

MECH 572 Introduction to Robotics

Fall 2012

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Office Hours: Mon & Thu 4:00 pm to 5:00 pm
MC455

Course Outline

Objective

To lay down the basic mechanics concepts pertaining to the analysis, programming and control of robotic systems, mostly serial manipulators, composed of multiple rigid links, coupled with either rotational or prismatic joints.

Topics

1. An overview of robotic mechanical systems: serial manipulators; parallel manipulators; multifingered hands; walking machines; rolling robots; etc.
2. Fundamentals of rigid-body mechanics: linear transformations of the three-dimensional Euclidean space. Invariant representations of rotations. Homogeneous coordinates. Velocity and acceleration analyses. Twist and wrench. The Newton-Euler equations of a rigid body.
3. Geometry of robotic mechanical systems: the Denavit-Hartenberg parameters. Cartesian and joint coordinates. Direct displacement analysis of serial manipulators. Inverse displacement analysis of *decoupled* manipulators.

OPEN-BOOK MIDTERM EXAM

4. Kinetostatics of robotic manipulators: velocity, acceleration and static force analyses of serial manipulators. Singularities. Workspace.
5. Dynamics of robotic mechanical systems: Recursive Newton-Euler formulation of serial manipulators. The Euler-Lagrange equations of general holonomic robotic mechanical systems. The derivation of the dynamics equations of robotic mechanical systems using the natural orthogonal complement. Algorithm complexity analysis. Dynamics simulation algorithms.
6. (If time permits) An introduction to robot control: The PID controller. Stability of the PID control scheme.

Marking Scheme:

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| Assignments | 10% |
| Midterm | 30% |
| Final | 60% |

Notes: Some assignments will require the running of a small computer program and plotting of results. Familiarity with both MATLAB and Maple or Mathematica is assumed. **Midterm and final exams will require the use of a calculator. Only the official Faculty of Engineering calculator is allowed.**

Text:

The textbook is currently under revision. A preliminary version:

Angeles, J., 2012, *Fundamentals of Robotic Mechanical Systems. Theory, Methods, and Algorithms*, Edition 3.5, Springer, New York.

can be purchased at COPIE-EUS that contains all the material in the textbook, except for Chs. 8–12.

References:

1. Craig, J., 1989, *Introduction to Robotics. Mechanics and Control*, 2nd. Edition, Addison-Wesley Publishing Company, Reading, MA.
2. Spong, M.W., Hutchinson, S. and Vidyasagar, M., 2006, *Robot Modeling and Control*, John Wiley and Sons, Inc., New York.

Important!

1. McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offenses under the code of student conduct and disciplinary procedures. For more information see

www.mcgill.ca/integrity

2. If you have any disability please contact the instructor to arrange a time to discuss your situation. It will help if you contact the Officer for Students with Disabilities at 398-6009 before you do this.
3. Every student has the right to write term papers, examinations and theses in English or in French, except in courses where knowledge of a language is one of the objectives of the course.
4. To protect trees, please submit your assignments on **double-sided sheets**.