BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 09.12.13 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.3, No of Questions. 8
3. Answer all the questions sequentially

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

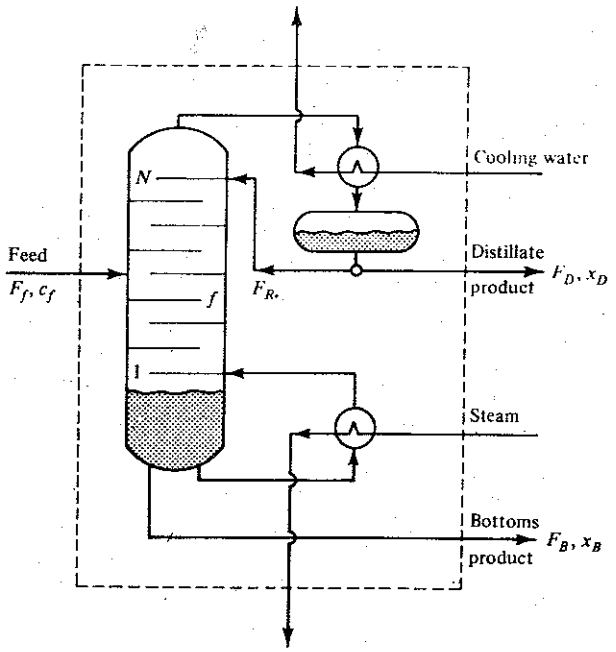

FIGURE 1

2. 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]**

3. 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]**

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

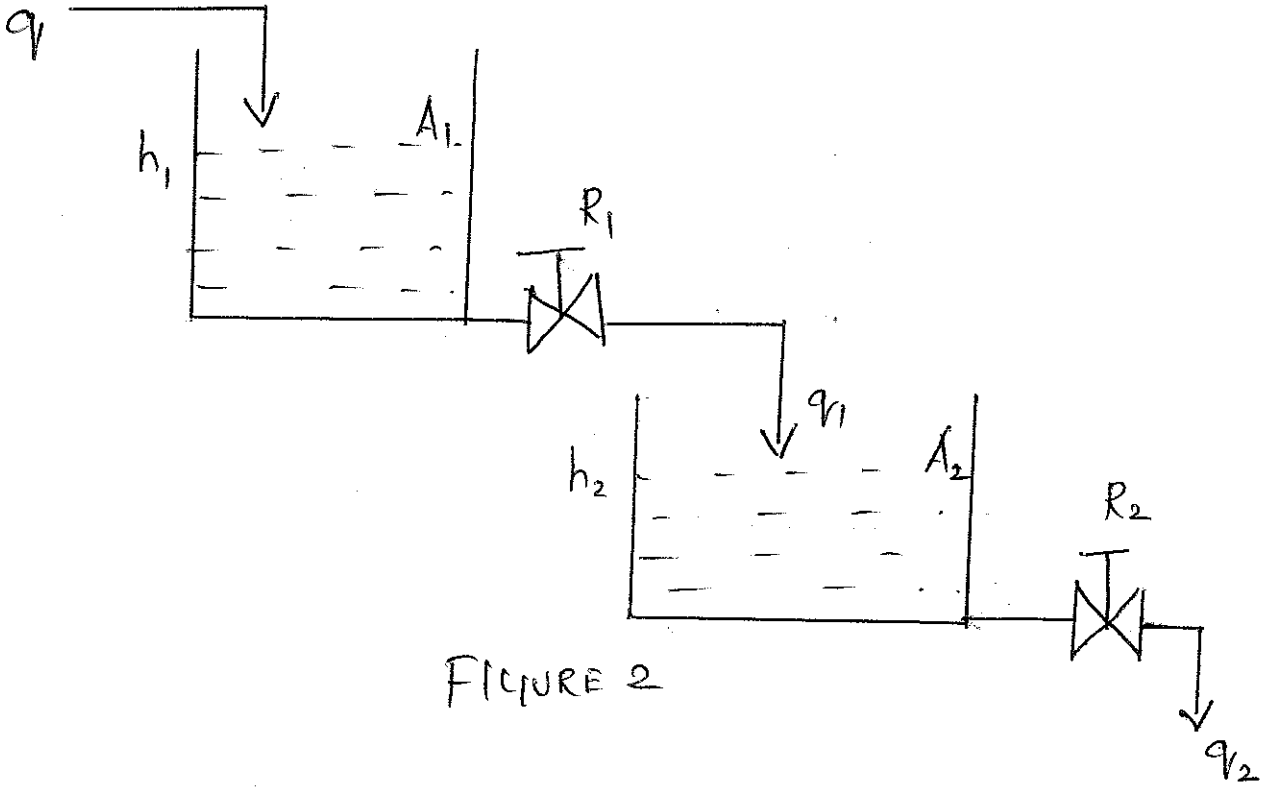

FIGURE 2

5. For the system shown in figure 3, 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. **[10M]**

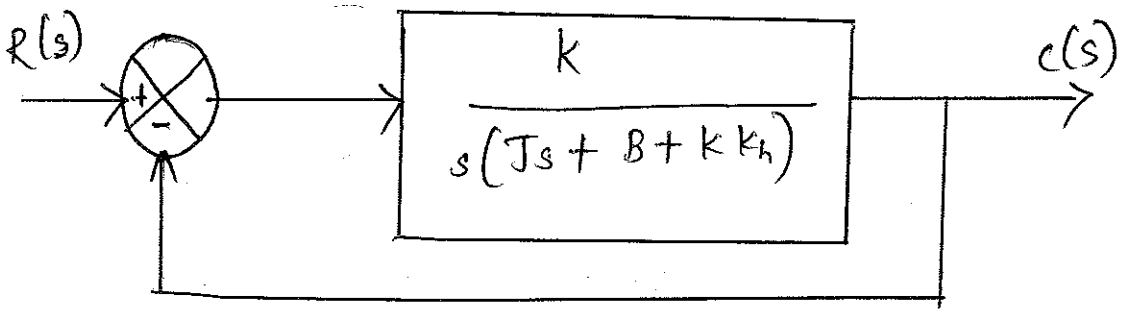

FIGURE 3

6. The forward path transfer function of a unity feedback control system is given by $G(s) = 100 + \frac{K}{s} \quad \frac{1}{4s^2+2s}$. Determine the range of value of K for which the system will remain stable. **[10M]**

7. Develop the mathematical model and find the degree of freedom for the stirred tank heater shown in Figure 4. **[10M]**

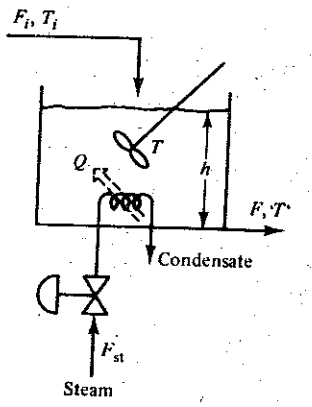

FIGURE 4

8. A. What is the difference between the servo and regulatory operation?
B. What is the response of a pure capacitive process for unit step input?
C. Mention the advantages and disadvantages of integral controller.
D. What are the four graphical elements of ISA S5.1?
E. What do the following terms mean in a P & I diagram- FFRC, TDI

[5*2=10M]

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
TEST II / (Closed Book)
BE (Hons) IV year EIE

Course No : **INSTR C451**
Course Title : **PROCESS CONTROL**
Date : **03.12.13** **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. Sketch the root locus for a unity feedback system with open loop transfer function

$$G(s) = \frac{K}{s\,(s+2)(s^2+2s+2)}$$ [8M]

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.? [4M]

3. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{1}{s\,(1+s)(1+4s)}$

Draw the polar graph (in the graph sheet) and determine (1) Gain margin (2) Phase margin
(Assume the frequencies as 0, 0.2, 0.25, 0.4, 0.6, 0.8, 1.0, 10 rad/sec) [8M]

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
TEST I / (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 30.09.13 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. Consider the air heating system used to regulate the temperature in a house (Fig 1). The heat is supplied from the combustion of fuel oil. [6M]

(a) Identify the control objective.
(b) Identify the available measurements.
(c) Identify the external disturbances.
(d) Is this a SISO system? Justify your answer.
(e) Develop a feed back control configuration to achieve your control objective.
(f) Is feed forward control configuration possible for achieving your control objective? Justify.

