PROCESS CONTROL
(AEIE 3201)
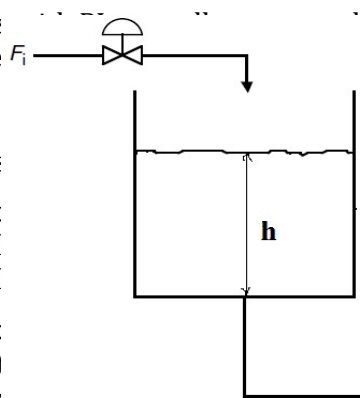
Time Allotted : 3 hrs   **Full Marks : 70**

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) Robotic arm motion is an example of
(a) regulatory control   (b) servo control
(c) feed forward control   (d) adaptive control.

(ii) The time constant of the following process $T(s) = \dfrac{1}{(4s+2)}$ is

(a) 1 sec   (b) 4 sec
(c) 2 sec   (d) ½ sec.

(iii) In order to specify a process completely, the number of degrees of freedom should be
(a) zero   (b) infinity
(c) process specific   (d) none of these.

(iv) For a process
(a) is indepe
(b) decrease
(c) decrease
(d) increase

(v) Integral win
(a) P control
(c) PI contro

(vi) Air-to-close
(a) direct act
(b) reverse a

trolled by
ntroller
ntroller.

(c) direct acting actuator and reverse acting valve body
(d) all of them.

(vii) In case of cascade control action, the secondary loop as compared to the primary loop is
(a) faster   (b) slower
(c) similar in time constant   (d) none of these.

(viii) Flashing occurs in control valve
(a) after cavitations occurs
(b) before cavitations occurs
(c) when liquid absolute pressure is less than its vapour pressure
(d) both (b) & (c).

(ix) In a temperature control system process variable varies from 40⁰C to 120⁰C. What will be the value of controller output for 60⁰C?
(a) 12 mA   (b) 20 mA   (c) 8 mA   (d) 4 m.

(x) The operation sequence of PLC is
(a) output scan, self check, input scan, logic solve, output scan...
(b) self check, output scan, input scan, logic solve, self check...
(c) self check, input scan, logic solve, output scan, self check...
(d) input scan, output scan, self check, logic solve, input scan...

Group – B

2. (a) Draw the block diagram for a regulatory control loop and discuss the same.

(b) Write down the system equation for a liquid level tank shown in the figure below. Assume the outlet valve is a linear resistance element. Hence derive the mathematical model of the system. Analyse the system response for a step change in input.

(c) Describe the integrating process with specific example.
3 + 6 + 3 = 12

3. (a) Draw a PI diagram for the temperature control system.

(b) A unity feedback system is characterized by an open-loop transfer function; $G(s) = \dfrac{K}{s(s+10)}$. the system has a damping ratio of 0.5. Determine the steady state gain and effective time constant of close-loop system.

(c) Explain distance velocity lag.

$$3 + 6 + 3 = 12$$

Group – C

4. (a) Derive the close loop transfer function for the first order process being controlled by integral controller $\left(G_c = \dfrac{K_c}{T_I s} \right)$. Draw the system responses for step change in set point considering two different controller gains $\left(K_c \right)$.

(b) Define proportional band. A controller is used to control the level in a tank which varies from 1 m to 5 m. Controller output is to change by 100% upon 1 m level deviation. Compute proportional gain.

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

5. (a) Write the PID control equation which is free from derivative kick.

(b) Design the pneumatic proportional controller and hence compute the transfer function for the same.

(c) Describe the Ziegler and Nichols close-loop method of controller tuning.

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

Group – D

6. (a) Describe the operation of an air-to-open control valve with a neat sketch.

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

(c) Draw and describe the valve characteristics.

$$5 + 4 + 3 = 12$$

7. (a) Explain the process of Progressive Valve Sequencing. How Progressive Valve Sequencing mechanism can be applied for control of pH of a process.

(b) Define control valve coefficient (C_v). A control valve regulates the liquid flow of a tank. The water level is controlled in the tank at a level of 25 feet by regulating the outflow. The measured inflow varies from 0 to 120 gallons per minute. Calculate C_v for the valve.

$$(3 + 3) + (2 + 4) = 12$$

Group – E

8. (a) Describe how cascade and feed-forward control action is used in 3-element boiler drum level control.

(b) Explain Ratio control.

(c) Describe the block diagram of a MIMO system.

$$6 + 3 + 3 = 12$$

9. (a) Describe the functional block diagram of PLC.

(b) A start pushbutton switch is used to turn on a motor M1. After 10 second motor M2 starts. Stop switch stops M1 and M2. Realize the above operation by PLC ladder diagram.

(c) Describe the operation of up-counter in PLC.

$$4 + 5 + 3 = 12$$