53 (IE 712) CCPR

2019

COMPUTER CONTROL OF PROCESSES

Paper : IE 712

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Draw the block diagram of a digital control system and explain the functions of different components. 10

   (b) Explain Tustin's method for signal discretization. 10

2. *(a)* Draw the block diagram of a Direct Digital Control (DDC) system and explain its operation. 10

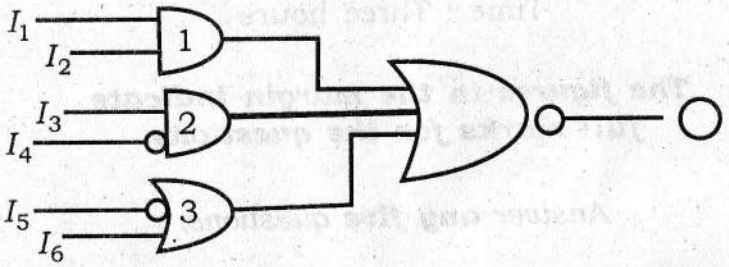
Contd.

(b) Explain, with a schematic diagram, the operation of Supervisory Control and Data Acquisition System (SCADA). 10

3. (a) Draw the block diagram of a PLC and explain the function of each block. 5

(b) Explain the operation of an ON Timer. 5

(c) Convert the following logic gate to PLC ladder diagram (I–Input and O–Output) : 3



(d) A temperature control system consists of four thermostats. The system operates three healing units. Thermostats are set at 55°*F*, 60°*F*, 65°*F* and 70°*F*. Below 55°*F*, three heaters are to be ON. A temperature between 55°*F* and 60°*F* causes two heaters to be ON. For 60°*F* to 65°*F*, one heater is to be ON. Above 70°*F*, there is a safety shut-off for all three heaters in case

one stays on by mistake. A master switch turns the system ON and OFF. Write a Program using PLC ladder diagram. 7

4. (a) Explain Jury's stability test. 14

(b) The characteristic equation for a system is given by—

$$P(z) = z^4 - 1{\cdot}2z^3 + 0{\cdot}07z^2 + 0{\cdot}3z - 0{\cdot}08 = 0$$

Test whether the given system is stable or not. 6

5. (a) Given that $H(s) = \dfrac{1}{(2s+1)(4s+1)}$ with a sample time of 0·25 sec. Determine $H(z)$ (express in standard form) and then find $H(\omega)$ using bilinear transformation technique. 12

(b) Derive the position and velocity algorithm forms for PI controller using forward rectangular rule for integration term. 8

6. *(a)* Derive the difference equation of $u(k)$ *vs* $e(k)$ for PID Controller using trapezoidal rule for integration term. Find the change in output at third sample for the following data :
$k_p = 2{\cdot}5$, $T = 0{\cdot}4$ sec, reset time = 2 sec^{-1}, derivative time = 6 sec, $e_1 = 1$, $e_2 = 2$ and $e_3 = 3$. 7

(b) Using the *Z*-transformation, find $X(z)$ when

$$x(k) = \left(\frac{1}{9}\right)^k \text{ for } k = 0,\ 1,\ 2,\ 3\ldots \quad 6$$

(c) Solve the difference equation : 7

$$x(k+2) - 3x(k+1) + 2x(k) = u(k)$$

Given that $x(k) = 0$ for $k \le 0$, $u(0) = 1$ and $u(k) = 0$ for $k \neq 0$.

7. *(a)* Derive the generalized equation of a controller for a digital control system. Using this equation, derive Dahlin's Controller algorithm. 10

(b) The open-loop transfer function of a process is given by $G(s) = \frac{e^{-2s}}{10s+1}$. Design a Dahlin's digital controller for the system to achieve a closed-loop time constant of 5 *sec.* Assume that the sampling time, $T = 1$ *sec.* 10

8. Write short notes on ***any two*** of the following : 10×2=20

(a) Stability of discrete data system

(b) Distributed Control System

(c) Pole-zero mapping technique

(d) Realization of half-adder circuit using PLC ladder diagram.