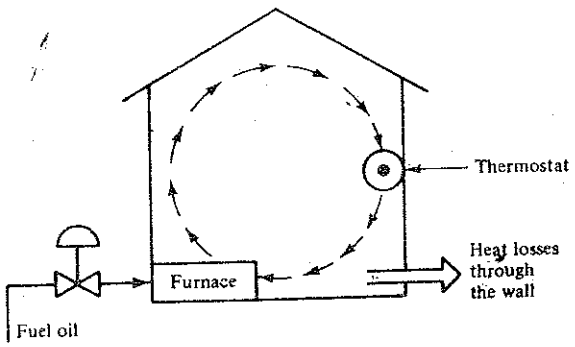

FIGURE 1

2. Consider the tanks shown in Figure 2.Find the over all transfer function. [7M]

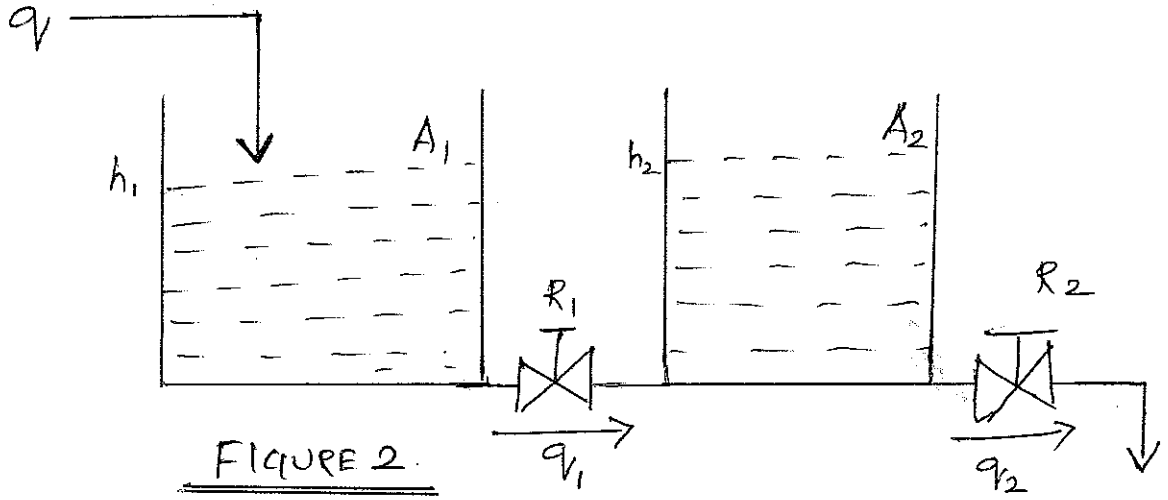

FIGURE 2.

3. Develop the mathematical model for the continuous stirred tank heater shown in figure 3. [7M]

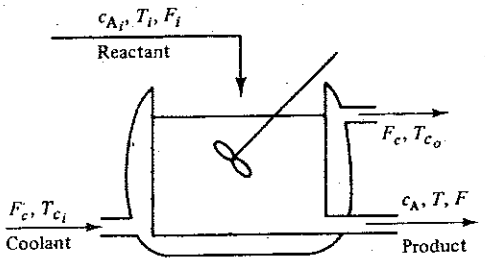

FIGURE 3

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
QUIZ II / (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 31.10.13 Time: 20 Minutes M.M = 10 (10%)

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

1. Mention the second order Pade approximation for exponential term. [1M]

2. Why the processes with dead time are difficult to control? [1M]

3. Inverse response otherwise called as..... [1M]

4. What is the response of a pure capacitive process for the unit ramp input? [1M]

5. Non interacting capacities always results in ..... damped system. [1M]

6. A first order lag process is self regulatory process.....(True/ False) [1M]

7.The smaller the value of the time constant, the steeper the initial response of the system.....(True/ false) [1M]

