# 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)]