AerE 5740: Optimal Control: Spring 2025

Iowa State University

Quiz 12: More on continuous time LQR, discrete time OCP and LQR

Name:____

For each of the following multiple choice problems, ONLY ONE option is correct. Clearly mark the correct option. Calculators or other electronic devices are NOT allowed.

Problem 1

A student is using an AI chatbot to solve a 2 state continuous-time LQR problem. The chatbot returns the Riccati ODE solution at $t = 0$ as

$$\boldsymbol{P}(0) = \begin{bmatrix} 1 & 0 \\ 0 & -3 \end{bmatrix}.$$

Which of the following is TRUE?

(A) This answer is possible since we don't know enough about the LQR problem data.

(B) This answer is possible because $\boldsymbol{P}(0)$ must be 2×2 symmetric matrix.

(C) This answer cannot be correct. The chatbot is hallucinating. `Reason:` $\boldsymbol{P}(0) \succeq \mathbf{0}$, see Lec. 13 p. 6.

Problem 2

In discrete-time OCP, the controlled dynamics is

(A) a vector difference equation/recursion. `Reason:` Lec. 13 p. 14.

(B) a vector differential equation.

(C) a vector algebraic equation.

Problem 3

In discrete-time finite horizon LQR, the Riccati matrix recursion is solved

(A) backward in time from time index $k = N - 1$ to $k = 0$. `Reason:` Lec. 13 p. 21.

(B) forward in time from time index $k = 0$ to $k = N - 1$.

(C) stationary in time.

Problem 4

In discrete-time finite horizon LQR, the Riccati matrix recursion is guaranteed to generate a sequence of

(A) positive semidefinite matrices. `Reason:` Lec. 13 p. 22.

(B) symmetric (possibly sign indefinite) matrices.

(C) diagonal matrices.

Problem 5

A car moving along 1D straight road with position-velocity state $(x_k, v_k) \in \mathbb{R}^2$ has discrete-time controlled dynamics

$$x_{k+1} = x_k + v_k, \quad v_{k+1} = v_k + u_k,$$

where u_k is the scalar control. This system is of the form $\boldsymbol{x}_{k+1} = \boldsymbol{A}\boldsymbol{x}_k + \boldsymbol{B}u_k$ where

(A) $\boldsymbol{A} = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$, $\boldsymbol{B} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$.

(B) $\boldsymbol{A} = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix}$, $\boldsymbol{B} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$.

(C) $\boldsymbol{A} = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$, $\boldsymbol{B} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. `Reason:` state space form with state vector $\boldsymbol{x}_k := (x_k, v_k)^\top$.