MEAM 520

Final Exam Summary

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General Robotics, Automation, Sensing, and Perception Lab (GRASP)

MEAM Department, SEAS, University of Pennsylvania

GRASP LABORATORY

December 24, 2013

Name _____

Final Exam

MEAM 520, Introduction to Robotics
University of Pennsylvania
Katherine J. Kuchenbecker, Ph.D.

December 18, 2013

You must take this exam independently, without assistance from anyone else. You may bring in a calculator and four 8.5"×11" sheets of notes for reference. Aside from these pages of notes, you may not consult any outside references, such as the textbook or the Internet. Any suspected violations of Penn's Code of Academic Integrity will be reported to the Office of Student Conduct for investigation.

This exam consists of several problems. We recommend you look at all of the problems before starting to work. If you need clarification on any question, please ask a member of the teaching team. When you work out each problem, please show all steps and box your answer. On problems involving actual numbers, please keep your solution symbolic for as long as possible before converting to numbers at the end; this will make your work easier to follow and easier to grade. The exam is worth a total of 100 points, and partial credit will be awarded for the correct approach even when you do not arrive at the correct answer.

	Points	Score
Problem 1	20	
Problem 2	20	
Problem 3	20	
Problem 4	20	
Problem 5	20	
Total	100	

I agree to abide by the University of Pennsylvania Code of Academic Integrity during this exam. I pledge that all work is my own and has been completed without the use of unauthorized aid or materials.

Signature _____

Date _____

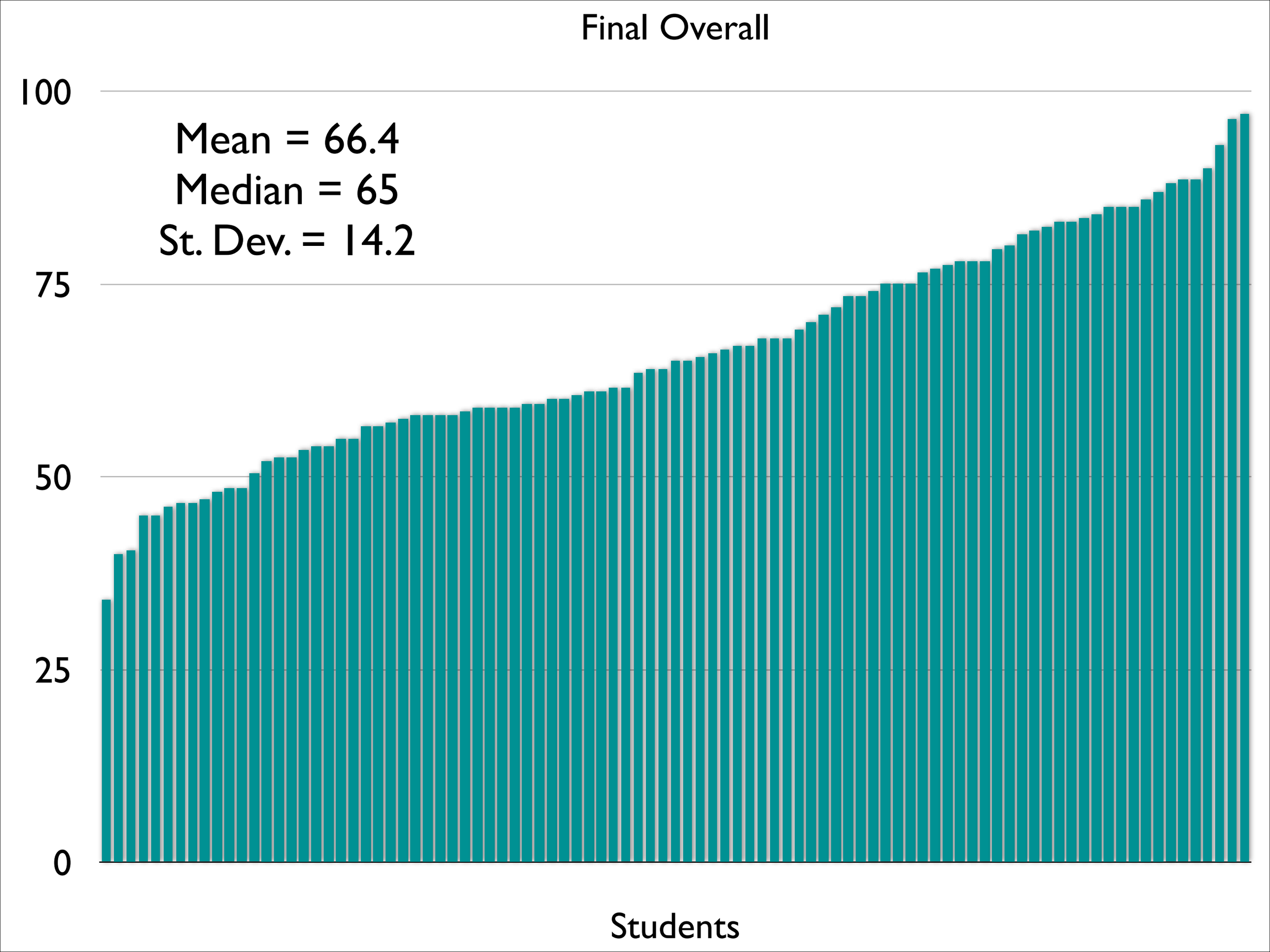
We have graded the final exam.

