ASTU 6402-Nonlinear control system Final Exam June. 24. 2024

1. Consider the system
2. Consider a positive definite function

Prove

in finite time

**Sol:**

Define =

Hence

implies

Since at some finite time

Hence

1. Consider

When design an asymptotic stable controller using sliding surface, .

And show that in ,

**SOL;**

Pick

Let as

Then

Since

which is negative definite. Using this controller, .

so that

which converges asymptotically to the origin. –EnD-

1. When design an asymptotic stable controller using sliding surface,

**Sol**: similar to the previous,

Pick

Let

Then

Hence

Since

implies .

When

1. Passivity
2. Consider a following system

Is this system passive? If not, prove it

**Sol**: Since the origin is not asymptotic stable, hence there are some initial points such that converge to infinity i.e., there are some time interval . Hence there exists an initial points, for any positive semi-definite function

So that if for any positive semi definite function

which implies the system is not passive.

1. Consider a positive real transfer function . Let us define the cascade system . Then check that the cascade system is a positive real transfer function? If not, show an example which is not a positive real transfer function.

**Sol:**

Then which is not passive(In Nyquist plot, ,Phase ( > 90 degree, implies

1. Consider the following cascade system such as driving (state ) and driven system (state )

as

Find a controller to stabilize the cascade system.

**Sol: Refer to the Theorem 9.2**

This system is a cascade serially connected a driving and driven system. First the driven system dynamic is

We may select a radially unbounded PDF as . Then

If we design

Select . Then

which implies the the driving system is passive.

Now the second, the driven system is

which is globally asymp.stable with

In conclusion by Theorem 9.2, with and the cascade system is asymp.stable.

(In the problem, , however, it is not possible to find a stabilizing controller. SORRY~~)

-The EnD-

1. Consider

Design a stabilizing controller using back-stepping method.

Sol:

1. The first backstepping
   1. Dynamic equation

Design to stabilize

* 1. Define a fictitious controller .

which is stabilizing

* 1. Define a fictitious state . Construct a fictitious s.s. model

Select

Then

1. Second back stepping

2.1) the original

From the first back stepping controller define

and

2.2) Define a fictitious model as

2.3) Design a controller

Select . Then

Here

So that

Taking

with

-The End-

1. Consider
2. Using circle criterion, the origin to be absolute stable, find

**Sol:**

* 1. For The transfer function which is a positive real transfer function, i.e., , the system is absolute stable.
  2. For . Since is Hurwitz, Find a circle outside the Nyquist plot, i.e., if pick a sector

,

1. Using passivity, for asymptotic stability at the origin, what condition on

Taking a storage function

Hence

Taking

Since is a positive definite the origin is asymptotic stable.

-The EnD-

1. Using observer, design an output feedback stabilizing controller of the following system.

**Sol**: See the lecture notes or tutorial matlab file.

-The EnD -