-based System

**AI and Robotics:**

- Machine Learning
- Decision-making & Robotics
- Perception & Language
- Human-AI Interaction
- Ethics & AI



# Robotics

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- To play a robot is easy. All high school students can do it.
- To program a robot need some programming skills, a college student can do it.
- To design a robot is hard, it needs a lot of knowledge.

CPSC 65000 Course Schedule – Fall 2 Term - 2022					
Date	Topic	Quiz	Assignment	Discussion	Project
W1-10/24-10/30	Introduction to Robotics, and the review of Linear Algebra (Ch. 1, Appendix A)	100 pts	150 pts	DB1-20 pts	
W2-10/31-11/06	Kinematics, Rotational Matrix and Displacement Vectors (Ch. 2)	150 pts	150 pts	20 pts	
W3-11/07-11/13	Inverse Kinematics and differential Kinematics. (Ch.2/Ch.3)	150 pts	150 pts	20 pts	Proposal 100 pts
W4-11/14-11/20	(Ch.3/Ch.4)	100 pts	150 pts	20 pts	
W5-11/21-11/27	Actuator and Sensor (Ch.5)	100 pts	150 pts	DB1-20 pts DB2-20 pts	
W6-11/28-12/04	Visual Control and Image Processing. (Ch.10)	100 pts	150 pts	20 pts	
W7-12/05-12/11	Control (Ch. 6/7/9)	100 pts	150 pts	20 pts	
W8-12/12-12/17	Motion Robotics. (Ch. 8/11/12)	100 pts	150 pts	20 pts	Final Report 500 pts
Class Participation	300 pts (Professor will provide this grade based on your class attendance record, discussion involvement, and many other factors. )				
Total	300 pts	900 pts	1200 pts	200 pts	600 pts
Grand Total (maximum base points)	3200 pts (May change)				