% Nonlinear Contro9l System Analysis and Design – Feedback Linearization

9.3 Feedback Linearization

Select m

Ex. 1 The non-linear mass-spring system

Can be written in the form

Then select

Ex.2 Consider

Select

9.4 Partial Linearization

9.5 Backsteeping

**Exercise 9.**

9.3 State linearization / Backstepping

First, it is not possible to use linearization at the origin to design to stabilize the system.

To design a stabilizing controller 1) state linearization and 2) backstepping methods.

1) feedback Linearization

Define . Then

Hence

To place the poles of the linearized system, select poles as -2 and -3, then

The final control is

With this controller, the closed loop system is , and from the definition,

2) Backstepping

1. First the fictitious controller

Select , to stabilize select as

1. Second(backstepping) define a fictitious state as

Using this change the original equation is (this is an another trick to connect the first equation to the second equation)

The first equation is then

The second equation is derived from

Since

The fictitious state dynamic equation is

1. Find a stabilizing controller for the whole system

To stabilize select as , and

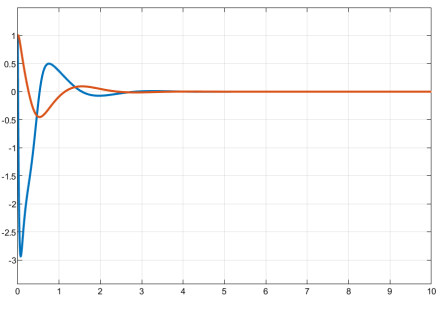
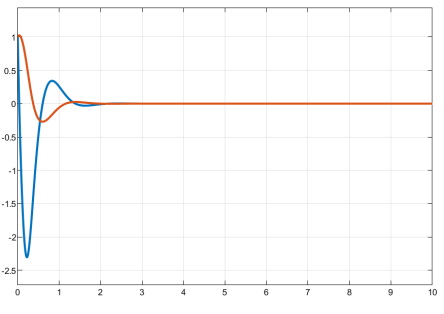
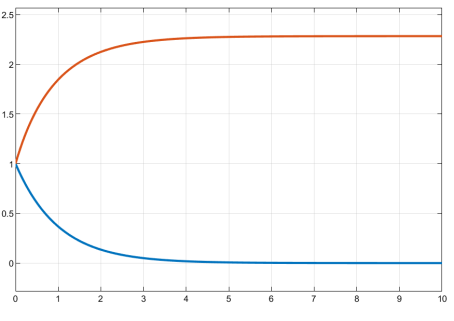
To be negative definite, select as

With this controller, the time derivative is

Here

3) comparison

a) open loop response with

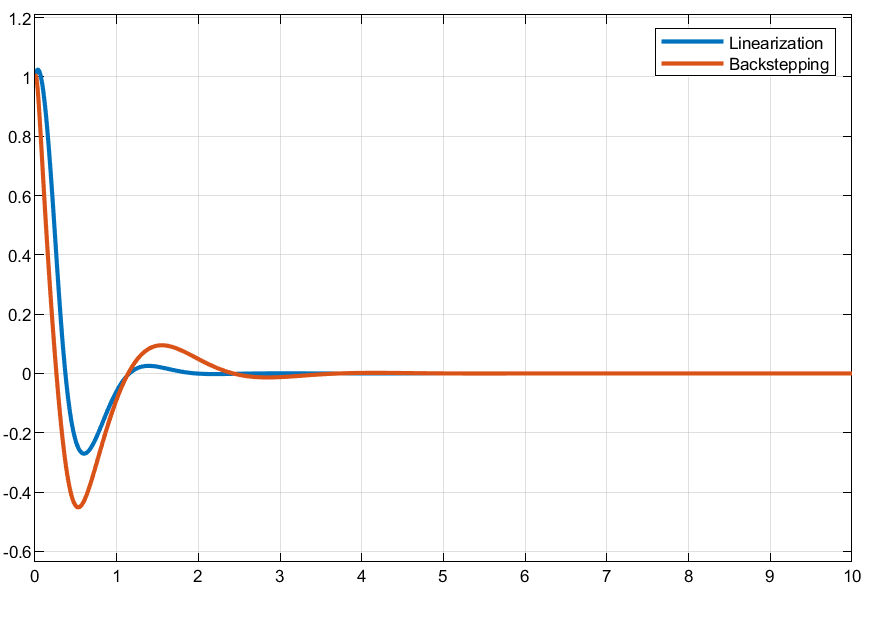


The first : the open loop system output : unstable

The Second: the linearization : stabilized

The third : The backstepping method.

* Compare the output with linear stabilization and backstepping, the overshoot of backstepping is larger than that if state linearization.



%%% Kim’s comment. – Direct state feedback stabilization

Consider the original system

If a lyapunov function is selected as

Then

Even if , so that the closed loop

To find so that is not a positive definite , is difficult.