BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) IV year EIE

Course No : **INSTR C451**
Course Title : **PROCESS CONTROL**
Date : **06.01.13** **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. What are the three general classes of needs that a control system has to classify? **[5*2=10M]**

PART B

2. Derive the state equations, mathematical model and find the degrees of freedom for the stirred tank heater shown in Figure 1. **[10M]**

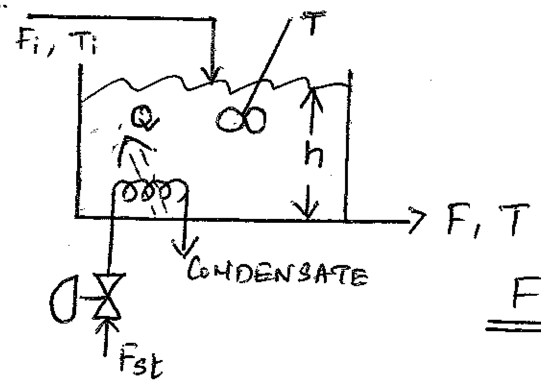

FIGURE1

3. A unity feedback control system has an open loop transfer function given by

$$G(s) = \frac{K e^{-t_d s}}{s(s^2+5s+9)}.$$ Determine the range of K for the stability when

(i) $t_d = 0$ (ii) $t_d = 1$ and $e^{-t_d s}$ is approximated by $1 - t_d s$
(iii) $t_d = 1$ and $e^{-t_d s}$ is approximated by $e^{-t_d s} = \dfrac{1 - \frac{t_d}{2} s}{1 + \frac{t_d}{2} s}$

4. Consider the tanks shown in Figure 2.Find the over all transfer function for a unit step input. **[10M]**

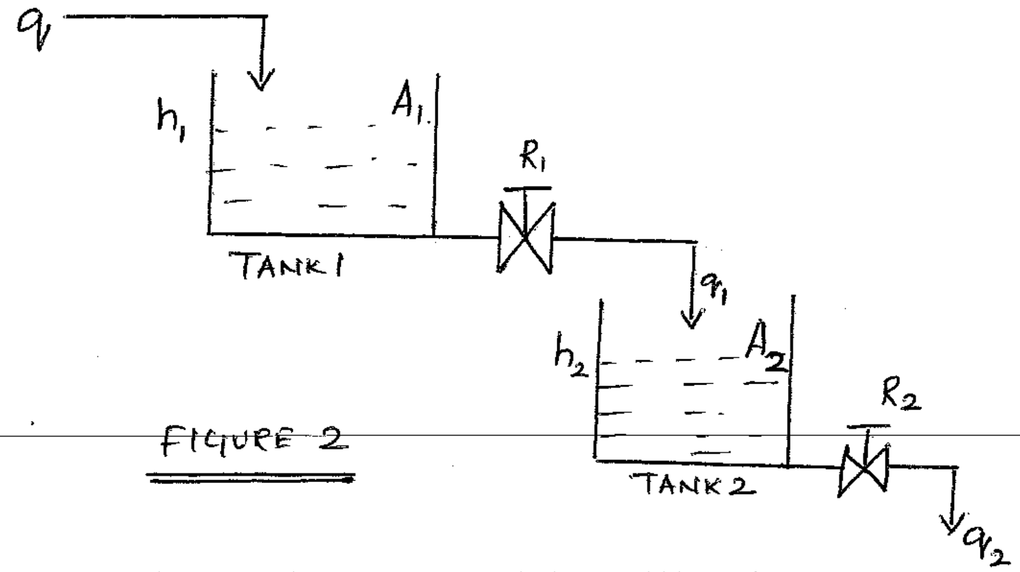

FIGURE 2

5. For a second order system whose open loop transfer function $G(s)= \frac{4}{s(s+2)}$.

Determine the maximum overshoot, the time to reach the maximum overshoot when a step displacement of 18° is given to the system. Find the rise time and the settling time for an error of 6%. What is the time constant of the system? **[10M]**

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

Process: $G_p(s) = \frac{K(s+7)}{(s+2)(s+6)}$.

Final control element: $G_f(s) = 1$ **[10M]**

7. Consider a process model which has the open loop transfer function with a unity feed back system

$G(s) = \frac{K}{s(1+0.2s)(1+0.1s)}$.

Sketch the polar plot in graph sheet and determine the phase margin & gain margin.

