PROCESS CONTROL SYSTEM DESIGN
(AEIE 5202)

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 × 1 = 10**

(i) The z-transform of 0.5^k is

(a) $\frac{z}{0.5+z}$ (b) $\frac{z}{z-0.5}$ (c) $\frac{0.5}{z-0.5}$ (d) $\frac{0.5}{z}$.

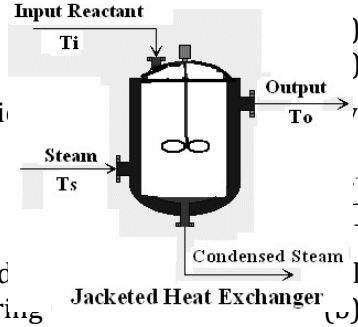
(ii) The order of two non-interacting tanks is
(a) 1 (b) 2 (c) 3 (d) 4.

(iii) The z-transform of $\frac{1}{s+a}$ is

(a) $\frac{z}{z-ae^{-aT}}$ (b) $\frac{z}{z-e^{-aT}}$ (c) $\frac{e^{aT}}{z-a}$ (d) $\frac{az^{-aT}}{z-T}$

(iv) Dual control is a/an _____ control.
(a) adaptive (b) cascade
(c) batch (d) supervisory.

(v) In electrical-pneumatic system analogy the current is considered analogous to
(a) velocity) pressure
(c) air flow) air flow rate.



(vi) The transfer functi ith delay time of 0.1 sec. is represented by
(a) $\frac{K}{0.1s+1}$ $\frac{e^{-0.1s}}{+1}$ (d) $\frac{K\,e^{0.1s}}{0.1s+1}$.

(vii) Parity bits are used l systems.
(a) power monitoring) symmetry generation
(c) diagnostic monitoring (d) error detection.

(viii) Many digital control systems utilize Ethernet as a communications network, because
(a) no terminating resistors are necessary
(b) speed is not affected by traffic
(c) it is a wireless network standard
(d) it is robust and inexpensive.

(ix) SCADA is
(a) real time data acquisition and processing
(b) data storing
(c) data monitoring and control
(d) all of the above.

(x) Fuzzy logic is a _____ valued logic
(a) binary (b) multi
(c) single (d) binary or multi.

Group – B

2. (a) What is process identification? Draw a block diagram to show an approach to identify the order and parameters of a process.

(b) Develop a mathematical model of two interacting tanks. Write down the state and output equations from the model mentioning various associated matrices.
(2 + 3) + (5 + 2) = 12

3. (a) Derive the column dynamics of a distillation column.

(b) A jacketed heat exchanger is heated by steam flow as shown in Fig. Develop a mathematical model of the system for the parameters given below:
Inlet fluid temperature and flow rate: Ti and q.
Outlet temperature and flow rate: To and q.
Steam (Jacket) temperature and Heat transfer area of walls: Ts and F.
Heat transfer coefficient = α, Specific heat capacity: Cp, Inside Volume of heat exchanger = V.

4 + 8 = 12

Group – C

4. (a) What is A SCADA system? What is SCADA network? How does the SCADA handle data? Mention how many generations of SCADA are there.

   (b) With a neat and labelled diagram, explain the SCADA architecture. What are the main differences between distributed control systems and SCADA?

(2 + 2 + 2 + 1) + (3 + 2) = 12

5. (a) What is a Distributed Control System? Mention with brief explanations, the basic elements of a distributed control system.

   (b) Mention the standard protocols of data communication in a control network? Explain with proper diagrams.

(2 + 5) + 5 = 12

Group – D

6. (a) Describe with proper block diagram, the control scheme of a first order process using model reference adaptive controller (MRAC).

   (b) Design an open loop adaptive control scheme for zinc deposition in a Hot-dip galvanizing process.

6 + 6 = 12

7. (a) How influences of process parameter variations are reduced by gain scheduling adaptive scheme?

   (b) Present the MIT rule for a closed loop system.

   (c) "Self-tuning regulator automatically tunes its parameters to obtain the desired performance of the closed loop system." — Justify the statement.

4 + 4 + 4 = 12

Group – E

8. (a) Illustrate a scheme to identify the model of an oven in open loop.

   (b) Draw an outline diagram to explain the temperature control of an electrical oven.

   (c) Design a scheme for flatness measurement and control of a steel strip in a steel plant.

3 + 4 + 5 = 12

9. (a) When you will not prefer a distillation column as a separation unit?

   (b) Derive the column dynamics of a Distillation Column consisting of 10 horizontal bubble cap tray.

   (c) How temperature gradient and pressure difference influence the separation of products in a distillation column?

2 + 4 + 6 = 12