2024 年 春 季 学 期

机器人学导论试题（回忆版本）

2024.5

说明：考试时间 120 分钟，满分 100 分。

注意行为规范　遵守考场纪律

Question 1（20 points）

(a) Find the inverse of the homogeneous transformation matrix. （具体矩阵不记得了）

(b) For a rotation matrix R, find ω and θ. （具体矩阵不记得了）

Question 2（30 points）

Figure 1 shows a two degree of freedom manipulator. Let l_0, l_1, l_2, h be the link length parameters and θ_1, θ_2 the joint angle variables of link 1 and link 2, respectively.

(a) Express the position and orientation of frame C_3 relative to frame C_0 in terms of the joint angle variables and the link parameters.

(b) Compute the spatial velocity of C_3 relative to C_0 as functions of the joint angles and the joint rates.

(c) Compute the body velocity of C_3 relative to C_0 as functions of the joint angles and the joint rates.

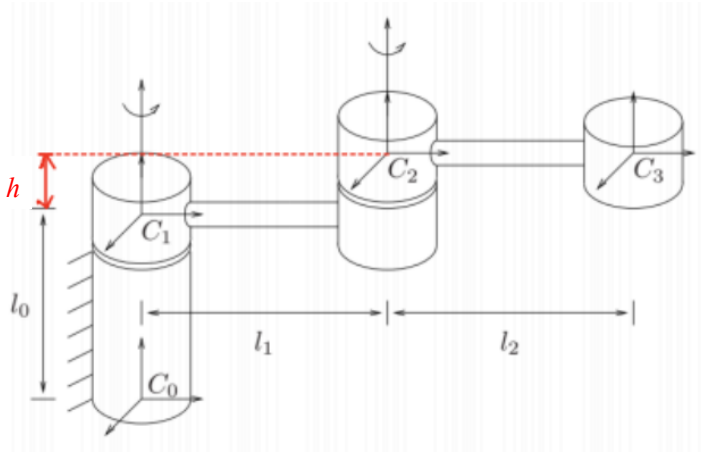

Fig.1. A two degree of freedom manipulator

Question 3（30 points）

Figure 2 shows a five degree of freedom manipulator. Let a_1, a_2, a_3, a_4, d_1 be the link length parameters and θ_1, θ_2, θ_3, θ_4, θ_5 the joint angle variables of joint 1 through 5, respectively.

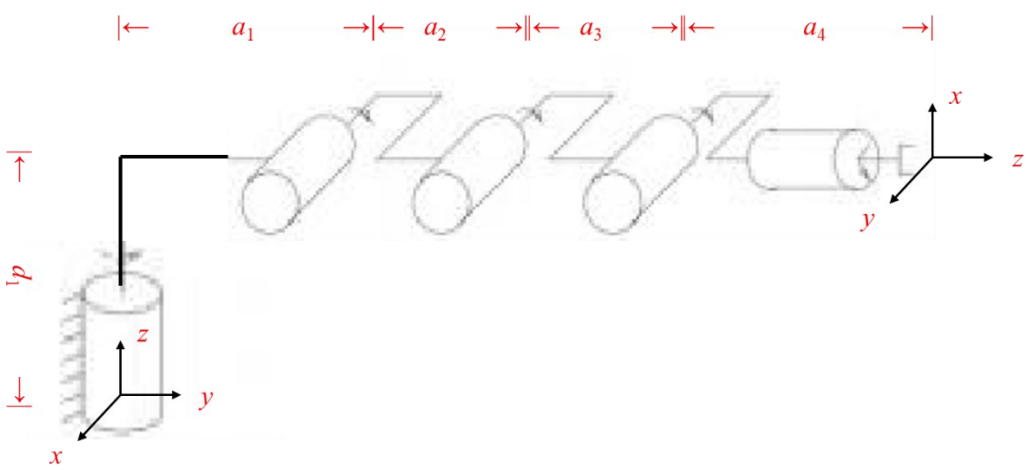

Fig.2. A five degree of freedom manipulator

(a) Find the forward kinematics map.

(b) Given the tip location and approach vector(the z-axis of tool frame), solve the inverse kinematics problem.

(c) Derive the spatial Jacobian.

(d) Give a geometric description of the singular configurations.

Question 4（20 points）

Calculate $\dot{\theta}_{12}$, $\dot{\theta}_{23}$, t_1, t_2, and t_3 for a two-segment linear function with parabolic blends (LFPB). For this joint, $\theta_1 = 5.0°$, $\theta_2 = 10.0°$, $\theta_3 = 20.0◦$. Assume that $t_{d12} = t_{d23} = 1.0$ seconds and that the default acceleration to use during blends is 80 degrees/second^2. Sketch plots of position, velocity, and acceleration of θ.