CHL202 : PROCESS SYSTEMS ANALYSIS AND CONTROL
Minor - 2: 23rd Mar 2014, 14:30 – 15:300 in MS702

1. *Saccharomyces cerevisiae* is being grown aerobically fed-batch process to produce biomass ($x(t)$) for the bakery and food industry. The transfer function (determined approximately) used for the process is $G_P = \dfrac{2}{(s^2+3s+2)}$. The cell mass being measured *in-line* has processing delay and has a transfer function $G_M = 0.3e^{-2s}$. A Proportional-Integral controller is being used to control the process along the desired trajectory $x_{SP}(t)$. Determine the domain of stability of the tuning parameters (K_C, τ_I) this process. The feed valve dynamics can be neglected ($G_V = 1$).

(8 marks)

2. An enzymatic process is being performed in a continuous stirred tank reactor (CSTR). The synthesis of the desired biomolecule can be described approximately by $G_P = \dfrac{3}{(s^2+5s+6)}$ and the measuring device has the following transfer function $G_M = \dfrac{0.5}{s+1}$. If the addition of substrate was being done by a proportional controller, draw a roots locus diagram to show how the stability of the process changes with K_C and hence find the value at the verge of instability.

(7 marks)

3. A certain continuous fermentation process is initially operating at steady state. At an instant of time $t = 0$, the feed flow rate is increased from 1.0 L/h to 4.0 L/h. Because of this step change, the glucose concentration changes as given in the data below. Assuming that the process can be represented by a first order-dead time model, determine the following

   a) the process transfer function
   b) the PI controller setting for a simple feedback control using the Cohen-Coon setting given below

Time (min)	0	1	2.5	3.8	5.5	6	7.3	8.5	9
Glucose Conc. (g/L)	10.0	10.2	10.4	10.65	10.95	11.2	11.3	11.4	11.5

Cohen-Coon Settings:

$$K_C = \frac{1}{K}\frac{\tau}{\theta}\left(\frac{9}{10}+\frac{\theta}{12\tau}\right), \quad \tau_I = \theta\left(\frac{30+3\theta/\tau}{9+20\theta/\tau}\right)$$

where K is the static gain, τ is the time constant for the process, θ is the dead time, K_C is the controller gain and τ_I the integral time constant.

(2+3 marks)