PROCESS CONTROL
(AEIE 3101)

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

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> 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)   Find the time constant of the following process $T(s) = \frac{1}{4s+2}$
    (a) 1 Sec   (b) 4 Sec   (c) 2 Sec   (d) ½ Sec

    (ii)   Washing machine is an example of
    (a) close loop control system   (b) open loop control system
    (c) servo control system   (d) regulatory control system.

    (iii)   The transfer function $G_c(s) = K_c \left(\frac{1+2s}{s}\right)$ describe which type of controller?
    (a) PID   (b) P   (c) PI   (d) PD.

    (iv)   Presence of derivative control in a process
    (a) reduce the noise   (b) enhance noise
    (c) not sensitive to noise   (d) accumulate the noise.

    (v)   The proportional gain of a PID controller can be expressed in terms of its proportional band (PB) as
    (a) PB   (b) 100/PB   (c) PB×100   (d) PB/100

    (vi)   Air-to-close control valve has
    (a) Reverse acting actuator and direct acting valve body
    (b) Direct acting actuator and direct acting valve body
    (c) Direct acting actuator and reverse acting valve body
    (d) All of them.

    (vii)   A 3 to 15 PSI pneumatic pressure signal applied to the input of a pneumatic relay will result in an
    (a) Identical output signal (3 to 15 PSI), but with greatly enhanced flow capacity
    (b) Identical output signal (3 to 15 PSI), but with greatly reduced flow capacity
    (c) Identical output signal (3 to 15 PSI), with same flow capacity
   (d) Increased output signal, with same flow capacity.

(viii) Ratio control is a special case of
(a) Feedback control (b) Feed-forward control
(c) Feedback feed-forward control (d) Adaptive control

(ix) PLC operation sequence are
(a) Self check, Input scan, output scan, logic solve
(b) Self check, logic solve, output scan, Input scan
(c) Self check, output scan, Input scan, logic solve
(d) Self check, Input scan, logic solve, output scan.

(x) Cascade control is characterized by
(a) One controller providing a set point for another controller
(b) The presence of a "lead/lag" relay or function block
(c) The presence of a "dead time" relay or function block
(d) Two controllers whose outputs are selected either by high or low value.

Fill in the blanks with the correct word

(xi) The unit of capacity for the thermal system is _____.

(xii) The _____ valve characteristic shows that the flow rate is directly proportional to the valve travel.

(xiii) If proportional band for the proportional controller increases, then offset error will _____.

(xiv) In cascade control, as a rule of thumb, the dominant time constant in the slave loop is _____ of the dominant time constant in the master loop.

(xv) Status of output Q of _____ timer in PLC changed from low to high after a pre-set time is elapsed.

Group - B

2. (a) Demonstrate potential value, process resistance, and process capacity with example. Write the units of potential value, process resistance, and process capacity for a level control system. *[(CO1)(Understand/LOCQ)]*
   (b) Illustrate the process reaction curve with example. *[(CO1)(Understand/LOCQ)]*
   (c) Determine the transfer function of the given two non-interacting level tanks. The output flow rates of tank1 and tank2 are m and n respectively.
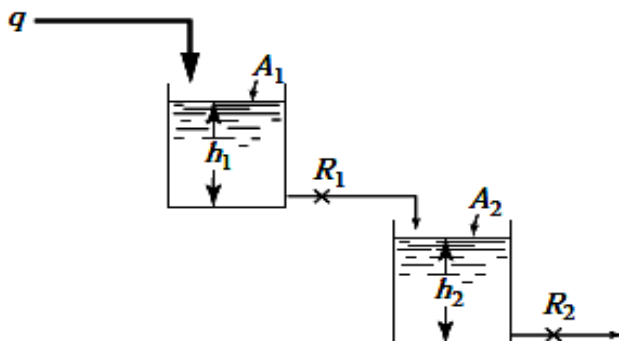
[(CO1)(Evaluate/HOCQ)]
(4.5 + 1.5) + 2 + 4 = 12

3. (a) Name two real-time examples of process control. *[(CO1)(Remember/LOCQ)]*
   (b) Distinguish between open loop and closed loop control systems and explain the operation of any manual feedback closed loop control system with a diagram. *[(CO1)(Understand/LOCQ)]*
   (c) What are the different process characteristics? Explain the self-regulation of a process with an example. *[(CO1)(Understand/LOCQ)]*

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

Group - C

4. (a) Why does a direct action type process must be controlled with a reverse action type controller to attain the control objective? *[(CO2)(Analyse/IOCQ)]*
   (b) Define proportional band. How is offset varied with the variation of proportional band? *[(CO5)(Understand/LOCQ)]*
   (c) Explain Ziegler-Nichol's continuous oscillation method of controller tuning and write down the tuning parameters. *[(CO3)(Understand/LOCQ)]*

$$4 + 3 + 5 = 12$$

5. (a) Describe operation of a two-step controller with necessary schematic diagram. State the disadvantages of such controller. *[(CO2)(Understand/LOCQ)]*
   (b) Define offset error. State two different way to reduce offset error. *[(CO2)(Remember/LOCQ)]*
   (c) Consider a process with transfer function $G(s) = 10/(s-1)$. Is the process is stable or not and explain why. Show how a proportional controller can be used to stabilise the process. Determine the proportional gain for which the controlled process is stable. *[(CO2)(Analyse/IOCQ)]*

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

Group - D

6. (a) A pH control process in which the incoming liquid has a constant high pH and must be neutralized with acid. Suggest and describe the appropriate valve sequencing for the aforementioned event. Create a P&I diagram of the control scheme that will be used to solve the stated problem. *[(CO5)(Apply/IOCQ),(Evaluate/HOCQ)]*
   (b) Describe operation of a volume booster with necessary schematic diagram. *[(CO4)(Understand/LOCQ)]*
   (c) Describe how flashing can occur in control valves. *[(CO4)(Understand/LOCQ)]*

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

7. (a) Which type of control valve one should select for the process where a small percentage of the total pressure drop is permitted by the valve? Draw the characteristics of the valve selected and explain the same. *[(CO4)(Apply/IOCQ)]*
   (b) Describe cavitation that may occur in control valves. *[(CO4)(Remember/LOCQ)]*
   (c) Explain working of a pneumatic relay with schematic diagram. *[(CO5)(Understand/LOCQ)]*

$$4 + 3 + 5 = 12$$

Group - E

8. (a) Define cascade control. Which control loop is faster in cascade control?

   [(CO5)(Remember/LOCQ)]

   (b) Explain the surge protection scheme for a compressor using relation control with a suitable schematic diagram. *[(CO5)(Apply/IOCQ)]*

   (c) Develop a process control scheme to control both the level and temperature of a liquid tank simultaneously. *[(CO2)(Apply/IOCQ)]*

   (2 + 1) + 5 + 4 = 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	62.51	33.33	4.16