Scores for each problem are available in Canvas.

The following slides show the distribution of scores overall and on each of the five problems.

You can pick your graded exam up from the MEAM Department Office (Towne 229) during business hours; they are closed 12/25 and some other upcoming holidays.

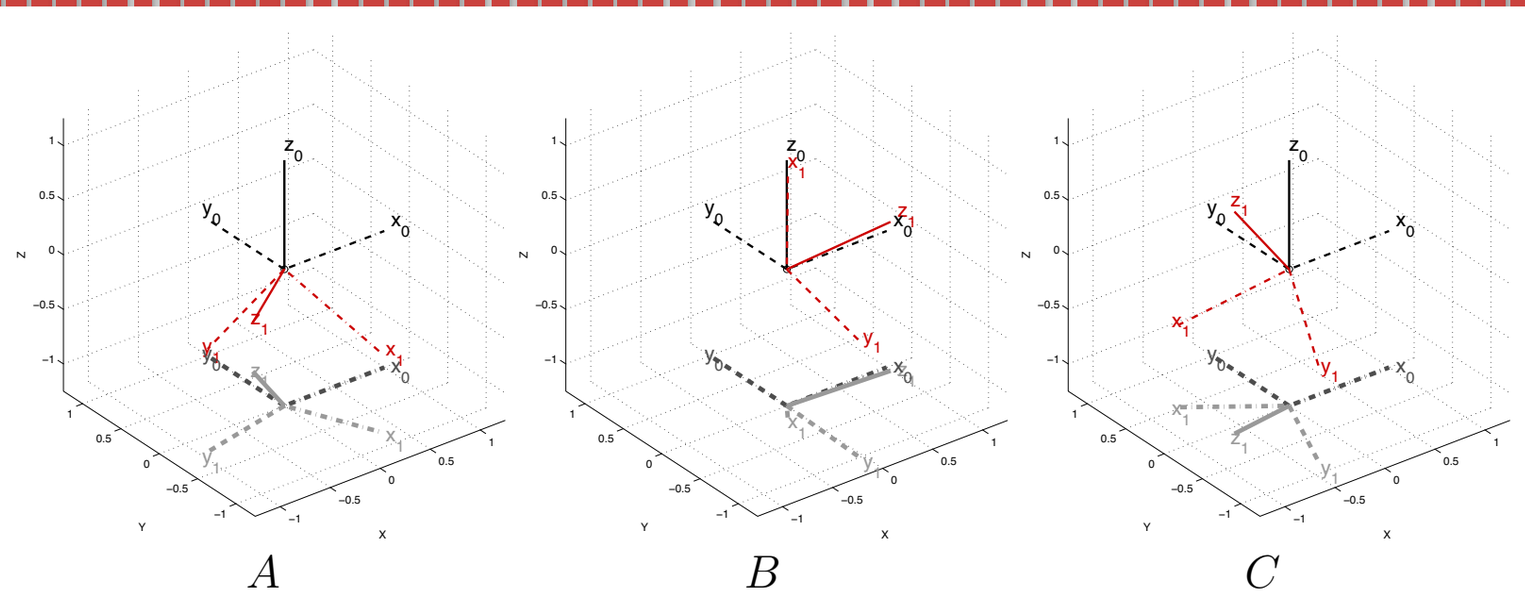
