ECE 569 / ME 587 Introduction to Robotic Systems

Course Description

ECE 569 Introduction to Robotic Systems (3 cr.) Class: 3. Lab: 0. Rec: 0. P/C: ECE 382 or graduate standing. Basic components of robotic systems; selection of coordinate frames; homogeneous transformations; solutions to kinematics of manipulator arms; velocity and force/torque relations; dynamic equations using Euler-Lagrange formulation; digital simulation of manipulator motion; motion planning; obstacle avoidance; controller design using torque method; and classical controllers for manipulators. Lab experiments and final project required.

Prerequisites: ECE 382 or graduate standing.

Course Information

- Website: `http://www.engr.iupui.edu/~skoskie/ECE569/ECE569_f17.html`

- Lecture: TR 4:30–5:45 pm in SL-055

- Instructor: Prof. Koskie, `skoskie@iupui.edu`

- Instructor's Office Hours: T 4–7 pm, or by appointment, in SL-164F

- Required Text: Robot Modeling and Control, by Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Wiley, 2006. ISBN : 978-0-471-64990-8.

- Course requirements / Exams / Grading

  - Laboratory Assignments   20%
  - Two midterm exams   each 20%
  - One final exam   20%
  - Homework   20%

Course Outcomes

Upon successful completion of the course, students should be able to:

- Define the coordinates and the corresponding kinematic parameters for robotic manipulators.

- Solve forward and inverse kinematic equations.

- Analyze robotic motion using the concepts of Jacobian matrix.

- Drive robot dynamic model using Lagrange's equations of motion.

- Design robot motion trajectories to meet the design specifications and requirements.

- Analyze and design simple robot control systems using classical control design methods.

- Evaluate and test the system performance using computer-aided tools.

- Program industrial robots to perform pre-specified tasks.

Topics to be Covered

All time estimates below are very rough estimates.

1. Introduction (one class)

2. Rigid Motions and Homogeneous Transformations (three classes)

3. Forward and Inverse Kinematics (three classes)

4. Velocity Kinematics and the Jacobian (four classes)

5. Path and Trajectory Planning (three classes)

6. Independent Joint Control (one class)

7. Dynamics (four classes)

8. Multivariable Control (three classes)

9. Force Control (three classes)

10. Computer Vision and Vision-Based Control (one class)

Homework Assignments

Homework assignments will be announced in class and posted on the web. Each assignment is due in class on the assigned date, which may be announced in class and will be posted to the course website. Homework may be submitted as pdf files by email before class. Please do not send obscure formats, zipped files, unreadable photos, or extremely large files.

- Late homework will NOT be accepted.

- Work submitted should be the student's own.

- All necessary steps towards obtaining the solution, as well as any MATLAB code, must be included in the writeup for full credit.

There will be approximately ten homework assignments during the course of the semester. Each student's lowest two scores will be dropped; thus, no late homework will be accepted. Students should keep returned homework, as results of some problems may be used in later homework assignments.

Students are allowed, even encouraged, to work on the homework in small groups, but each student must hand in an individual set of answers, which must be their own work. Students may discuss the problems but should not work jointly on them. Discussions should be noted, e.g. "John and I compared approaches to this problem because we found our results surprising; but after considering the alternatives decided that we both had the right approach." or "I kept getting a negative number for an answer and Jane suggested I check whether I forgot to whiten the data, which I had. I fixed this and got the answer indicated." or "John and Jane and I couldn't see how to approach this and Jean suggested . . . which yielded a successful approach." Each student must write and submit their own MATLAB code where needed.

Lab Assignments

Lab assignments will be announced in class and posted on the web. Each lab report is due in class on the assigned date, which may be announced in class and will be posted to the course website. Lab reports may be submitted as pdf files by email before class. Please do not send obscure formats, unclear photos, or extremely large files.

- Late lab reports will NOT be accepted.

- Work submitted should be the student's own.

- All necessary steps towards obtaining the solution, as well as any MATLAB code, must be included in the writeup for full credit.

There will be approximately seven lab assignments during the course of the semester. Students should keep returned lab reports as results of some problems may be used in later labs.

As with homework, students are allowed, even encouraged, to work in small groups, but each student must hand in an individual report, which must be their own work. Each student must write and submit their own Matlab code where needed.

Exams

Exams will take place on Friday evenings from 6:30-9:30pm.

