Problem-1

Q1. Based on the Ac and Bc matrices, is the system stable?

Marginally stable

Please give a brief (~10 words) explanation to justify your answer

Eigen-values of Ac are 0,0,-1. Since some are equal to zero and the rest are less than 0, it is marginally stable.

Q2. Discretize the above system and comment on the stability of the discrete-time state space model.

Marginally stable.

Please give a brief (~10 words) explanation to justify your answer

Eigen-values are 0.8187,1,1. Since absolute value of some are equal to one and the rest are less than 1, it is marginally stable.

Q3. Is the system controllable? Please give a brief explanation.

No not controllable. Because doesn't satisfy Hautus condition.

[A-0.8187*I B] = [0 0 0.1813 0.1813; 0 0.1813 0.2000 0; 0 0 0.1813 0]

Rank = 3 = n =3

[A-1*I B] = [-0.1813 0 0.1813 0.1813; 0 0 0.2000 0; 0 0 0 0]

Rank([A-1*I B]) = 2<n(=3) =>Hautus Condition for controllability not satisfied.

Q4. Is the system stabilizable? Please give a brief explanation.

The system is not stabilizable. For lambda = 1, as stated above, rank of the [A-1*I B] < n. So doesn't satisfy Hautus condition.

Q5. Is the first-order-plus-time-delay SISO system you considered in previous assignment stable?

S = [0 2.51707348104295 4.08658237973633 4.66397243630125 4.87638236764830 4.95452361449152 4.98327017271264 4.99384544048663 4.99773586408557 4.99916707094506 4.99969358252473 4.99988727531043 4.99995853090420 4.99998474437221];

We can see the step response of the system is converging to a value. This means that we can asymptotically take the system to any state by giving appropriate step changes.

This implies, we can say that asymptotically, we can also take the state to origin. Therefore, the system is Asymptotically stable.

Problem-2

Please provide your A matrix (for ease of grading)

For example: If your roll number is CH01B234, then please type: A=[0.3,-0.4;0.4,0.25];

A = [0.2 -0.4; 0 0.25];

Q6. Is the discrete-time system stable?

Asymptotically stable

Q7. Is the discrete-time system controllable?

Not Controllable but Stabilizable

Q. Please provide a brief explanation for Q6 and Q7 (~10 words)

Eigen values of A:0.2,0.25

Eigen values are all less than one. This means the system is asymptotically stable and stabilizable.

[A-0.25I B] = [-0.05 -0.4 1; 0 0 0]

Rank = 1 < n (=2)

[A-0.2I B] = [0 -0.4 1; 0 0.05 0]

Rank = 2 = n

One of the matrices have rank < n. So according to Hautus condition, the system is uncontrollable. However, since both eigen values are less than one, the system is stabilizable.

Q. Please compute the open-loop autonomous response of the system (i.e., with u=0), starting with x0=[1; 1]; and report the value at the end of time-instance k=10.

Since the system is autonomous, we can compute it simply as A^10*x0.

[-0.6708*10^(-5) ; 0.0954*10^(-5)]