MECH 563 Robotics

(3 Credits)

Course Structure
3 hours of lecture per week, T/Th 11-12:30, DMP 201.

Course Grading (approximate scheme only)

Lab	20 %
Midterm	30 %
Final Exam	50 %
	100 %

Instructor

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Course Text
Mark W. Spong, Seth Hutchinson and M. Vidyasagar, *Robot Modeling and Control*, John Wiley and Sons, 2006.

Course Website
Course information will be posted on VISTA – www.vista.ubc.ca. If you are registered in the course you should be able to access the course materials.

Course notes are available on the website. Bring the notes to class - they are indispensable.

References

1. Books

a) Sciavicco, L. and Siciliano, B., Modeling and Control of Robot Manipulators, McGraw Hill, New York, 2nd Ed, Springer-Verlag, 2000.
b) S. B. Niku, Introduction to Robotics, Analysis, Systems, Applications, Prentice Hall, 2001.
c) R.L. Andersson, *A Robotic Ping-Pong Player - Experiment in Real-Time Intelligent Control,* MIT Press, 1988.
d) J. Angeles, *Spatial Kinematic Chains: Analysis, Synthesis and Optimization*, Springer Verlag, 1982
e) H. Asada and J.J. Slotine, *Robot Analysis and Control*, Wiley-Interscience, 1986.
f) J.J. Craig, *Introduction to Robotics: Mechanics and Controls, Second Ed.*, Addison Wesley, 1989.
g) C.W. de Silva, *Control, Sensors and Actuators*, Prentice Hall, 1989.
h) K.S. Fu, R.C. Gonzalez, C.S. Lee, *Robotics: Control, Sensing, Vision, Intelligence, McGraw-Hill, 1987*.

i) J.M. McCarthy, *An Introduction to Theoretical Kinematics*, MIT Press, 1991
j) R.P. Paul, *Robot Manipulators: Mathematics, Programming and Control*, MIT Press, 1981.
k) G. Strang, *Linear Algebra and Its Applications*, Second Ed. Academic Press, 1980. (or your favorite linear algebra text)
l) S.G. Tzafestas, Ed., *Intelligent Robotic Systems*, Marcel Decker Inc., 1991.
m) T. Yoshikawa, *Foundations of Robotics - Analysis and Control*, MIT Press, 1990.
n) V. Daniel Hunt, *Robotics Sourcebook*, Elsevier, 1988.

2. Journals

a) ASME Journal of Dynamic Systems, Measurement and Control
b) Robotics and Autonomous Systems, Elsevier.
c) Robotica, Cambridge University Press.
d) Journal of Field Robotics, John Wiley and Sons
e) International Journal of Robotics Research, MIT Press
f) IEEE Transactions on Robotics
g) IEEE Transactions on Systems Man and Cybernetics
h) International Journal of Human-Robot Interaction

3. Software

a) Matlab – Student edition is fine.
b) Robotics Toolbox for Matlab by Peter I. Corke. See course website for the link to download this free toolbox.
c) ROS – Software is installed in the PACE lab. More information will be provided.

Tentative Course Outline	**Approx. # of hours**
1. Introduction to Robotics	1 Hour
1.1 What does a robot look like?	
1.2 What do robots do?	
1.3 Robot Manipulators	
1.4 Some of the Research Issues involving Robotic Manipulators	
1.5 Robots and Industry	
2. Rigid Motions	2 Hours
2.1 Review of Linear Algebra. Notations and Definitions.	
2.2 Frames and Rotations	
2.3 Basic Rotations	
2.4 Composition of Rotations	
2.5 More 'Fun' Properties of Rotation Matrices - The Axis-Angle Representation	
2.6 Homogeneous Transformations	
2.7 Basic Homogeneous Transformations	

8.4 Optimal Motion Planning
8.5 Obstacle Avoidance
8.6 Exercises

9. Computer Vision — 4 Hours
    9.1 Image Processing Fundamentals
    9.2 Image Acquisition
    9.3 Frame Grabbing
    9.4 Image Formation
    9.5 Camera Calibration
    9.6 Introduction to Visual Servoing
10. Robot Motion Control — 3 Hours
    10.1 The Control Problem
    10.2 Actuator Dynamics
    10.3 PD Compensation
    10.4 PID Compensation
    10.5 Inverse Dynamics Compensation
    10.6 Exercises
11. Interaction Control — 2 Hours
    11.1 Single Degree of Freedom Stiffness Control
    11.2 Inverse Dynamics in Task Space
    11.3 Impedance control
    11.4 Exercises
12. Project presentation — 3-4 Hours

LAB
The lab outline will be posted on VISTA in late January. The lab involves implementing a motion planning task on a Willow Garage PR2.

There are no marked assignments for the course. However, there are assignments given with each chapter of the notes and solutions will be posted.

MIDTERM
February 14. Closed book. Formula sheet provided.

FINAL EXAM: The final exam is scheduled by the university. It will be a closed book exam covering the complete course. The invigilators will not answer any questions regarding material on the exam, during the exam period.

All exams are CLOSED BOOK.