Final Overall



Problem 1 (Rotation Matrices and Rotation Parameterizations)

Mean = 14.9
Median = 17.5
St. Dev. = 5.2

20
15
10
5
0

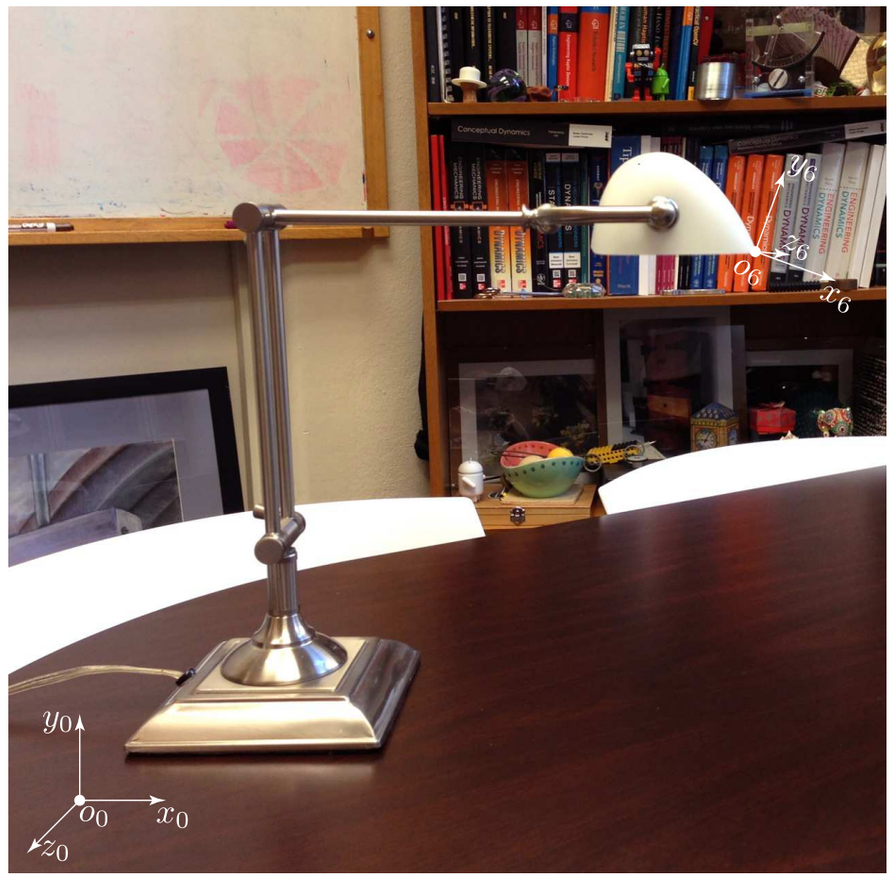


Students

Problem 2 (Kinematics of a Desk Lamp Robot)

Mean = 15.0
Median = 16
St. Dev. = 4.1

20
15
10
5
0



Students

Problem 3 (Motor Dynamics)

