**CHE507 ADVANCED PROCESS CONTROL**

**FINAL EXAM**

Professor Shi-Shang Jang 1/11/2019

Problem #1 (25%)

Air and water streams are fed into a pressurized tank through two control valves. Air flows out of the top of the tank through a restriction, and water flows out the bottom through another restriction. The linearizied equations describing the system are



where *P*= pressure

*h*= liquid height

*Fa*= air flow rate into tank

*Fw*= water flow rate into tank

Use state variable methods to calculate:

1. The open loop eigenvalues and the open loop transfer function matrix.
2. Calculate the RGA, what is the suitable pairing for two SISO controller?
3. Design a decoupling algorithm for this system.

**Problem #2 (25%)**

Consider the following Internal Model Control Structure (or Model Predictive Control Structure:

GI

Gm

GP

ys

e

d

y

ym

u

+

+

+

-

-

+

Show that:



Based on the above derivation, also show that:

1. Dual stability: *y* and *u* are both stable provided that *Gp=Gm*, *Gp* and *GI* are stable.
2. Perfect Control*: y=ys* provided that *Gp=Gm, Gp=GI-1* and *GI* realizable.
3. Zero offset: *y*(0)*=ys*(0) provided that *Gm*(0)*=GI-1*(0).

**Problem #3 (25%)**

Consider the following process:

1. What is the discrete transfer function of this process with a zero-order-hold (T=1 time unit)?
2. In case of not knowing the exact above transfer function, perform a MATLAB simulation and obtain the following parameters α and β such that:
3. Compare the above results to the discrete transfer function:

**Problem #4 (25%)**

Take Home

(i) Construct a pulse response model for the following process:

with H=30.

(ii) Demonstrate the predicting capability using a random number input to the process and model simultaneously.

(iii) Design a MPC controller and show that the controller works with P=4, B=4.

(iv) Show that MPC controller and show that the controller works with P=4, B=2.