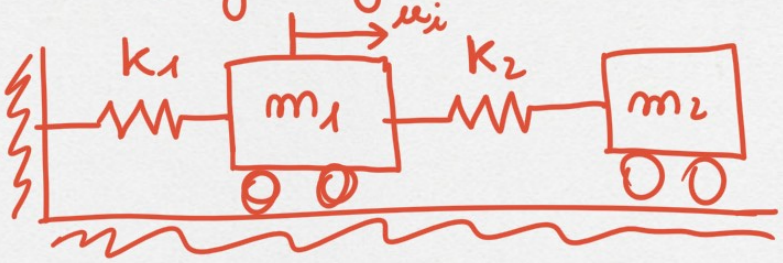
• Homework: Cooperative tracking through SVFB

Let's consider a multi-agent system where:

(1) Each single agent S_i is described as follows:



S_i: $x_i = \begin{bmatrix} x_{i,1} \\ x_{i,2} \end{bmatrix}$

$x_{i,1}$ = displacement of m_i

$x_{i,2}$ = velocity of m_i

S_i: $\begin{cases} \dot{x}_i = Ax_i + Bu_i \\ y_i = x_i \end{cases}$

$m_1 = 1.1\,kg$

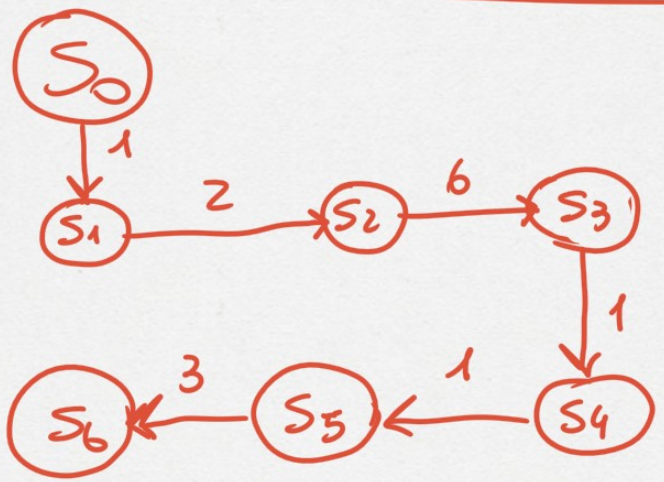
$m_2 = 0.9\,kg$

$k_1 = 1.5\,N/m$

$k_2 = 1\,N/m$

$$S_0 : \begin{cases} \dot{x}_0 = A x_0 \\ y_0 = x_0 \end{cases}$$

(2) Communication network is described by the following graph topology:



Problem: design SVFB (design K, c) according to the control protocol discussed in theory, such that the global disagreement error $\delta(t) \xrightarrow[t \to \infty]{} 0$

How to solve the algebraic Riccati equation presented in the slides:

 → **MATLAB COMMAND**: `are`

$$P = \text{are}(A, BR^{-1} \cdot B^T, Q)$$

1. Solve the SVFB problem applying theorem 1
2. Build the controlled multi-agents system with the SVFB distributed control protocol
3. Simulate the system by assuming initially that $x_i(0) = 0$ for $i = 1, 2, \dots, N$ and $x_0(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$
4. Discuss the behavior of the controlled multi-agents system and check if the global disagreement error $\delta(t) \xrightarrow[t \to \infty]{} 0$
5. In order to better investigate the behavior of the controlled system you are invited to change the initial condition $x_i(0)$ $i = 0, \dots, N$ and you have also to investigate the effect of the coupling gain c (how the value of c affect the performance?)

(6) How can you modify the reference behavior dictated by the leader agent? (Could you modify the reference behavior by acting on a local control loop closed around the leader node?)

(7) In particular, try to design our whole control system such that all the agents' outputs are converging ($\forall t \to \infty$) to the same constant value

(8) Try to modify the structure of the communication network (i.e. the graphs G, $\bar{G}$) in order to analyze the effect of the network structure on the behaviour of the controlled multi-agents system