Mean = 13.1
Median = 14
St. Dev. = 5.0

20
15
10
5
0

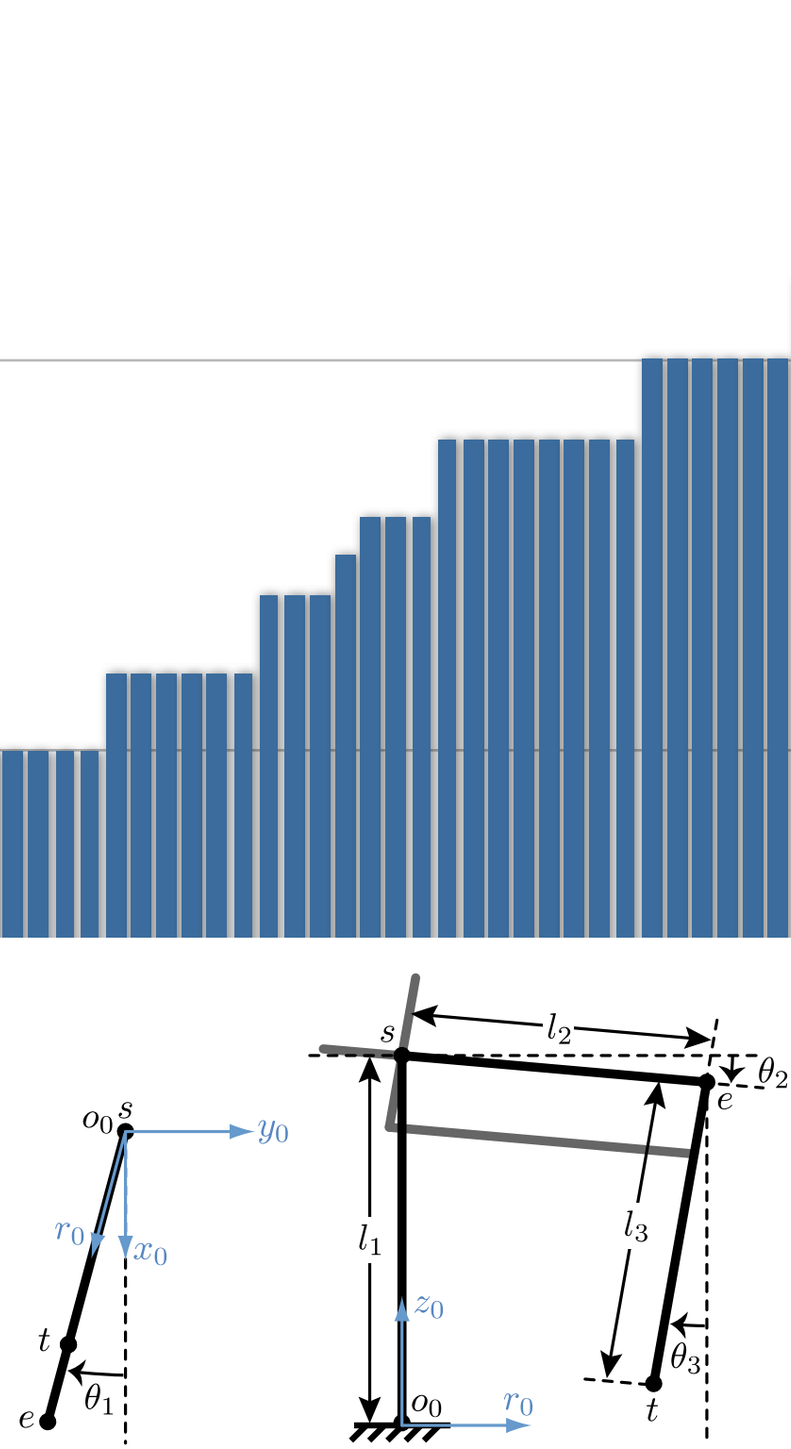
Students

Motor Data			
	Values at nominal voltage		
1	Nominal voltage	V	15
2	No load speed	rpm	7180
3	No load current	mA	247
4	Nominal speed	rpm	6500
5	Nominal torque (max. continuous torque)	mNm	73.1
6	Nominal current (max. continuous current)	A	4
7	Stall torque	mNm	929
8	Starting current	A	47.8
9	Max. efficiency	%	83
	Characteristics		
10	Terminal resistance	Ω	0.314
11	Terminal inductance	mH	0.085
12	Torque constant	mNm/A	19.4
13	Speed constant	rpm/V	491
14	Speed / torque gradient	rpm/mNm	7.93
15	Mechanical time constant	ms	5.65
16	Rotor inertia	gcm²	68.1