(Assume the frequencies as 0.6, 0.8, 1.0, 5.0, & 10 rad/sec) **[10M]**

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

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

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]**

ALL THE BEST

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
TEST II / (Open Book)
BE (Hons) IV year EIE

Course No : **INSTR C451**
Course Title : **PROCESS CONTROL**
Date : **27.11.2012** **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.
3. No of questions 3

1. For the system shown in figure 1, determine the values of gain K and velocity feedback constant K_h, so that the maximum overshoot in the unit step response is 0.2 and the peak time is one second. With these values of K and K_h, obtain the rise time and settling times. Assume that J= 1kg-m^2 and f =1 N-m/rad/sec. **[7M]**

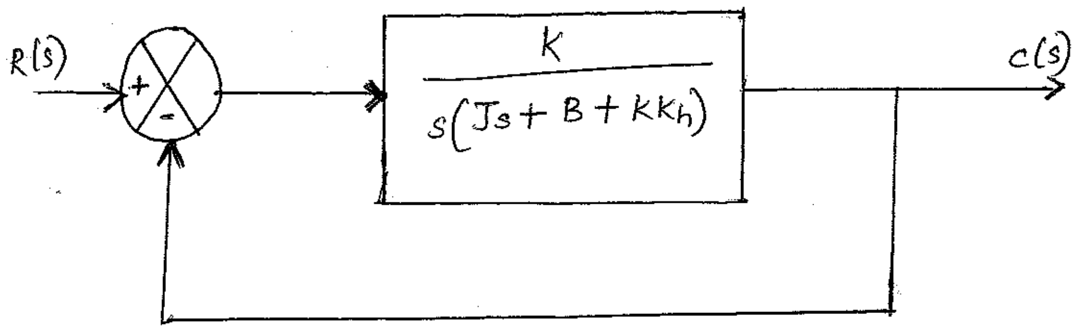

FIGURE 1

2. The open loop transfer function of a unity feedback control system is given by $G(s) = k_c/ (s+2) (s+4) (s^2+6s+25)$.By applying the Routh criterion, discuss the stability of the closed loop system as function of k_c .Determine the value of k_c which will cause sustained oscillation in the closed loop system.? **[3M]**

PTO

3. Consider the two storage tanks in Figure 2. For each of these systems, (a) develop the transfer functions between the liquid levels and the inlet streams (b) determine the time constants and process static gains and (c) determine which of the two system have constant or variable time constant and process gains. Assume that the flow rates of all free effluent streams are linear functions of the corresponding liquid levels.(Flow rates in figure are steady state values.) **[8M]**

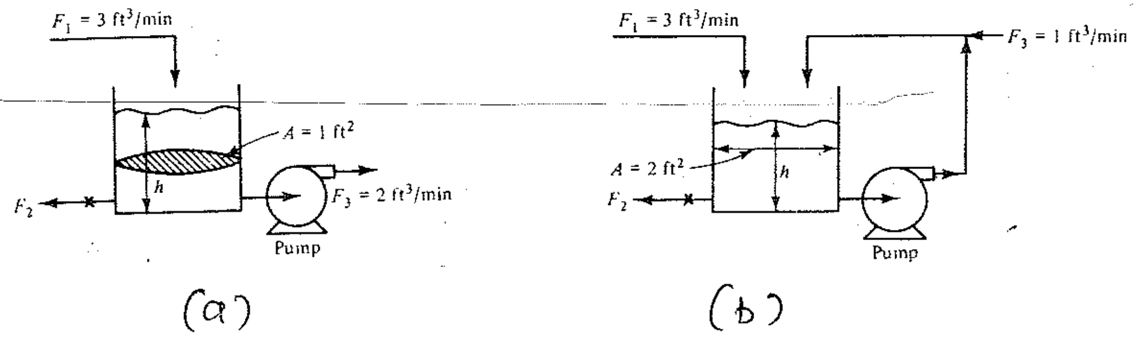

FIGURE 2

4.Find the response of the first order system for unit impulse signal. **[2M]**

ALL THE BEST

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
TEST I / (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 09.10.2012 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. Find the total no of variables, total no of equations & the degrees of freedom for the binary distillation column shown in Figure 1. [8M]

