COMPREHENSIVE EXAMINATION (Closed Book)

Course No	: INSTR UC451
Course Title	: Process Control
Date	: 29.12.05
Time	: 3 Hours

Max.Marks   : 80 (40 %)

NOTE: *ANSWER ALL QUESTIONS FROM PART A & PART B.*

PART - A   (2 x 10 = 20)

I.

1. What are the general classes of needs that a control system has to satisfy?

2. Develop the state equation that will describe the dynamic behavior of bottom tray of Distillation column.

3. For Fig 1, Find the transfer function and conclude which type of process it will be.
   (F_0 is determined by a constant displacement pump)

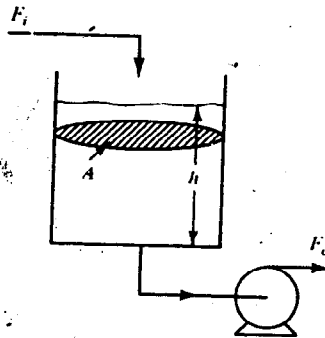Fig.1

4. Non interacting capacities always result in an over damped system or critically damped system and never in an under damped system. Why?

5. What are the types of plugs for pneumatic valves.

6. State whether the Processes with dead time are easy or difficult to control and why?

7. What are the difference between the Feed forward and feedback controllers.

8. Which type of Time Integral criteria is used to suppress errors which persist for long times and why.

9. Find the mathematical model of a process from the block diagram shown in Fig 2. in time domain.

$$G_1(s)$$

$$\bar{T}_i(s) \qquad \frac{1/\tau}{s+a}$$

$$+ \qquad \bar{T}'(s)$$

$$+$$

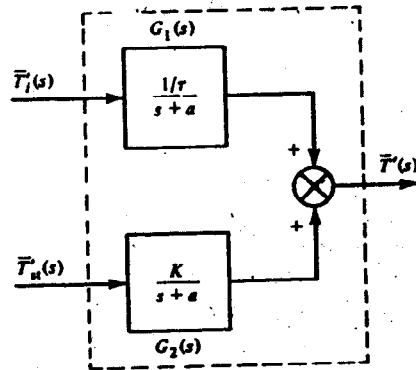$$\bar{T}_{st}(s) \qquad \frac{K}{s+a}$$

$$G_2(s)$$

Fig. 2

10. Which type of a control scheme is a special type of feed forward control? Mention the applications of it.

PART B (ANSWER ALL THE QUESTIONS)   (6*10=60)
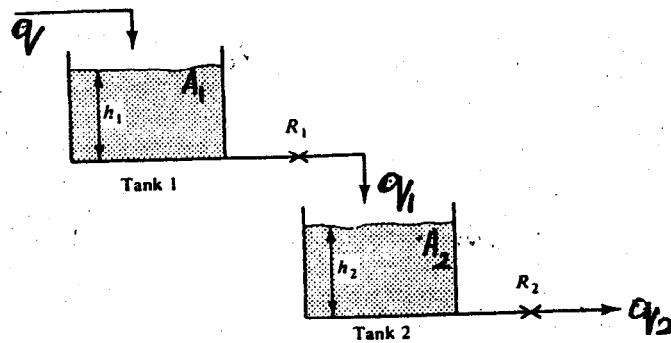
II. Consider the tanks shown in fig. 3 .

q

A_1

h_1

R_1

Tank 1

q_i

A_2

h_2

R_2

Tank 2

q_2

Fig. 3

a. Find the over all transfer function

b. In the over all transfer function apply the step input and find the response.

III. A transient disturbance test is run on a process loop. The results of a 9% controlling variable change give a process –reaction graph as shown in Fig4.

      a. Find the settings for three mode action

      b. Find the three mode settings for a quarter- amplitude response.
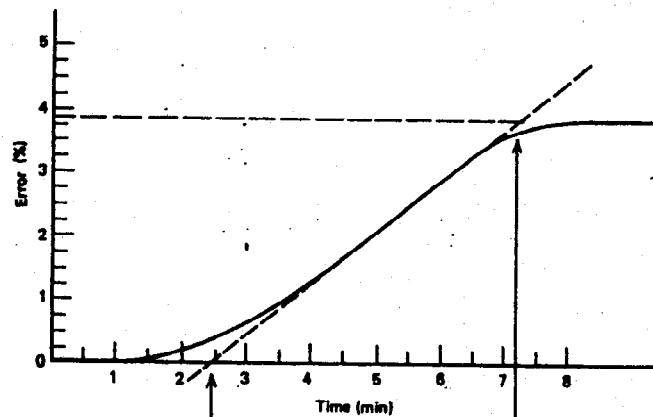

Fig. 4

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

$$G(s) = 1 / s(1+s)^2.$$

    a. Sketch the Nyquist plot

    b. Determine the gain and phase margin

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

VI. a. Discuss the logic of an Inferential Control scheme. Explain with an example.

    b. Explain in detail of the Control system scheme which has more than one manipulated variable

VII. 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?

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Date: 5.12.05   **Time: 50 Minutes**   **M.M = 20(20%)**

NOTE: ONLY TEXT BOOK IS ALLOWED

1 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

$$G_p(s) = 1/ (s^2+3s+1) \text{ and } G_m = G_f = 1$$

(4 Marks)

2. The characteristics polynomial of a system is

$$s^7+ 9s^6 + 24s^5 + 24s^4 + 24s^3 + 24s^2 + 23s + 15 = 0.$$

Determine the location of roots on s-plane and hence the stability of the system using Routh Hurwitz criterion.

