BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester II 2011-2012
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) III year CHEM

Course No : CHE C441
Course Title : PROCESS CONTROL
Date : 12.06.12 Time: 3Hours M.M = 80 (40%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Total No of Pages.2, No of Questions. 8
3. Answer all the questions sequentially

PART A

1A. What is the difference between the servo and regulatory operation?
1B. What is the response of a pure capacitive process for the unit step input?
1C. How to eliminate the derivative and proportional kick in modified PID algorithm.
1D. Why the processes with dead time are difficult to control?
1E. Mention the advantages and disadvantages of Integral controller. [5*2=10M]

PART B

2. Find the total no of variables, total no of equations & the degrees of freedom for the binary distillation column shown in Figure 1. [10M]

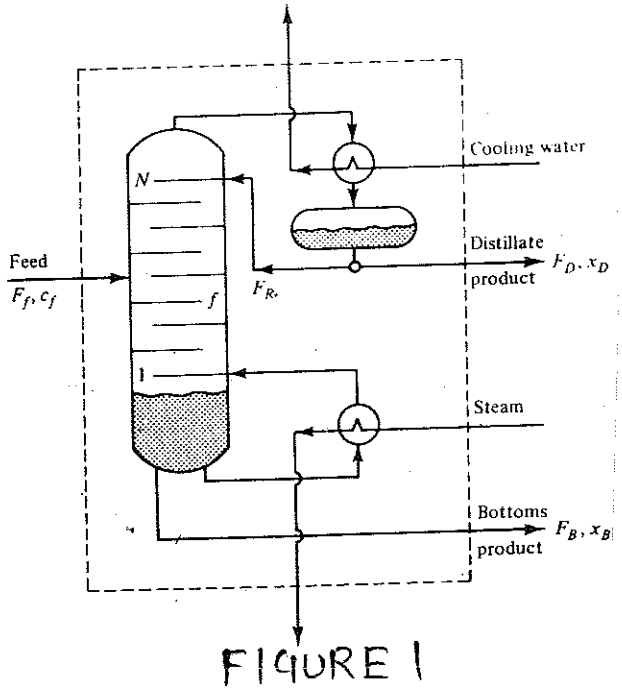

FIGURE 1

3. Consider a process model which has the open loop transfer function with a unity feed back system
$G(s) = \frac{(1+0.2s)(1+0.025s)}{s^3(1+0.005s)(1+0.001s)}$. Sketch the polar plot in graph sheet and determine the phase margin.

(Assume the frequencies as 0.9, 0.95, 1.0, 1.1, 1.2, 1.4, 1.7 rad/sec) [10M]

4. Draw the Bode plot (in the graph sheet) for the open loop transfer function with the following dynamic components:

$$G_p(s) = \frac{50}{s(1+0.2s)(1+0.1s)} \quad ; \quad G_f(s) = 1$$

and determine (1) gain cross over frequency (2) phase cross over frequency.
(Assume Lower frequency = 0.1 rad/ sec; Higher frequency = 20 rad/sec) **[10M]**

5. Draw the root locus of a closed loop system with the following characteristics:

Process: $\mathbf{G_p(s) = \frac{1}{(s+1)(2s+1)}}$.

Controller: $\mathbf{G_c(s) = K_c}$

Measuring Device: $\mathbf{G_m(s) = 1}$

Final control element: $\mathbf{G_f(s) = 1}$

Indicate what segments of the root locus (ie. Values of K_c) yield (a) over damped (b) Critically damped and (c) Under damped closed loop responses. **[10 M]**

6A. Consider a dynamic system described by two state variables x_1 and x_2 and the following state equation.

$$\frac{dx_1}{dt} = f_1(x_1, x_2)$$

$$\frac{dx_2}{dt} = f_2(x_1, x_2)$$

Find the linearized approximation of the non linear state equation in terms of deviation variables. **[5M]**

6B. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{s(1+as)(1+bs)}$

Derive an expression for gain K in terms of **a and b** for the stability of the system. **[5M]**

7. The overall transfer function $G(s) = \frac{K}{s(1+Ts)}$.

(i) By what factor K should be multiplied to increase damping ratio from 0.2 to 0.8

(ii) By what factor K should be multiplied to reduce overshoot from 60% to 20%. **[10 M]**

8A. What is meant by cascade control system? Under what situation we should select the cascade? When the cascade control will be ineffective?