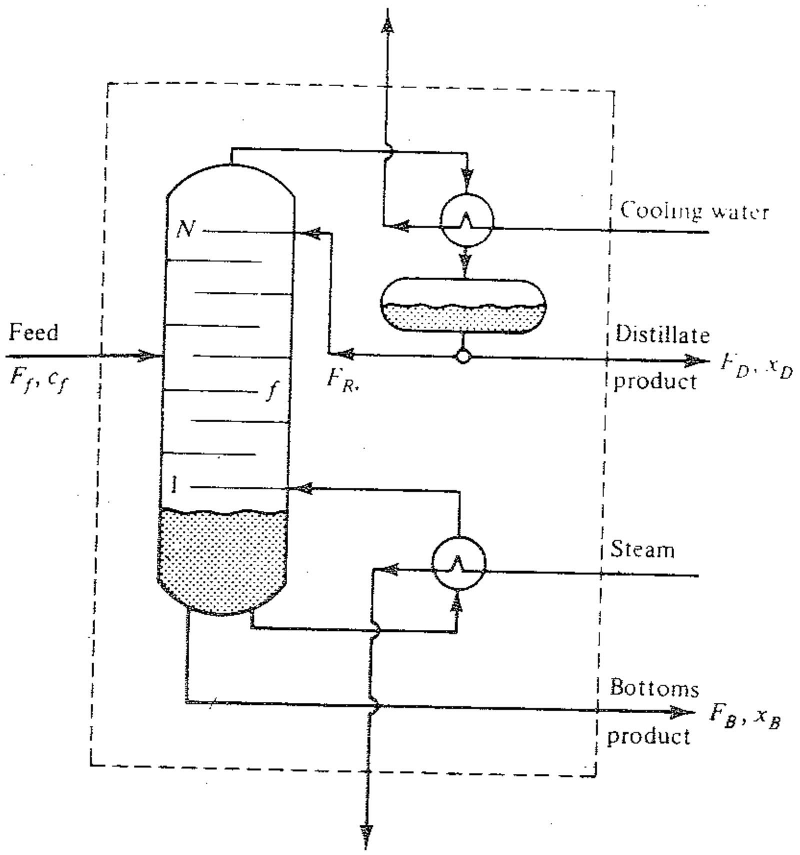

FIG 1. BINARY DISTILLATION COLUMN

2. Consider the heat exchanger shown in figure 2. Identify:
    a. The control objective for this system
    b. All the external disturbances that will affect the operation of the exchanger.
    c. All the available manipulated variables for the control of the exchanger in the presence of disturbances.
    d. Construct two different feedback control configurations that will satisfy the control objective in the presence of disturbance.

[8M]

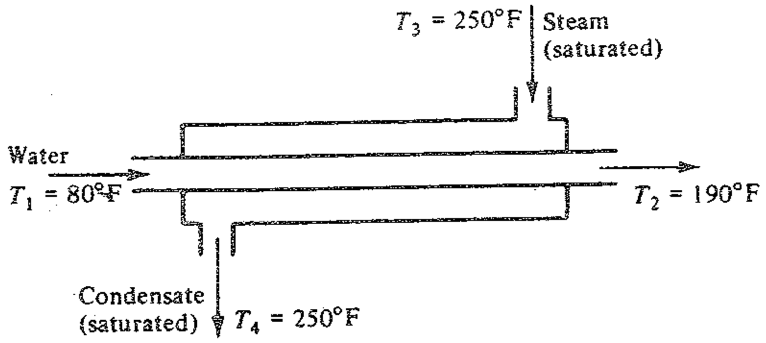

FIG 2. HEAT EXCHANGER

3. Develop the mathematical model for the continuous stirred tank heater shown in figure 3. [9M]

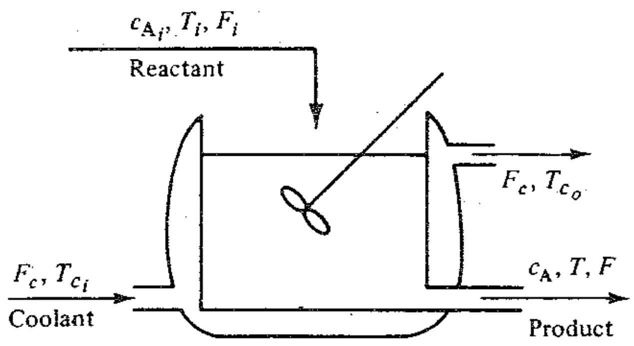

FIG 3. CONTINUOUS STIRRED TANK HEATER

ALL THE BEST

Name: ID No:

BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2012-2013
QUIZ II / (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 20.12.12 Time: 20 Minutes M.M = 7 (7%)

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

Sketch the root locus for a unity feedback system with open loop transfer function

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