(5Marks)

3. Sketch the root locus for the unity feedback system whose open loop transfer function is

$$G(s) = K / s(s^2+6s+10)$$

(6 Marks)

4. Plot the bode diagram for the following transfer function and obtain the gain and phase cross over frequencies.

$$G(s) = 10 / s(1+ 0.4s)(1+0.1s)$$

(5 Marks)

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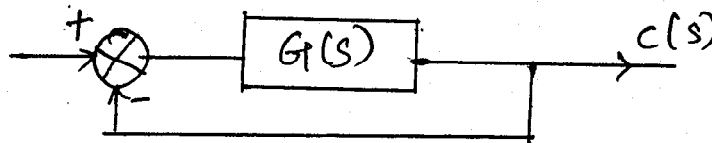
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Date: 26.10.05   Time: 30 Minutes   M.M = 20(10%)

A. The unity feedback system is characterized by an open loop transfer function $G(s) = K / s(s+10)$.

1. Determine the gain K, so that the system will have a damping ratio of 0.5 for this value of K. ....

2. The value of W_n is ....

3. The value of settling time is ....

4. The value of peak overshoot 1s ....

5. The value of time to peak overshoot is ....

B. Say true or False

6. The tank with larger capacity has a larger time constant............

7. Non interacting capacities always results in an ....damped system or an .... Damped system.

8. In order to specify a process completely , the number of degrees of freedom should be greater than zero...................

9. Pure capacitive process otherwise called as linear lag....................

10. The smaller the value of the time constant , the steeper the initial response of the system............

C.

11. What do you mean by multi capacity process?

12.What is the principle of conservation ?

13.What is the Equilibrium equation in binary Distillation column?

14.Mention the general energy balance equation.

15.What is the transfer function of Pure integrator?

D. Two liquid streams with flow rates F1 and F2 and temperatures T1 and T2 flow through two separate pipes which converge at a mixing junction. We want to the maintain constant flow rate F3 and the temperature T3 of the liquid stream resulting from the mixing of the first two streams. Identify
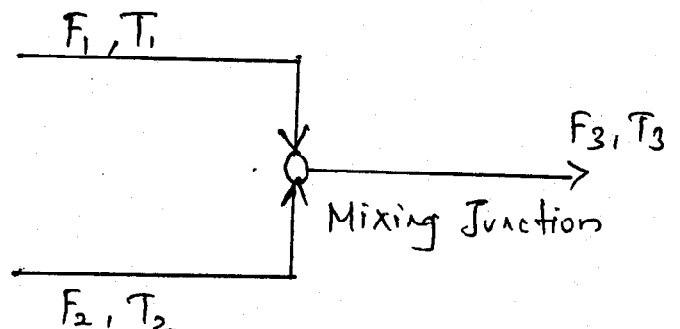
16. The objectives are...

17. The manipulations are...

18.Develop a control system that uses only feedback
controllers...

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

20.Develop the control systems that use both feedback and feed forward controllers

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<u>**Date: 16.10.05**</u>   **Time: 50 Minutes**   <u>**M.M = 20(20%)**</u>

## ANSWER ALL THE QUESTIONS   (4*5=20)

1. Consider the air- heating system used to regulate the temperature in a house. The heat is supplied from the combustion of fuel oil.

   a. Identify the control objective, the available measurements. What are the external disturbances for such a system?

   b. Is this a SISO system?

   c. Develop a feedback control configuration to achieve your control objective.

   d. Is a feed forward control configuration possible for achieving your control objective?How?
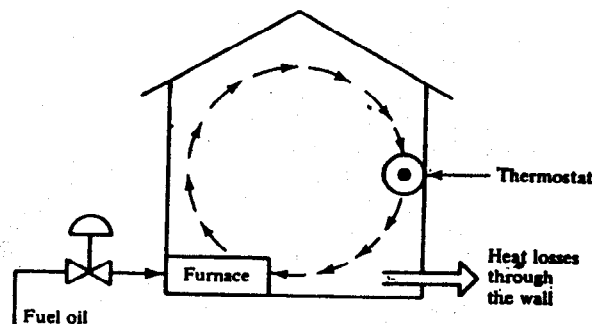
2. Develop the mathematical model and the Input – Output model for the Stirred tank heater shown below.
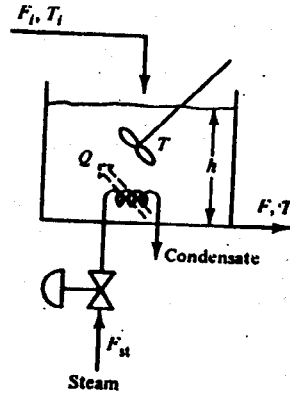
3. Consider a dynamic system described by two state variables x_1 and x_2 and the following state equation.

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

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

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 all the Differential equations for the binary distillation column shown below.