Last updated: Wednesday 6 April, 2016

Faculty of Engineering
Department of Mechanical Engineering

ROBOT DESIGN AND CONTROL
MCG4134A
Davide Spinello
Winter 2016

Course Hours

Monday 13:00 - 14:30
Location: STE-C0136
Type: LEC 1

Wednesday 11:30 - 13:00
Location: STE-C0136
Type: LEC 2

Professor

Davide Spinello (dspinell@uottawa.ca)
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Office Hours
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Location: Appointment by email

Teaching Assistant

Xunzhe Wen (xwen055@uOttawa.ca)
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Office Hours
Thursday 15:00 - 17:00
Location: CBY B207 desk #9

Friday 09:00 - 12:00
Location: CBY B207 desk #9

Course Description

Classification of robot manipulators. Forward and Inverse Kinematics. Design of joint actuating systems. Independent joint control. Point-to-point control. Path planning and trajectory control. Computed torque technique. Compliance and force control. Sensory components for robot control. End of arm tooling.

General and Specific Objectives

This course presents the concepts of robot manipulators kinematics and dynamics, and teaches methods for designing classical linear controllers 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.

Required Material

The textbook in Section "Monographies" is mandatory. In the course calendar, sections of the book that cover lectures' material are referenced by numbers in square brackets. Additionally, the robotic manipulator simulator RoboDK (download link in Section "Other documents") will be used during lectures to demonstrate theoretical concepts, and will be part of assignments along with Matlab.

Evaluations

Problem Set

Evaluation Date: Ongoing
Evaluation Percentage: 16

Four homework assignments will be given during the term. Each part will weigh 4% of the final grade.

Written exam (e.g. exam, long answer)

Evaluation Date: Wednesday 24 February, 2016
Evaluation Percentage: 24

Midterm exam. The exam is take home. The due date is indicated above.

Written exam (e.g. exam, long answer)

Evaluation Date: Final Exam Period
Evaluation Percentage: 60

Final exam. The exam is take home.

Course Calendar

Monday 11 January, 2016	**Lecture 1** • Robotic manipulators and their classification [1.2; 1.3]. • Review of rigid bodies kinematics [2.1; 2.2].
Wednesday 13 January, 2016	**Lecture 2** • Review of rigid body kinematics [2.3; 2.4; 2.5].
Monday 18 January, 2016	**Lecture 3** • Review of rigid body kinematics [2.6; 2.7].
Wednesday 20 January, 2016	**Lecture 4** • Review of rigid body kinematics [2.6; 2.7].
Monday 25 January, 2016	**Lecture 5** • Kinematic chains [3.1]. • The Denavit-Hartenberg convention [3.2].
Wednesday 27 January, 2016	**Lecture 6** • The Denavit-Hartenberg convention [3.2].
Monday 1 February, 2016	**Lecture 7** • Inverse kinematics [3.4].
Wednesday 3 February, 2016	**Lecture 8** • Inverse kinematics [3.4].

Monday 8 February, 2016	**Lecture 9** • Angular velocity: the fixed axis case [4.1]. • Skew symmetric matrices [4.2].
Wednesday 10 February, 2016	**Lecture 10** • Angular velocities: the general case [4.3]. • Addition of angular velocities [4.4].
Monday 22 February, 2016	**Lecture 11** • Derivation of Jacobians [4.6].
Wednesday 24 February, 2016	**Lecture 12** • Singularities [4.9].
Monday 29 February, 2016	**Lecture 13** • Inverse velocity and acceleration [4.11].
Wednesday 2 March, 2016	**Lecture 14** • Manipulability [4.12].
Monday 7 March, 2016	**Lecture 15** • The configuration space [5.1].
Wednesday 9 March, 2016	**Lecture 16** • Path planning using potential fields [5.2].
Monday 14 March, 2016	**Lecture 17** • Path planning using potential fields [5.2].
Wednesday 16 March, 2016	**Lecture 18** • Trajectory planning [5.5].
Monday 21 March, 2016	**Lecture 19** • Independent joint control. Actuator dynamics [6.1]. • Independent joint model [6.2].
Wednesday 23 March, 2016	**Lecture 20** • Set point tracking [6.3].
Wednesday 30 March, 2016	**Lecture 21** • Feed forward control [6.4]. • Drive train dynamics [6.5].
Monday 4 April, 2016	**Lecture 22** • Drive train dynamics [6.5]. • State-space design [6-6].
Wednesday 6 April, 2016	**Lecture 23** • Force control: coordinate frames and constraints [9.1].
Monday 11 April, 2016	**Lecture 24** • --

Other Information

At the beginning of the course the students are assumed to be familiar with the theory of ordinary differential equations, with Laplace transforms, Fourier transforms, basic complex numbers algebra, and most importantly with material covered in MCG3305 and MCG3306. You are strongly encouraged to review the related material from pre-requisite courses.

Monographs

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

Other Documents

RoboDK: robotic manipulator simulator. Free download at http://www.robodk.com/index.php

Plagiarism

Beware of academic fraud!

Academic fraud is an act by a student that may result in a false evaluation (including papers, tests, examinations, etc.). It is not tolerated by the University. Any person found guilty of academic fraud will be subject to severe sanctions.

Here are some examples of academic fraud:

- Plagiarism or cheating of any kind;
- Present research data that has been falsified;
- Submit a work for which you are not the author, in whole or part;
- Submit the same piece of work for more than one course without the written consent of the professors concerned.

Please consult this webpage: it contains regulations and tool to help you avoid plagiarism.
An individual who commits or attempts to commit academic fraud, or who is an accomplice, will be penalized. Here are some examples of possible sanctions:

- Receive an “F” for the work or in the course in question;
- Imposition of additional requirements (from 3 to 30 credits) to the program of study;
- Suspension or expulsion from the Faculty.

You can refer to the regulations on this webpage.

Student Services

Academic Writing Help Centre
At the AWHC you will learn how to identify, correct and ultimately avoid errors in your writing and become an autonomous writer.
In working with our Writing Advisors, you will be able to acquire the abilities, strategies and writing tools that will enable you to:

- Master the written language of your choice
- Expand your critical thinking abilities
- Develop your argumentation skills
- Learn what the expectations are for academic writing

Career Services
Career Services offers various services and a career development program to enable you to recognize and enhance the employability skills you need in today's world of work.

Counselling Service
There are many reasons to take advantage of the Counselling Service. We offer:

- Personal counselling
- Career counselling
- Study skills counselling

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The Access Service acts as intermediary between students, their faculty and other University offices to ensure that the special needs of these students are addressed and that the best possible learning conditions are being offered.

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