Problem 4 (Phantom Inverse Kinematics)

Mean = 12.6
Median = 12
St. Dev. = 4.9

20
15
10
5
0



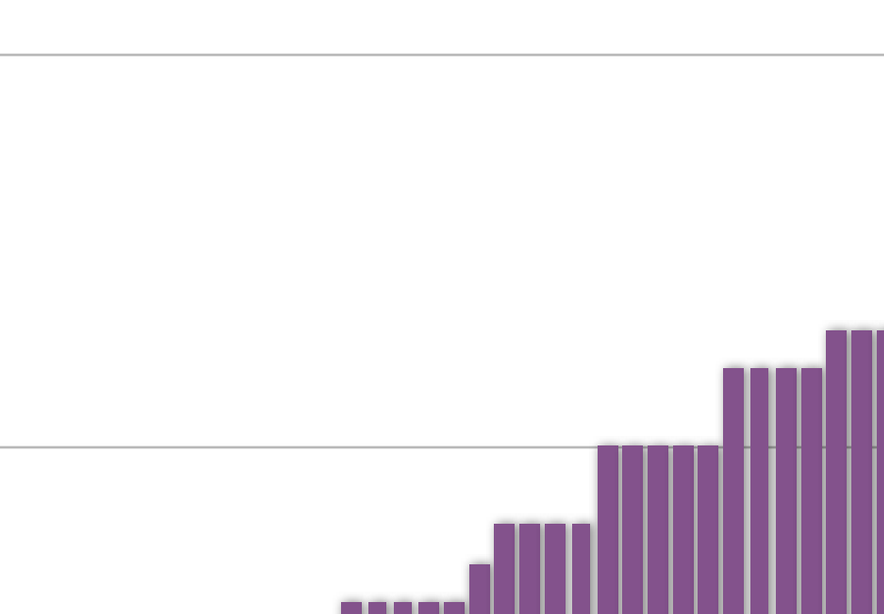
$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} (l_2 \cos\theta_2 - l_3 \sin\theta_3)\cos\theta_1 \\ -(l_2 \cos\theta_2 - l_3 \sin\theta_3)\sin\theta_1 \\ l_1 - l_2 \sin\theta_2 - l_3 \cos\theta_3 \end{bmatrix}$$

Students

Problem 5 (Encoded Stylus for the Phantom Premium)

Mean = 10.8
Median = 11
St. Dev. = 3.4

20
15
10
5
0



Students

MEAM 520 | Class Profile | Piazza

https piazza.com/upenn/fall2013/meam520/resources

Reader

General Resources (10 out of 14 resources displayed)

Solutions are posted on Piazza.

General Resources	Actions
final_solutions.pdf	Edit Post a note Delete
practice_final_solutions.pdf	Edit Post a note Delete
practice_final.pdf	Edit Post a note Delete
SHV_312_solution.pdf	Edit Post a note Delete
orientation_ik_solution.pdf	Edit Post a note Delete
orientation_ik_problem.pdf	Edit Post a note Delete
midterm_solutions.pdf	Edit Post a note Delete
midterm_resubmission.pdf	Edit Post a note Delete
practice_midterm_solution.pdf	Edit Post a note Delete
practice_midterm.pdf	Edit Post a note Delete
visualize_puma.zip	Edit Post a note Delete

Show all resources

Add Links Add Files

Look over your exam and compare with the solution.

If you think we made a mistake in grading your test, write out an explanation on a separate piece of paper. Do not write on your actual exam.

Attach your written inquiry to the front of your exam and slide it under Professor Kuchenbecker's office door (Towne 224). Please submit your request before Friday, January 17.

We will correct any grading mistakes.