8B. Mention any four major difference between feed forward control and feedback control.

8C. Whether ratio control is a type of feed forward control. Justify your answer. **[4+4+2M]**

ALL THE BEST

BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester II 2011-2012
TEST II / (Open Book)
BE (Hons) III year CHEM

Course No	: CHE C441		
Course Title	: PROCESS CONTROL		
Date	: 13.05.2012	Time: 50 Minutes	M.M = 20 (20%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.

1. Write the balancing equations and state variables for the system shown in Figure 1. All the flow rates are volumetric and the cross sectional areas of the three tanks are A_1, A_2 and A_3 (ft^2) respectively. The flow rate F_5 is constant and doesn't depend on h_3, while all other effluent flow rates are proportional to the corresponding hydrostatic liquid pressures that cause the flow. [3M]

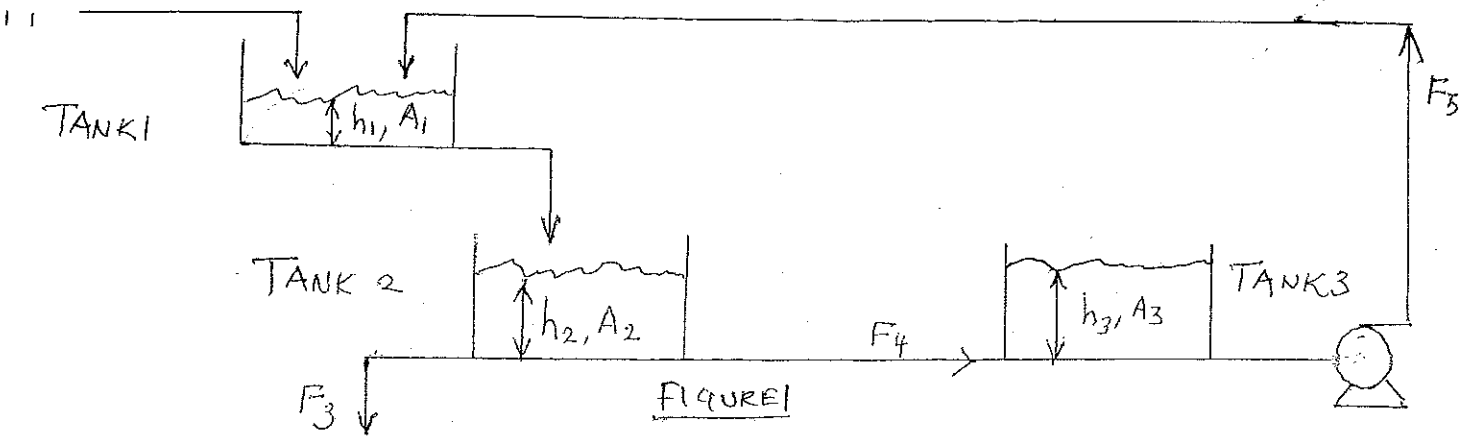

FIGURE1

2. For a system with $G(s) = K_1/ s^2$ and $H(s) = 1+ k_2s$. Find K_1 and k_2 so that the peak overshoot is 0.25 and peak time is 2 secs when step input is applied. [6M]

3. The forward path transfer function of a unity feedback control system is given by $G(s)=\left(100 + \frac{K}{s}\right)\left(\frac{1}{4s^2+2s}\right)$. Determine the range of value of K for which the system will remain stable. [4M]

4. Sketch the root locus for the open loop transfer function of unity feedback system

$$G(s)\,H(s) = \frac{K}{s(s+3)(s^2+2s+2)}$$ [7M]

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester II 2011-2012
TEST I / (Closed Book)
BE (Hons) III year CHEM

Course No : CHE C441
Course Title : PROCESS CONTROL
Date : 22.03.2012 Time: 50 Minutes M.M = 25 (25%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.

