PROCESS CONTROL
(AEIE 3201)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   What is the output of the controller?
         (a) Manipulating variable   (b) Set point variable
         (c) Measured variable   (d) Manipulated variable.

   (ii) The Laplace transfer function of a 4 second transportation lag element is
         (a) $\dfrac{1}{(s+4)}$ (b) e^{4s} (c) e^{-4s} (d) $e^{-4/s}$

   (iii) Which of the following in the reference input is given to the controller?
         (a) Manipulating variable   (b) Set point variable
         (c) Measured variable   (d) Manipulated variable.

   (iv) The transfer function $T(s) = K_c\left(1 + \tau s\right)$ describes which type of controller?
         (a) PI controller   (b) PID controller
         (c) P controller   (d) PD controller.

   (v)   Which of the following control action is used to limit the operation of a process between two values by lower select switch and higher select switch?
         (a) Override control   (b) Auctioneering control
         (c) Adaptive control   (d) Split range control.

   (vi) Ratio control is a special case of
         (a) feedback control   (b) feedforward control
         (c) feedback feedforward control   (d) adaptive control.

(vii) By using the PI control action
(a) offset increases
(b) offset decreases
(c) offset eliminated
(d) offset becomes very high.

(viii) To establish successful control on any process, if the process is of direct action type then the controller must be of
(a) direct action type
(b) reverse action type
(c) any type
(d) none of these.

(ix) In case of cascade control action, the secondary loop as compared to the primary loop is
(a) faster
(b) slower
(c) very fast
(d) very slow.

(x) Flashing occurs if the liquid absolute pressure
(a) falls below vapour pressure
(b) rises above vapour pressure
(c) is equal to vapour pressure
(d) none of these.

Group – B

2. (a) Define Process Resistance and Process Capacitance.

(b) Derive the transfer function for an interacting two-tank system with linear resistance element.

(c) Describe an integrating process with a specific example.

2 + 7 + 3 = 12

3. (a) Draw a PI diagram for a level control system

(b) Explain the operation of an electronic three position controller with necessary circuit diagram.

(c) How the transfer function of a 1st order process will be modified in presence of process lag? Compare the responses for the processes.

3 + 6 + 3 = 12

Group – C

4. (a) Define proportional band. A controller is used to control the pressure in a tank which varies from 40 psi to 140 psi. Controller output is to change by 100% upon 60 psi pressure deviation. Compute proportional gain.

(b) Derive the close loop transfer function for a first order process being controlled by a proportional controller. Hence show that the use of

proportional control makes the system faster and effective gain of the system is decreased.

(2 + 3) + (5 + 2) = 12

5. (a) Show that order of the close loop transfer function remains unchanged when derivative control is added in the control loop. Hence, show that the system becomes slower.

(b) What do you mean by 'derivative kick' and how it can be eliminated?

(c) A PID controller has the transfer function as $2 + \dfrac{0.4}{s}$ with the unit of time expressed in minutes. Calculate the proportional band and reset rate.

(5 + 1) + 3 + 3 = 12

Group – D

6. (a) Explain the operation of I/P converter with the schematic diagram.

(b) Describe flashing and cavitation that may occur in control valves.

(c) Draw and describe quick opening valve characteristic.

5 + 4 + 3 = 12

7. (a) State the importance of a control valve positioner. Explain the operation of the electronic positioner with necessary diagram.

(b) State the advantages and disadvantages of double seated valve over the single seated valve.

(2 + 6) + 4 = 12

Group – E

8. (a) Explain the cascade control scheme used in chemical reactor with necessary schematic diagram. State the advantages of cascade control.

(b) Describe ratio control with suitable example.

(5 + 2) + 5 = 12

9. (a) Explain the operation of an up-down counter with necessary timing diagram. What is the function of watchdog timer?

(b) Draw a PLC ladder diagram to realise the following: when the garage door is opened, a light is switched on. After the garage door is closed, the light remains on for 60 second. Use a pushbutton switch to open the garage door and a stop switch to close the same.

(5 + 2) + 5 = 12