Université d'Ottawa
Faculté de génie

Département de
génie mécanique

uOttawa

University of Ottawa
Faculty of Engineering

Department of
Mechanical Engineering

MCG 4134: Robot Design and Control

Winter 2012

Instructor: Dr. Davide Spinello
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phone: 613.562.5800 ext. 2460
office hours: Take an appointment by email

Lecture: MCD 121, Tuesday 17:30 - 20:30

Tutorial: LMX 220, Thursday 16:00 - 17:30
CBY B109C (computer room), only for Matlab tutorials

Textbook: Spong M. W., Hutchinson S., Vidyasagar M. *Robot Modeling and Control*. Wiley, 2006

Web page: http://by.genie.uottawa.ca/~spinello/webpage/teaching.html

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Course Outline

Classification of robot manipulators. Review of rigid motions. Forward and Inverse Kinematics. Independent joint control. Point-to-point control. Path planning and trajectory control. Computed torque technique. Compliance and force control. Sensory components for robot control.

Description and objectives

This course presents the concepts of robot manipulators kinematics and dynamics, and teaches methods for designing classical linear controlles to achieve desired motions of robot manipulators, with a brief introduction on sensory components for feedback control of robotic systems. Students will develop the capability of analyzing the motion of robot manipulators and of designing simple controllers to regulate their behaviour.

Exams: policy and dates

All exams will be closed book - closed notes. A formula sheet will be provided by the instructor if necessary.

Illegible work and loose sheets will not be graded. If a student cannot attend a test/exam due to a medical condition, certified by a doctor, he/she must notify the instructor in advance. Unexcused absence from an exam will result in a grade of 0 for that exam.

The dates of the mid-term exam can be changed within the first week of class, according with specific exigences of the students.

Mid-term exam LMX 220, Thursday Feb 16 16:00 - 17:30

Final exam TBD

Computer oriented assignments

Two computer oriented problems will be assigned during the term. Assignments will be individual.

Marks

Marks from computer oriented assignments and mid-term exam determine the semester mark S, computed as follows:

Mid-term exam	60%
Computer oriented assignments	40%
Total of semester (S)	100%

This mark will be combined with the final exam mark F in the following way:

$$0.6F + 0.4S$$

If $F < 55\%$, regardless of the mark of the semester S the overall course grade will be F.

Regulations on Academic Fraud

The following link provides information regarding academic fraud, including the Regulation on Academic Fraud which provides information on the definition of fraud, the disciplinary process and the consequences of dishonest behaviour: `http://web5.uottawa.ca/mcs-smc/academicintegrity/regulation.php`

Suggested problems

Chapter 2: 2-1; 2-2; 2-15; 2-20; 2-22; 2-24; 2-37; 2-38; 2-39; 2-41

Chapter 3: 3-2; 3-3; 3-4; 3-5; 3-6; 3-7; 3-8; 3-9; 3-11; 3-12; 3-13; 3-14; 3-15; 3-16; 3-18; 3-21

Chapter 4: 4-1; 4-2; 4-6; 4-7; 4-13; 4-14; 4-15; 4-16; 4-17; 4-18; 4-20; 4-21

Tentative lecture schedule

Lecture	Reading	Topic
1: Tu, Jan 10	1.2; 1.3; 2.1 - 2.7	Robotic manipulators and their classification; Review of rigid bodies kinematics
2: Tu, Jan 17	3.1; 3.2	Kinematic chains; The Denavit-Hartenberg convention
3: Tu, Jan 24	3.3	Inverse kinematics
4: Tu, Jan 31	4.1; 4.2; 4.3; 4.4	Angular velocity: the fixed axis case; Skew symmetric matrices; Angular velocity: the general case; Addition of angular velocities
5: Tu, Feb 7	4.6; 4.7; 4.8	Derivation of the Jacobian; The tool velocity; The analytical Jacobian
6: Tu, Feb 14		**Mid-term exam**[1]
Feb 19 - Feb 25		*Study week*
7: Tu, Feb 28	4.9; 4.10; 4.11; 4.12	Singularities; Static force/torque relationships; Inverse velocity and acceleration; Manipulability
8: Tu, Mar 6	5.1; 5.2; 5.5	The configuration space; Path planning using potential fields; Trajectory planning
9: Tu, Mar 13	6.1; 6.2; 6.3; 6.4	Actuator dynamics; Independent joint model; Set-point tracking; Feedforward control
10: Tu, Mar 20	7.1; 7.2; 7.3	The Euler-Lagrange equations; Kinetic and potential energy; Equations of motions; Some common configurations
11: Tu, Mar 27	8.1; 8.2; 8.3	PD control revisited; Inverse dynamics; Robust and adaptive motion control
12: Tu, Apr 3	11.1; 12.1	The geometry of image formation; design considerations
13: Tu, Apr 10		Examples and questions

[1] The midterm exam will cover topics lectured up to lecture 5 (remind: this is a *tentative* lecture schedule).