

Process Control System Design  
(AEIE 5201)

Time Allotted : 3 hrs

Full Marks : 70

*Figures out of the right margin indicate full marks.*

***Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.***

***Candidates are required to give answer in their own words as far as practicable.***

Group - A  
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: 10 x1 =10

(i) The z-transform of  $a^k$  is

(a)  $\frac{z}{z-a}$       (b)  $\frac{z}{z-k}$       (c)  $\frac{a}{z-a}$       (d)  $\frac{a}{a-z}$ .

(ii) The closed loop pole of a stable second order system could be

- (a) complex conjugate with positive real parts      (b) both real and negative  
(c) one real positive and the other real negative      (d) both real and positive.

(iii) Flapper nozzle is used in a/an \_\_\_\_\_ controller.

- (a) electronic      (b) pneumatic  
(c) hydraulic      (d) none of these.

(iv) Which of the following controller has the least maximum deviation?

- (a) P-D controller      (b) P-I controller  
(c) P-Controller      (d) P-I-D controller.

(v) A system with a double pole at the origin is unstable since the corresponding term in the time domain

- (a) decays linearly with time      (b) grows exponentially with time  
(c) is a constant      (d) grows linearly with time.

(vi) Which controller is suitable for offset elimination?

- (a) P-D controller      (b) P-I controller  
(c) P-Controller      (d) P-I-D controller.

(vii) Reset rate is the another term used for \_\_\_\_\_ time

- (a) integral      (b) derivative  
(c) dead      (d) delay.

- (viii) Centre of Area is a  
 (a) fuzzification technique (b) defuzzification technique  
 (c) normalization technique (d) all of these.
- (ix) Gain Scheduling is a/an \_\_\_\_\_ control.  
 (a) adaptive (b) cascade  
 (c) batch (d) supervisory.
- (x) Fuzzy logic is a \_\_\_\_\_ valued logic  
 (a) binary (b) multi  
 (c) single (d) binary or multi.

**Group - B**

- 2.(a) What is Process reaction curve? How process parameters can be evaluated from the process reaction curve?  
 (b) Write Sundaresan formula of first moment and express first moment in terms of  $\theta_d$ ,  $T_1$  and  $T_2$  of an overdamped 2<sup>nd</sup> order plus dead time model. [where  $\theta_d$  =dead time,  $T_1$  and  $T_2$  are time constants]

**6+6=12**

- 3.(a) Differentiate between instantaneous process and dead time process with example.  
 (b) The process transfer function of a Third order system is given by:

$$G(s) = \frac{C(s)}{G(s)} = \frac{1}{(s+1)(0.5s+1)(2s+1)}, \text{ where the time constants}$$

are expressed in minutes. The true response of  $C(t)$  to a step change in input  $X(t)$  is shown in the following figure(Fig-A). Approximate this process by a second-order plus dead-time model.

Given that the first moment  $m_1$  is computed to be 3.5mins and the tangent line drawn at the point of inflection of the plot has a slope  $M_i = 0.23\text{min}^{-1}$ , and it intersects  $C(t)=1$  line at  $t_m = 5.1\text{min}$ . Find  $\eta$  from Fig.B.

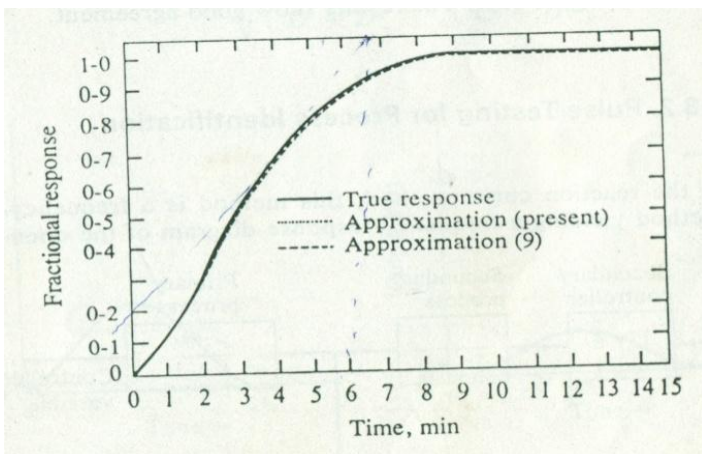


Fig. A

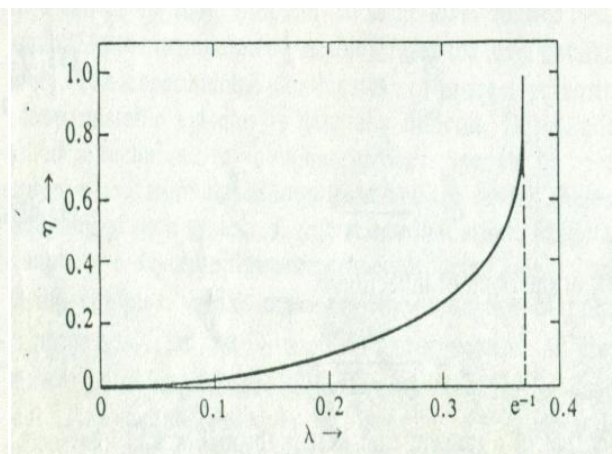
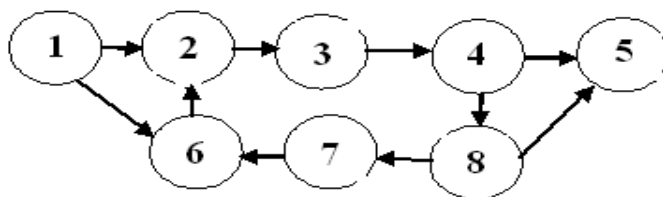


Fig.B

**4+8=12**

Group - C

4.(a)



Write the transition matrix for the above graph.

(b) How reachability matrix is related with digraph?

(c) What is an interconnection matrix?

**6+2+4=12**

5.(a) State the characteristics of a multi-level control system. Why coordination problem is encountered in multilevel control.

(b) Show giving reasons and using block diagram, how steady state coordination problem for the complete system can be formulated.

**4+8=12**

Group - D

6.(a) State the differences between conventional control and adaptive control.

(b) Illustrate Model Reference Adaptive System (MRAS) with block diagram for adjustment of a feed forward gain based on MIT rule.

**4+8=12**

7.(a) Distinguish between probability and possibility theorem.

(b) When we can use a fuzzy controller?

(c) Explain-“Degree of Membership” with suitable example.

**4+2+6=12**

Group - E

8.(a) An oven in open loop generates an output voltage of 1.93 volt for application of 0.84 volt at the input. Find out the system model, if the dead time and time constant of the oven are 270 secs. and 4000 secs. respectively.

(b) Design a scheme for thickness measurement and control of a steel strip.

**4+8=12**

9. Outline the control problem of a thermoset resin plant (**Fig-below**) and show how by using the batch controller of Honeywell TDC3000 distributed control system, the control problem is efficiently tackled.