Cheating on any exam will result in a grade of F in the course. Don't do it. It's better to just get a low grade on one exam if you find yourself not adequately prepared. That still leaves you a chance of passing the course.

Exams are closed-book, closed-notes, and neither calculators nor smart watches are allowed.

ECE Department policies on exams should be read and understood.

Grading

The instructor will scan the graded exams. Solutions will be posted. If a student has a question about the grading of a question, the student must email the instructor, explaining why they believe the grade should be changed. The instructor will review the exam and the criteria used for grading that question and then email a response to the student. The purpose of this policy is to ensure that all students' answers are graded according to the same criteria. There will be no exceptions to this policy.

IUPUI Campus Wide Policies

Policies covering campus wide policies that apply to this course can be found at the following links:

- Academic Integrity `http://www.iupui.edu/code/#part_5`

- Academic Misconduct `http://registrar.iupui.edu/misconduct.html`

- Code of Conduct `http://www.iupui.edu/code/#page`

- Disabilities `http://aes.iupui.edu/policies.htm`

- Emergency Withdrawal `http://registrar.iupui.edu/emergency_withdrawal.html`

- Military Service `http://veterans.iupui.edu/resources/withdrawal/`

- Religious Holidays `http://registrar.iupui.edu/religious.html`

- Equal Opportunity `http://www.iupui.edu/~oeo/policy/`

Links to additional policies can be found at `http://registrar.iupui.edu/course_policies.html` but it should be noted that some of the listed policies, e.g. grade replacement, grade forgiveness, and pass/fail option, apply to undergraduates only.

Policy on Incompletes: An Incomplete (I) grade will be given in this class only when these three conditions are met:

- Unusual circumstances such as illness prevent the student from completing the work.

- The student has successfully completed three-fourths (75the required course work.

- The student is clearly passing the course.

The instructor may involve the Associate Dean for Academic Affairs to determine whether the unusual circumstances warrant a grade of Incomplete. Should the instructor agree to assign a grade of Incomplete, he or she must set a specific date (no more than one year away) by which all unfinished work must be completed and include a list of assignments to be completed. The student must sign the official Incomplete Grade Form Agreement or no Incomplete grade will be awarded. Upon submission of completed work, or the students failure to meet the deadline, the instructor will change the students Incomplete grade to the earned letter grade (A F). If the work has not been completed and a grade assigned within a year from the end of the semester in which the Incomplete was awarded, the Office of the Registrar will automatically change the grade to an F. For more information, refer to the Registrars website: `http://registrar.iupui.edu/incomp.html`

Resources

Technical Communication Writing Center: The Purdue School of Engineering and Technology supports the TCM Writing Center (ET 232). You may schedule individual tutoring on campus or online. Drop-ins are taken (on-campus only) on a first-come/first-served basis. For more information and available hours, visit their website: `http://www.engr.iupui.edu/sites/tcmwritingcenter/`.

Purdue Online Writing Lab (OWL):   Another excellent resource for communication skills is The Purdue Online Writing Lab (OWL). http://owl.english.purdue.edu/

Counseling and Psychological Services: During the semester, if you find that life stressors are interfering with your academic or personal success, consider contacting IUPUI's Counseling and Psychological Services (CAPS). All IUPUI students are eligible for individual counseling services at minimal fees. Group counseling services are free of charge. CAPS also performs evaluations for learning disorders and ADHD; fees are charged for testing. CAPS is located in Walker Plaza, Room 220 (719 Indiana Avenue) and can be contacted by phone (317-274-2548). For more information, see the CAPS web-site at: `http://life.iupui.edu/caps/`.

Adaptive Educational Services: Accommodations are available for students with special challenges or disabilities that may affect their performance in this class. To determine if you are eligible for accommodations, you must register with Adaptive Educational Services (AES), which can be reached at (317) 274-3241. You must let your instructor know you are registered with AES. For more information, visit the AES website at `http://aes.iupui.edu/`.

Additional Resource Links

- Student code of Rights, Responsibilities, and Conduct `http://studentcode.iu.edu/`

- Info from the Registrar `http://registrar.iupui.edu/misconduct.html`

- Division of Student Affairs `http://studentaffairs.iupui.edu/student-rights/student-code/report.shtml`

This printed document may be revised as necessary due to extenuating circumstances and to correct any errors found. The information on the course website `http://www.engr.iupui.edu/~skoskie/ECE569/ECE569_f17.html` will supersede this printed document.