1. In Fig.1 the distillation configuration for the separation of benzene from toluene is given. The feed to the distillation comes from the reactor, where toluene has been hydro dealkylated to produce benzene.

Toluene $+H_2$ ..... $\rightarrow$ Benzene $+CH_4$

after the excess H_2 and the produced CH_4 have been removed in a flash unit. For the distillation system,

(a) Identify all the control objectives(make sure that you have included all the operational objectives)
(b) Identify all the external disturbances.
(c) Identify all the available measurements.
(d) Identify all the manipulated variables. [8M]

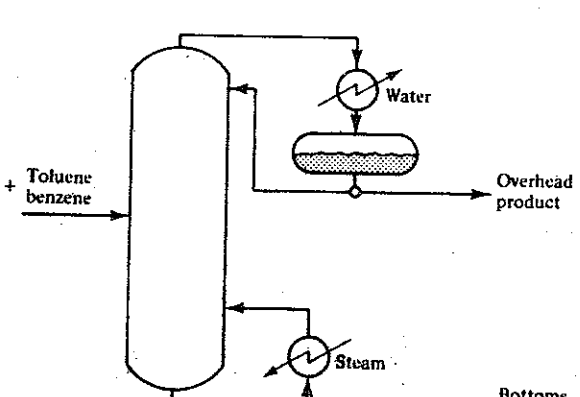

FIGURE 1

2. a. Define differential gap.
b. Draw the responses for step input to P, I, D, PI, PD and PID controllers [2+3M]

PTO

3. a. In Proportional controller, how will you eliminate the offset?
   b. The derivative controller as a single mode, is not recommended for any process. Why?
   c. What is the disadvantage of PID controller?
   d. What is the status of settling time in Preact control and why?
   e. Which controller is used for Temperature control process?
   f. 12 psig process signal equals to ..... in electronic signal. [6M]

4. Derive the state equations and find the degrees of freedom for the stirred tank heater shown in Figure 2. [6M]

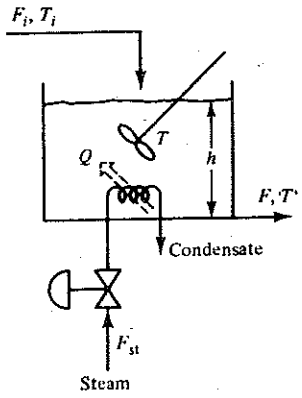

FIGURE 2

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BITS, PILANI – DUBAI
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Semester II 2011-2012
QUIZ I / (Closed Book)
BE (Hons) III year CHEM

Course No : CHE C441
Course Title : PROCESS CONTROL
Date : 06.03.2012 Time: 20 Minutes M.M = 16 (8%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions.

1. What are the control objectives of any process control? [2 M]

2. What are the fundamental quantities used in the process control? [2 M]

3. What is the equilibrium equation in binary distillation column? [2 M]

4. What is the principle of conservation? [2 M]

5. A steam turbine drives a compressor (Fig.1) whose load can change with time. Small variations in the shaft speed of the turbine are controlled through the use of a fly ball speed governor. [8 M]

For this system: (a) Identify all the external disturbances.
(b) Identify all the available manipulated variable.
(c) Determine the basic control objective
(d) Suggest a feedback control system that can be used to satisfy the control objective.

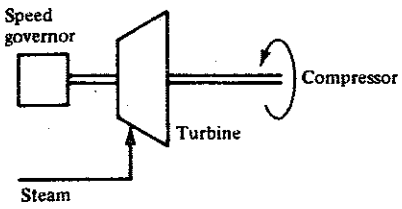

FIG 1

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