8. Determine the value of ξ , t_p and ω_n so that the second order system respond to a step input with approximately 5% overshoot and with a settling time of 2 sec for 2% error. [3M]

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
QUIZ I / (Closed Book)
BE (Hons) IV year EIE

Course No : INSTR C451
Course Title : PROCESS CONTROL
Date : 22.10.13 Time: 20 Minutes M.M = 10 (10%)

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

1. Develop the mathematical model for the system shown in Figure 1. What are the state variables for this system and what type of balance equations have you used? 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. [5.5M]

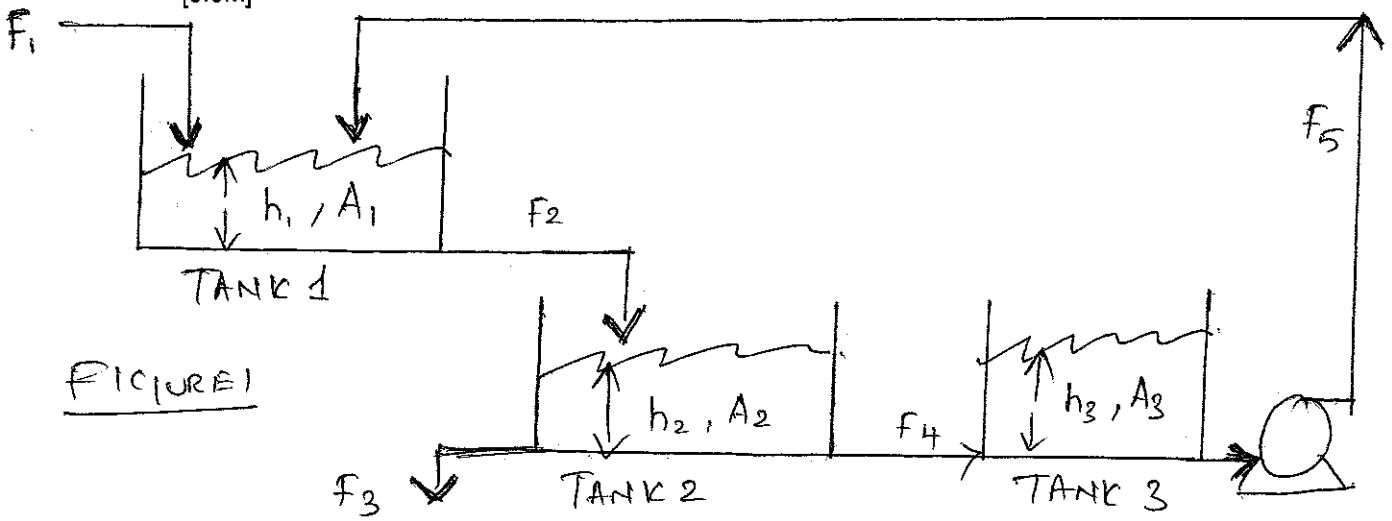

FIGURE 1

2. Two tanks are connected together in the following unusual way as shown in Figure 2. Develop a model for this system that can be used to find h1, h2, w2 and w3 as functions of time for any given variations in inputs. Perform a degree of freedom analysis. Indentify all input and output variable. [4.5M]

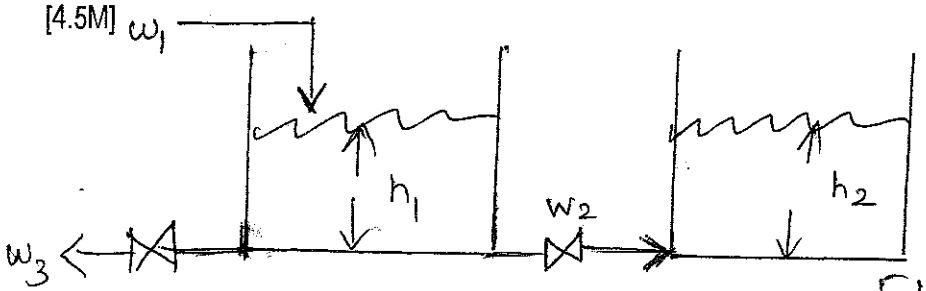

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FIGURE 2