ME-GY 7943/ECE-GY9273
Network Robotic Systems, Cooperative Control and Swarming

Exercise series 3

Please typeset your answers (e.g. using LaTeX) or write all your answers in a Jupyter notebook (it is ok to write your answers directly in a notebook. For all questions, justify clearly your answers.

Exercise 1

Exercise 1 is given in the Jupyter notebook called *Exercise1.ipynb*.

Exercise 2

Consider the framework depicted in Figure 1.

- Compute the rigidity matrix. What is the dimension of its kernel? What is the dimension of its range space?
- How many directions of motions are there that do preserve the distance constraints of the framework?
- Prove that the vectors of infinitesimal motions in the x direction and y direction and rotations around a point p^* form a basis for the kernel of the rigidity matrix. (Use the unit vector $\dot{q}_x = [1, 0, 1, 0, 1, 0, 1, 0]^T$ for infinitesimal motions of all the agents in the x direction. For a rotation around a point p^* use the following infinitesimal rotation for one agent $\dot{\mathbf{p}} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} (\mathbf{p} - \mathbf{p}^*)$).

Exercise 3

Exercise 3 is given in the Jupyter notebook called *Exercise3.ipynb*.

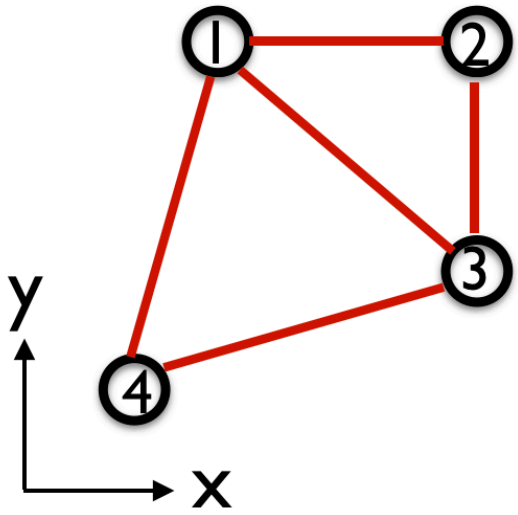

Figure 1: Framework with distance constraints $d_{12} = 1,\ d_{23} = 1,\ d_{13} = \sqrt{2},\ d_{14} = 1.5,\ d_{34} = 1.5$