Dept. of Chemical and Biological Engineering *Korea University*

Digital Process Control CHBE507

Mid-Term Exam.

Closed Book Exam. (Submit the problem sheet with your answer sheets.) 2009. 10. 20

1.(30) For the following digital control algorithm has been proposed:

$$p_n=2e_n+1.3e_{n-1}+0.7e_{n-2}-0.8p_{n-1}-0.4p_{n-2}$$

a) Derive the corresponding pulse transfer function $P(z)/E(z)$.

b) Is the controller stable?

c) Suppose that a unit step change in e occurs. What is the steady-state value of p?

2.(30) Determine the inverse transform of $\{z(z+1)\}/\{(z-1)(z^2-z+1)\}$ by the following methods.

a) Partial fraction expansion.

b) Long division.

3.(30) For $HG(z)=(0.2z^{-1}+0.073\,z^{-2})/\,(1-0.503z^{-1}+0.05\,z^{-2})$ with $\Delta t=1$,

a) Design a non-ringing Dahlin controller with $\lambda=\Delta t$.

b) Write down the corresponding difference equation for the controller.

c) Can you say this is a PID controller? (Justify your answer.)

4.(30) For a second-order process with hold, the pulse transfer function is given as follows:

$$HG(z)=\frac{(-0.131-0.124z^{-1})z^{-5}}{(1-0.716z^{-1})(1-0.819z^{-1})}$$

a) Obtain the IMC controller ($\Delta t=1$) with IMC filter $f(z)=1$.

b) A unit step change in load occurs at time $t=10$, with a known load transfer function $G_L(s)=1/(7s+1)$. Find $C(z)$ assuming no modeling error.

5.(30) Draw a standard block diagram for a digital feedback control system showing all components including hold, sampler and etc.