BITS, PILANI – DUBAI CAMPUS
Knowledge Village, Dubai
Year IV – Semester II 2006 – 2007

COMPREHENSIVE EXAMINATION (Closed Book)

Course No : **INSTR UC451**

Course Title : **Process Control**

Date : **27.05.07**

Time : **3 Hours** **Max.Marks** : **40 (40 %)**

NOTE: 1. ***ANSWER ALL QUESTIONS IN SEQUENTIAL ORDER***

2. ***ALL QUESTIONS CARRY 5 MARKS EACH.***

3. ***GET SIGNED IN GRAPH SHEET BY THE INVIGILATOR BEFORE YOU USE.***

(8*5=40 Marks)

1. Find the Degrees of freedom for the binary distillation column shown below (Fig 1.)

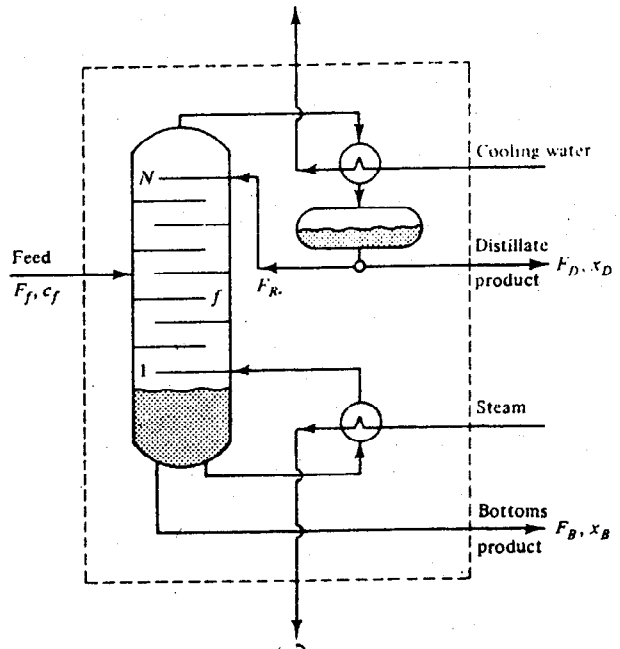


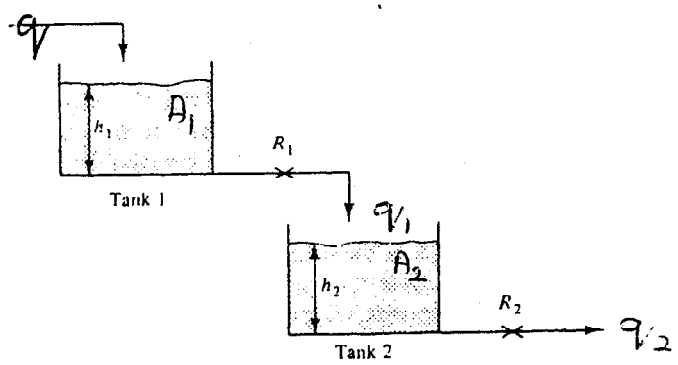
Fig (1)

2. Plot the bode diagram for the following transfer function and obtain the gain cross over frequency.(Assume low frequency as 0.1rad/sec and High frequency as 10 rad/sec)

G(s) = 5(1+2s)/ (1+4s)(1+0.25s)

3. A closed loop servo is represented by the differential equation $d^2c/dt^2 + 8\, dc/dt = 64\, e$, Where c is the displacement of the output shaft, r is the displacement of the input shaft and e = r-c. Determine undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input.

4. Consider the tanks shown in Fig 2. Find the over all transfer function for a unit step input.



Fig(2)

5. Sketch the root locus of the system whose open loop transfer function is $G(s) = K / s(s+2)(s+4)$.

6. The open loop transfer of a unity feedback system is given by

$$G(s) = (1+0.2s)(1+0.025s)/s^3(1+0.005s)(1+0.001s).$$

Sketch the polar plot and determine the phase margin. (Assume the frequency ranges from 0.9 to 1.7)

7. What is adaptive control? When we have to go for adaptive control system?. Explain the types of self adaptive control.

8. The open loop transfer function of a unity feedback control system is given by

$$G(s) = K / (s+2)\,(s+4)\,(s^2+6s+25).$$

By applying the Routh criterion, discuss the stability of the closed loop system as a function of K. Determine the value of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillating frequencies?

ALL THE BEST

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Year IV – Semester II 2006 – 2007

TEST II (OPEN BOOK)

Course No: INSTR UC451

Course Title: Process Control

Date:06.05.07 Time: 50 Minutes M.M = 20(20%)

NOTE: ONLY TEXT BOOK IS ALLOWED

(4*5=20M)

1. Sketch the Bode plot for the following transfer function.

   $$G(s) = K\, e^{-0.2s} / s(s+2)(s+8).$$

   Find K so that the system is stable with

   (a) gain margin equal to 6bd

   (b) Phase margin equal to 45°.

   (Assume low frequency as 0.5rad/sec and high frequency as 50rad/sec)

2. A feedback system has open loop transfer function of $G(s) = K\, e^{-s} / s\,(s^2+5s+9)$. Determine the maximum value of K for stability of closed loop system by applying the Routh criterion method.

3. Sketch the Root locus for the unity feedback system whose open loop transfer function is $G(s) = K / s(s^2+6s+10)$.

4. Find the gain of the proportional controller that produces a closed loop response for second order with decay ratio equal to ¼. The process is described by

   $G_p(s) = 1/(s^2+3s+1)$ and $G_m = G_f = 1$

Name : ID No:

BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai.

