

## Mid-Term Exam.

Closed Book Exam. (Submit the problem sheet with your answer sheets.) 2003. 10. 29

- 1.(10) Answer briefly.
- Compare feedback and feedforward controls.
  - What kinds of flow measurements are available?
  - Why the inherent and installed characteristics for a control valve are different?
  - Roughly draw the Bode plot for first-order transfer function.
- 2.(10) For PID controller,
- Write down the PID controller equation in time domain.
  - How would you suggest to modify this equation to prevent the derivative kick?
  - What are the disadvantages and advantages of I mode?
  - What is bumpless transfer?
- 3.(10) For second-order underdamped process, list the terms for characterization of a step response and explain each characteristic briefly.
- 4.(20) Find  $y(t)$  for the followings.
- $\frac{d^2y}{dt^2} + \frac{dy}{dt} + y = u(t)$  where  $u(t) = \begin{cases} 1 & \text{for } 0 \leq t \leq 1 \\ 0 & \text{for } 0 > t, t > 1 \end{cases}$  ( $y(0) = y'(0) = 0$ )
  - $Y(s) = \frac{1}{[(s+1)^2 + 1](s+2)^2}$
- 5.(20) Linearize the following ODE w.r.t.  $T$ ,  $T_i$ ,  $T_c$  and  $C_A$  around  $T_0$ ,  $T_{i0}$ ,  $T_{c0}$  and  $C_{A0}$ . ( $k = k_0 \exp(-E/RT)$ )
- $$V \rho C_p \frac{dT}{dt} = q \rho C_p (T_i - T) + (-\Delta H) V k C_A + UA(T_c - T)$$
- 6.(40) A drug is ingested into gastrointestinal tract (GIT) and distributed to blood stream (BS), and then it is absorbed by organs. Let  $u$  be the drug ingestion rate [mass/time],  $x_1$  be the amount of drug in GIT [mass],  $x_2$  be the amount of drug in BS [mass]. From the clinical experiments, it is found for a patient that the distribution rate from GIT to BS is  $k_1 x_1$  [mass/time] and the consumption rate by organ from BS is  $k_2 x_2$  [mass/time]. The patient is drug-free initially.
- Construct a model to monitor the drug level in mass in GIT and BS.
  - Find the transfer functions related to drug levels of GIT and BS regarding drug ingestion rate.
  - If the patient ingested a drug tablet of 500mg, calculated the drug levels in GIT and BS with time for the following conditions.  
 $k_1 = 10$  [mg/mg·min],  $k_2 = 5$  [mg/mg·min]