

## Robotics I - Sheet for Exercise 2

March 27, 2018

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

Consider only serial manipulators having  $\mathbf{q} \in \mathbb{R}^6$ , with direct kinematics expressed by homogenous transformation matrices  ${}^0\mathbf{T}_6(\mathbf{q})$ , and their  $6 \times 6$  geometric Jacobians  $\mathbf{J}(\mathbf{q})$ . Check if each of the following statements about singularities is **True** or **False**, and provide a *very short* motivating/explanation sentence.

1. In a singular configuration, there may be an infinite number of inverse kinematics solutions.

True  False

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2. In a singularity, the manipulator can access instantaneously any nearby joint configuration.

True  False

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3. Close to a singularity of  $\mathbf{J}$ , some Cartesian directions of motion are not accessible.

True  False

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4. In a singularity, the end-effector angular velocities  $\boldsymbol{\omega}$  are linearly dependent on the linear velocities  $\mathbf{v}$ .

True  False

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5. In a singular configuration,  $\mathcal{R}\{\mathbf{J}^T\} \oplus \mathcal{N}\{\mathbf{J}\} \neq \mathbb{R}^6$ .

True  False

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6. The linear part  $\mathbf{J}_L(\mathbf{q})$  and the angular part  $\mathbf{J}_A(\mathbf{q})$  of the Jacobian cannot lose rank simultaneously.

True  False

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7. The lower is the rank of  $\mathbf{J}$ , the larger is the loss of mobility of the end-effector.

True  False

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8. All singularities of a manipulator can be found by inspecting the null space  $\mathcal{N}\{\mathbf{J}(\mathbf{q})\}$ .

True  False

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9. There cannot be singularities of  $\mathbf{J}(\mathbf{q})$  outside the joint range of the manipulator.

True  False

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10. Cyclic motions in the Cartesian space always correspond to cyclic motions in the joint space.

True  False

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