Semester II 2006-2007

QUIZ I (Closed Book)

BE (Hons) IV year EIE

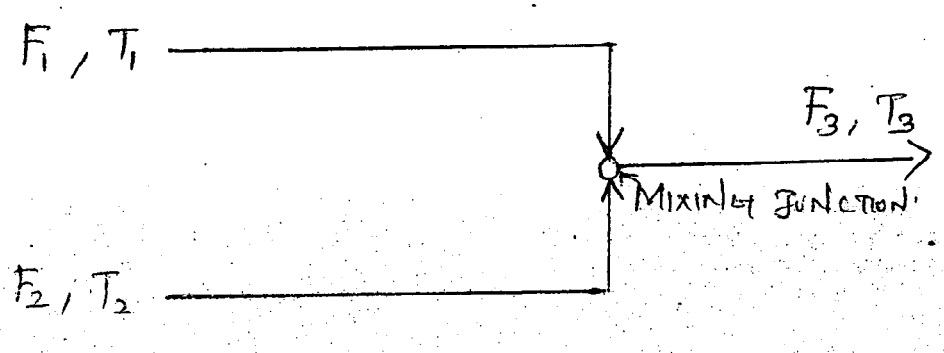
Course No : INSTR UC451
Course Title : PROCESS CONTROL
Date : 22.03.07 Time: 30 Minutes M.M = 20 (10%)

ANSWER ALL THE QUESTIONS

A. A unity feedback system has an open loop transfer function G(s) = 10/s(s+2), for a unit step input of 12 units. Find the following parameters

1. **Percent overshoot.....**
2. **Peak overshoot.....**
3. **Peak time.....**
4. **Settling times.....**
5. **Decay ratio.....**

B. Two liquid streams with flow rates F1 and F2 and temperatures T1 and T2 flow through two separate pipes which coverage at a mixing junction. We want to maintain constant flow arte F3 and the temperature T3 of the liquid stream resulting from the mixing of the first two streams.



Fig(1)

Now , Identify

6. The objectives are.....

7. The manipulation variables are .....

8. Develop a control system that uses only feedback Controllers.....

9. Develop a control system that uses only feed forward controllers.....

10. develop the control systems that use both feed back and feed forward controllers.

C.

11. What are the control objectives of any process control?

12. What do you mean by self regulation?

13. What do you mean by exothermic and Endothermic reaction? Give an example.

14. Give examples for economic considerations.

15. What are the fundamental quantities used in process control.

16. What do you mean by multi capacity process?

17. What is the principle of conservation?

18. What is the equilibrium equation in binary distillation column?

19. Mention the general energy balance equation.

20. What is the transfer function of pure integrator?

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Year IV– Semester II 2006 – 2007

TEST I (Closed Book)

Course No: INSTR UC451

Course Title: Process Control

Date:01.04.07 Time: 50 Minutes M.M = 20(20%)

ANSWER ALL THE QUESTIONS (4*5=20)

1.In the figure 1 shown , 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 ..... 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 objective

b. Identify all external disturbances.

c. All the available measurements and manipulated variables.

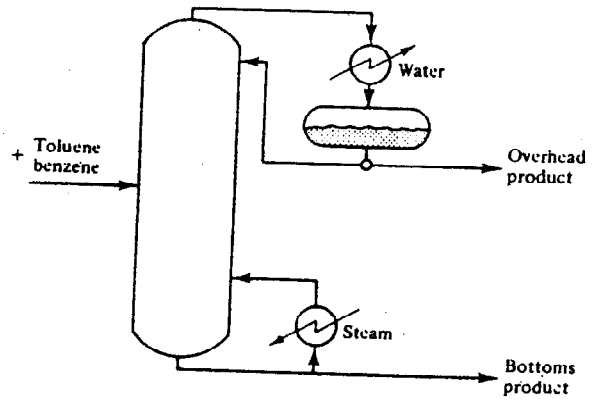

Fig (1)

2. Develop the mathematical model and Find the degrees of freedom for the Stirred tank heater shown in figure 2.

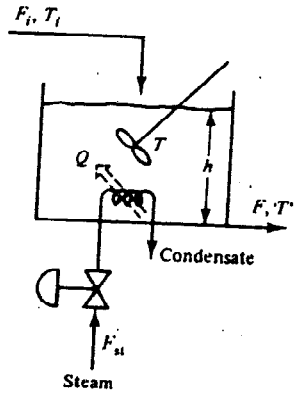

Fig (2)

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

$$dx_1 / dt = f_1(x_1, x_2, m_1, m_2, d_1)$$

$$dx_2 / dt = f_2(x_1, x_2, m_1, m_2, d_2)$$

m_1, m_2 are the manipulated variables and d_1, d_2 are the two disturbances affecting the system. Find the linearized approximation of the non linear state equation in terms of deviation variables.

4. Find the linearized model of the system in terms of deviation variable for the figure 3 shown below. Assume $F_0 = \beta\sqrt{h}$

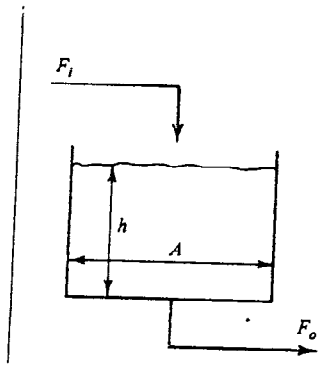

Fig (3)