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Assignment 7

The due date for submitting this assignment has passed.

Due on 2021-03-10, 23:59 IST.

As per our records you have not submitted this assignment.

Problem 1: Short Questions

Please answer the questions below for the following system

$$\frac{dx}{dt} = \begin{bmatrix} -1 & 0 & 1 \\ 0 & -1 & 1 \\ 0 & 0 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

 1) Obtain the eigenvalues of A^c matrix. Hence comment about stability of the system.

0.25 points

- Asymptotically stable
 Marginally stable
 Unstable

No, the answer is incorrect.
Score: 0
Accepted Answers:
Marginally stable

 2) Discretize the above system (either using MATLAB `c2d` command or the method considered in Week-4) with sampling interval of $h=0.2$. Compute the eigenvalues of the resulting A matrix for the discrete system. Please report the eigenvalues in ascending order.

No, the answer is incorrect.
Score: 0
Accepted Answers: (Type: Numeric Array)
 0.8187

 0.8187

 7

0.25 points

 3) From the eigenvalues of A matrix obtained above, please comment about stability of the system.

0.25 points

- Asymptotically stable
 Marginally stable
 Unstable

No, the answer is incorrect.
Score: 0
Accepted Answers:
Marginally stable

4) Comment about the controllability of the system. Use either the Controllable Gramian or Hautus condition for this. Please tick all the options that apply

0.25 points

- System is controllable
 System is uncontrollable
 System is stabilizable
 System is not stabilizable

No, the answer is incorrect.
Score: 0
Accepted Answers:
System is uncontrollable
System is not stabilizable

Problem 2: Stability and System Response

Consider the following discrete-time system

$$x(k+1) = \begin{bmatrix} 0.3 & -0.4 \\ 0.4 & 0.25 \end{bmatrix} x(k) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(k)$$

5) Please comment about stability of the system.

0.25 points

- Asymptotically stable
 Marginally stable
 Unstable

No, the answer is incorrect.
Score: 0
Accepted Answers:
Asymptotically stable

6) Comment about the controllability of the system. Use either the Controllable Gramian or Hautus condition for this. Please tick all the options that apply

0.25 points

- System is controllable and stabilizable
 System is uncontrollable, but stabilizable
 System is neither controllable nor stabilizable

No, the answer is incorrect.
Score: 0
Accepted Answers:
System is controllable and stabilizable

 7) Starting with $x(0)=[1; 1]$, compute $x(1)$ to $x(5)$ for autonomous system (i.e., with $u(k) = 0, \forall k$).

 Please report the value of $x(1)$ obtained.

No, the answer is incorrect.
Score: 0
Accepted Answers: (Type: Numeric Array)
 -0.1

 0.65

0.25 points

 8) Also report the value of $x(5)$ obtained.

No, the answer is incorrect.
Score: 0
Accepted Answers: (Type: Numeric Array)
 0.0283

 -0.0216

0.25 points

Problem 3: Controllability and Observability

Consider the following discrete-time system

$$x_{k+1} = \begin{bmatrix} 0.65 & 0.1 & 0 & -0.45 \\ 0.35 & 0.4 & 0.3 & -0.15 \\ 0 & 0.25 & 0.35 & -0.2 \\ -0.2 & -0.05 & -0.15 & 0.4 \end{bmatrix} x_k + \begin{bmatrix} 0.5 \\ 0.5 \\ 0 \\ 0 \end{bmatrix} u_k$$

$$y_k = \begin{bmatrix} 2 & 0 & 0 & -2 \end{bmatrix} x_k$$

Please answer the following questions.

 9) Please compute the controllability Gramian (i.e., controllability matrix), \mathcal{W}^c . Compute its rank and report it here.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Numeric) 2
0.2 points

 10) Also use the Hautus condition for controllability. Based on Hautus condition and rank of \mathcal{W}^c , please check which of the following are correct about this system.

0.2 points

- System is controllable
 System is uncontrollable
 System is stabilizable
 System is not stabilizable

No, the answer is incorrect.
Score: 0
Accepted Answers:
System is uncontrollable
System is stabilizable

 11) Controllable subspace can be obtained using SVD. Please perform SVD and do a coordinate transformation along the direction given by the U matrix. Which of the following represent controllable subspace?

0.2 points

- $\text{span}\{u_1\}$
 $\text{span}\{u_1, u_2\}$
 $\text{span}\{u_1, u_2, u_3\}$
 Entire \mathcal{R}^4 space
 $\text{span}\{u_4\}$
 $\text{span}\{u_3, u_4\}$
 $\text{span}\{u_2, u_3, u_4\}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
 $\text{span}\{u_1, u_2\}$

 12) Now compute the observability Gramian, \mathcal{W}^o . Compute its rank and report it here.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Numeric) 2
0.2 points

 13) The four eigenvalues of A are 0.0 , 0.3 , 0.5 and 1.0 . Use Hautus condition for observability. Please provide a comma separated list of eigenvalues for which the system loses observability.

 For example, if the system is unobservable at all four eigenvalues (which is not possible), then please report "0.0, 0.3, 0.5, 1.0". (This problem is auto-graded using string comparison. So, please use $x.y$ format for any eigenvalue.)

No, the answer is incorrect.
Score: 0
Accepted Answers:
String containing all of these (AND): /(\.)(?=.\b0.0\b)(?=.\b0.3\b)(.)/i
0.2 points

[Deleted question group]