

Use your method of choice to find the Jacobian for the following manipulators (or parts of manipulators) where details of each are provided in a handout. Also, investigate and identify kinematic singularities for each.

1. Adept SCARA (work with  $4 \times 4$  Jacobian after rows of zeros are removed)
2. first three links of Stanford Arm and linear velocity of wrist, i.e., the Jacobian  $J_P$  that maps  $[\dot{\theta}_1, \dot{\theta}_2, \dot{d}_3]^T$  to  $\dot{\sigma}_3^0$
3. last three links (wrist) of Stanford Arm and angular velocity, i.e., the Jacobian  $J_O$  that maps  $[\dot{\theta}_4, \dot{\theta}_5, \dot{\theta}_6]^T$  to  $\vec{\omega}_{3,6}^3$