

## Robotics I - Extra sheet #2 (for Exercise 5)

November 29, 2019

Name: \_\_\_\_\_

Answer to the questions or comment/complete the statements, providing also a *short* motivation/explanation (within the given lines of text) for each of the 7 items.

1. Are there 3-dof robots with just a single inverse kinematics solution in their primary workspace? If so, which ones? If not, why?

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2. In order to measure the joint velocities of a robot, extra dedicated sensors may not be needed since ...

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3. A large reduction ratio for a robot joint transmission is good because ..., and is bad because ...

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4. Use of link acceleration measurements to generate torques that move the robot may be critical. Why?

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5. Compare an incremental encoder with  $N = 900$  pulses per turn and quadrature electronics, mounted on a motor connected to the link with a reduction ratio  $n_r = 40$ , with a 16-bit absolute encoder mounted directly on the link side of the transmission. Which is better in terms of link position resolution?

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6. An installed 6-dof industrial robot has repeatability  $\rho = 0.1$  [mm] and accuracy  $\delta = 0.6$  [mm] in a certain region of its workspace. Which of these two parameters can be improved, and how?

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7. An object of mass  $m = 5$  [kg] is hanging statically to a 6D F/T sensor, whose only non-zero outputs are  $f_z = -49.05$  [N],  $\mu_x = 7.3575$  [Nm]. Where is the object center of mass located in the sensor frame?

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