Ph.D. Qualifying Exam: Robotics

Department of Mechanical Engineering University of Utah

Exam Description:

This qualifying exam will test the student's graduate-level knowledge of robotics. The exam is focused on testing the knowledge and approach to problem solving involving fundamental concepts appropriate to the field of robotics.

Recommended Reference:

ME EN 6220 course notes: https://my.eng.utah.edu/~cs5310/, User ID: Robotics, Password: KUKABaxter.

Exam Materials:

An equation sheet will be provided to students before the exam. The same sheet will be provided with the exam. Students may bring a department issued calculator. No other materials will be allowed during the exam.

Topics:

Spatial transformations and displacements:
- Rotation matrices
- Homogeneous transformations
- Angle-axis formula
- Euler angles
- Quaternions

Manipulator position kinematics:
- Denavit-Hartenberg parameters
- Forward kinematics
- Inverse kinematics
- Workspace

Trajectory planning:
- Polynomial trajectories
- Spliced trajectories
- Taylor trajectories

Kinematic Velocities and Accelerations:
- Velocity and acceleration kinematics
- Angular velocity vector
- Spatial motion of objects
- Forward velocity and acceleration kinematics
- Velocity Jacobian
- Inverse velocity and acceleration kinematics

Statics:
- Force and torque balance
- Center of mass
- Gravity forces and torques on manipulator joints

Dynamics:
- Inertia matrix
- Parallel axis theorem
- Newton-Euler equations
- Recursive Newton-Euler equations for manipulator dynamics