PROCESS CONTROL
(AEI3101)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

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

(ii) The dynamics of a second order system is given by $8\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = 3x$. The time constant for the system is
(a) 8/3 Sec (b) 3/8 Sec
(c) 4 Sec (d) 2 Sec

(iii) A PID controller has the transfer function as $2 + \frac{0.4}{s} + 3s$. The proportional band for the controller is
(a) 200% (b) 100%
(c) 75% (d) 50%

(iv) Integral windup may occur for the process being controlled by
(a) P controller (b) PD controller
(c) PI controller (d) D controller.

(v) In regulatory control mode is the scheme which counters the change in
(a) Set point (b) Disturbance enter in process
(c) Both of these (d) None of these

(vi) For pneumatic control valve, the reverse acting actuator in which
(a) The stem moves up with increasing diaphragm pressure
(b) The stem moves down with increasing diaphragm pressure
(c) The stem moves down with decreasing diaphragm pressure
(d) Any of the above

(vii) Within a control valve, the specific components performing the work of throttling (or completely shutting off) of fluid flow are collectively referred to as the
(a) Valve body (b) Valve trim
(c) Actuator (d) Packing box

(viii) Which of the following is a difference between feedforward and cascade control?
(a) Cascade control uses two controllers
(b) Feedforward uses a disturbance model to determine the feedforward gain
(c) Cascade has an inner control loop to directly reject disturbances
(d) All of the above.

(ix) The primary controller in a cascade control system must always be tuned
(a) Faster than the secondary
(b) With the same parameters as the master
(c) With greater filtering than the secondary
(d) After the secondary is tuned

(x) Which type of PLC memory is used to store the user program permanently?
(a) RAM (b) ROM
(c) EPROM / Flash memory (d) Cache memory.

Fill in the blanks with the correct word

(xi) The unit of process potential for the level system is _____ .

(xii) Control valves configured to follow the command of the same controller are said to be _____ .

(xiii) For a system with N manipulated variables and N controlled variables the number of loop configurations possible is _____ .

(xiv) Integral control action helps in eliminating the _____ error in a control system.

(xv) A control valve with an equal percentage characteristic provides a flow rate that changes _____ with respect to valve travel.

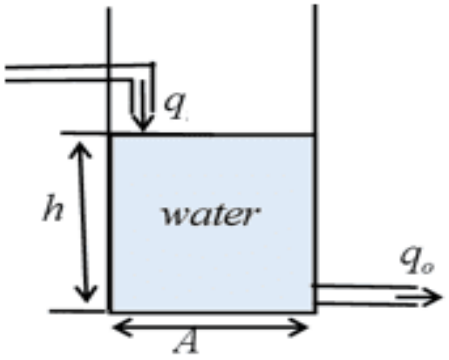
Group - B

2. (a) Outline the position servo control system diagram. *[(CO1)(Understand/LOCQ)]*
(b) State the operation of the position servo control system briefly. What would be the basic requirements of a DC motor to be used as a servo motor? *[(CO1)(Understand/LOCQ)]*
(c) Determine the mathematical model of an armature-controlled DC (servo) motor. *[(CO1)(Evaluate/HOCQ)]*

2 + (2 + 2) + 6 = 12

3. (a) What is feedforward control? How is it different from a feedback control system? *[(CO1)(Understand/LOCQ)]*
(b) Explain the operation of any (level/ pressure/ flow/ temperature) automatic feedback control system step by step with a proper diagram. *[(CO1)(Understand/LOCQ)]*

(c) Compute the system output q_0 as a function of $(q-q_0)$, height (h), and time (t) and develop the block diagram of the given level system to satisfy the derived function.



[(CO1)(Apply/IOCQ)]

(2 + 2) + 4 + (2 + 2) = 12

Group - C

4. (a) Why is step change in set-point not inevitable for a process controlled with PID or PD controller? How can such constraint be tolerated? *[(CO5)(Analyse/IOCQ)]*

(b) Design an electronic PD controller and compute the proportional gain and derivative time. *[(CO3)(Create/HOCQ)]*

(c) Draw the block diagram of a close loop control system with controller transfer function $G_c=K_c$ and process transfer function $G_p=K_p/(sT_p+1)$ and the disturbance transfer function $G_d=K_d/(sT_p+1)$. Assume transfer function for final control element and measuring element are unity. Find the overall close loop gain and time constant. Compute the offset error if any for servo control system.

[(CO2)(Understand/LOCQ),(Analyse/IOCQ)]

(2 + 2) + 3 + (1 + 4) = 12

5. (a) Draw a block diagram of a digital control system and explain each block.

[(CO3)(Understand/LOCQ)]

(b) What do you mean by process reaction curve? How can the process reaction curve be used to estimate the controller's tuning parameters? *[(CO3)(Apply/IOCQ)]*

(c) Draw block diagram for a self-tuning regulator. *[(CO3)(Understand/LOCQ)]*

4 + (1 + 4) + 3 = 12

Group - D

6. (a) Describe flashing that may occur in control valves. *[(CO4) (Remember/LOCQ)]*

(b) Explain exclusive valve sequencing scheme with suitable diagram.

[(CO5) (Understand/LOCQ)]

(c) Design a current to pressure converter and describe its operation.

[(CO4) (Create/HOCQ)]

4 + 4 + 4 = 12

7. (a) How is installed valve characteristic deviates from inherent valve characteristic? Suggest the strategy to overcome the above problem. *[(CO4) (Analyse/IOCQ)]*

(b) Why the stem of the port-guided valve may be made smaller in diameter than if the valve trim were stem-guided? *[(CO4)(Remember/LOCQ)]*

(c) What do you mean by fail safe mode of pneumatic valve? Explain how air to open pneumatic valve may be constructed combining direct/reverse type actuators with direct/reverse type valve bodies. *[(CO4)(Apply/IOCQ)]*

(d) What do you mean by control valve trim? *[(CO2)(Remember/LOCQ)]*

(2 + 1) + 2 + (2 + 4) + 1 = 12

Group - E

8. (a) Define ratio control. *[(CO5)(Remember/LOCQ)]*

(b) Which multivariable controller is suitable for Ammonia production? Apply the suggested control scheme and describe the production scheme with a proper control diagram. *[(CO5)(Apply/IOCQ)]*

(c) How is relation control different from ration control? *[(CO5)(Understand/LOCQ)]*

(d) Explain swelling of boiler drum level in 3-element drum level control. *[(CO5)(Understand/LOCQ)]*

2 + (1 + 5) + 2 + 2 = 12

9. (a) Describe the functional block diagram of the PLC input module. *[(CO6) (Remember/LOCQ)]*

(b) Create a PLC ladder logic diagram for sequential motor control using start and stop push buttons for the following sequence. The start push button activates motor-1, followed by motor-2 after 5 seconds. Motor-3 starts 10 seconds after motor-2 starts. The stop button disables all motors. *[(CO6) (Apply/IOCQ)]*

(c) Analyse the operation of an Up Counter in a PLC using the timing diagram. *[(CO6) (Analyse/LOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	48.95	37.5	13.54