

DEPARTMENT OF CHEMICAL ENGINEERING
MODELING, SIMULATION AND CONTROL
CHL 762 MAJOR TEST
OPEN BOOK TEST

2-5-09
Duration: 2 hr

1. Hot air – steam mixture is flowing at a given inlet temperature, T_{Gf} and inlet partial pressure p_{Af} of water vapor., and inert gas flow G_s kg/m² s. through a bubble column containing fixed quantity of water at a given initial temperature, T_{wi} . It is desired to predict the temperature of water in the bubble column and exit gas temperature and partial pressure of water vapor as a function of time. Assume that a) water in the bubble column is well mixed and gas is in plug flow condition b) the gas holdup is uniform and equal to e_g and cross sectional area of the column and height are given as A sq. m and H m respectively c) Total pressure at gas inlet is P atm. d) heat losses from the column to atmosphere are negligible.. Develop a mathematical model to describe the unsteady state behaviour and give the method of numerical solution.

2. Given the following pulse transfer function model for a first order system incorporating a zero order hold element

$$y(z) = \frac{2.0(1-\phi)z^{-1}}{1-\phi z^{-1}} u(z)$$

Find $y(k)$ for a unit step change input in $u(z)$ for the following values of $\phi = 0.5, -0.5, 1.5$ and 0.8

3. Given $G(s) = \frac{0.9(0.3s-1)}{s(2.5s+1)}$

and $\Delta t = 0.1$, obtain the pulse transfer function model for the sampled process incorporating a zero order hold element.

4. The following is a transfer function model representing the dynamic behaviour of a process:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} \frac{4.05e^{-27\Delta}}{50\Delta+1} & \frac{1.77e^{-28\Delta}}{60\Delta+1} & \frac{5.88e^{-27\Delta}}{50\Delta+1} & \frac{1.44e^{-27\Delta}}{40\Delta+1} \\ \frac{4.38e^{-20\Delta}}{33\Delta+1} & \frac{4.42e^{-22\Delta}}{44\Delta+1} & \frac{7.2}{19\Delta+1} & \frac{1.26}{32\Delta+1} \end{bmatrix} \begin{bmatrix} m_1 \\ m_2 \\ m_3 \\ m_4 \end{bmatrix}$$

Which of these inputs should be paired with the two outputs ?